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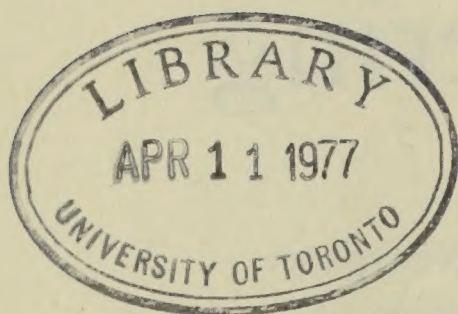
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Optimistic Outlook in The Chemical Industries

IN EXTENDING to the friends of CHEMICAL & METALLURGICAL ENGINEERING a cordial holiday greeting and sincere wish for a happy and prosperous New Year, the editors are not lightly repeating a perfunctory salutation. On the contrary, we are fully mindful of the serious industrial and economic problems which must be happily solved if our wish is to be consummated before Nineteen Hundred and Twenty-One slips away. With the year that has gone we need have little concern except to profit by its lessons. In many respects it was disappointing. It had a skyrocket career; and while a skyrocket in flight is an interesting spectacle until after it bursts in radiant splendor at the zenith, there is always the dull and uninteresting but inevitable accompaniment—the descent of the stick.

But it is with neither the rise of the rocket nor the descent of the stick that we salute our friends. Rather do we wish to greet them at the opening of the year with a note of optimism and confidence which we ourselves feel and which we have found in a remarkable degree pervading the chemical industries. Being somewhat curious as to the mental attitude of manufacturers in the chemical and allied industries under the industrial depression which has prevailed for some time, and wishing to discover at first hand what plans they were making for the future, when they expected a revival of business and how they felt about our chemical industries as a whole, we resorted to the useful questionnaire. The replies have been gratifying. If we had been suffering from depressed spirits, we would have been revived by the expressions of optimism and confidence in the future voiced by our correspondents. Seventy-five per cent of them were distinctly optimistic, and the balance noncommittal. The current industrial depression has been felt by only 60 per cent, although some who have not yet felt it admit the possibility of a slight lull early this year. It is noteworthy, however, that two-thirds of our friends have neither reduced their forces nor curtailed their outputs. In many instances they are running on accumulated orders which will require from two to four months for completion, thus tiding them over any temporary lull in business which may occur between now and spring. Such labor as is being dispensed with is mainly the unskilled variety, because manufacturers of engineering and technical equipment and apparatus realize the value of the skilled artisan and are preserving their organizations. As a consequence we may conclude that unemployment is not widespread in these industries. In some cases forces are being reduced in order to weed out the inefficient, and the beneficent influence of this process has already been observed in the attitude of the employee toward his job.

Speculation has been rife as to the time when we might look for normal resumption of business. Economists, industrial leaders, business men and the average citizen have all made their guesses. The matter is not altogether one of psychology, because time is required for the physical accomplishment of certain things. Curiously enough, the impression seems to be almost universal that late spring or early summer should witness the transition from depression to activity. This opinion is concurred in by our correspondents.

As to the factors which will influence a speedy return to normal conditions, there is remarkable unanimity of opinion that tariff legislation is of primary and vital importance. There is a marked tendency to place confidence in the lawmakers at Washington, as well as to impose upon them the necessity for hard work and exercise of brain power. Not a few are of the opinion that Congress must listen more and more to technical advisers. The feeling that a tariff on dyes, chemicals and apparatus is essential arises largely from the fact that many of these industries have a direct relation to national welfare. In the case of dyes particularly, the fact that other nations have already protected their domestic industry only adds to the necessity of prompt action here.

Next to tariff protection, improvement in methods of taxation is mentioned as a factor in the return to normal business conditions. Next, in the opinion of our friends, is the matter of foreign exchange. Those who have commodities for export find it difficult, if not impossible, to do business at current rates, while those who are manufacturing in competition with foreign countries feel that the United States will become a dumping ground for cheap imports as long as the inequality in exchange exists. A hopeful note is sounded in one instance by a correspondent who sees the buying power of the dollar increased as domestic prices fall so that it will more nearly equal its value in foreign markets. It is noteworthy that few referred to the necessity of reducing wages as a prerequisite to business prosperity. Evidently manufacturers are not concerned so much with what a man earns as what return he gives for his wage.

Not infrequently during the past few years the fundamental soundness of our chemical industry has been the subject of question and discussion. Consequently we were particularly anxious to get the opinion of manufacturers on this point. The gist of the matter as contained in replies to our questionnaire is that in general the chemical and allied industries are on a sound basis, both financially and technically. This is particularly true with the organizations having large resources in men and money, though it is recognized that some of the smaller organizations which have been overcapitalized and poorly manned are not likely to weather the

distress of this period of readjustment. This curious but fatal combination prevails: Poor technology is observed in those organizations which have not the financial means to withstand the present strain. As a consequence they will fall under severe competitive conditions. If the service which they performed during the war is still needed it will be supplied by the larger organizations, whereas if their product is relatively unimportant, small in quantity and low in value, it may not be manufactured here at all. In any event it is the general impression that American chemical industry will hold most of the advanced positions gained during the war, although tariff protection is considered necessary in some instances.

All of this bears directly upon the ability with which we can meet foreign competition and establish ourselves in a position of independence. It is quite evident that industrial independence can usually be achieved if the people are willing to pay the price. Already there is evidence of the fact that competition with German and other European products is actively threatening the existence of some of the industries which during the war we came to regard as vitally necessary to our national welfare. As an example we may cite a widely used scientific instrument for which domestic manufacturers are charging about seven times as much as the cost of an imported article of equal grade. With such a discrepancy of price there is but one inevitable result, because buyers will look first at the price. The general feeling, however, as reflected in the replies to our questionnaire, is that the United States has thoroughly established its independence in those chemical industries which are characterized by large-scale production. On the contrary, it is not felt that the manufacture of many specialties has been perfected to a sufficiently high degree to meet foreign competition. Of course, a basic factor in the whole matter is the difference in cost of labor at home and abroad which cannot be materially altered by technology or good business methods.

Scattered here and there throughout our correspondence we find a few points mentioned only incidentally which we believe worthy of further emphasis. It is quite evident that those manufacturers who serve a diversity of consumers are in a strategic position when a period of depression comes. This can be accomplished in two ways: Either by manufacturing a variety of products for different industries or, more fortunately, producing some one thing that is useful in a number of industries. In either case the demand for the products may also have a seasonal nature which will distribute business uniformly throughout the year.

One of the most hopeful aspects of business in the chemical and allied industries is the money-saving and waste-eliminating character of the service, equipment or process offered by manufacturers and engineers. This is responsible for more than a few of our correspondents stating that inquiry for their product is more brisk than for some time past and that the prospect for closing contracts is unusually good. In other words, those who are prepared to put our industries on a scientific basis find their services in demand in direct proportion with the necessity for reducing costs, saving wastes, or increasing output.

Considering all conditions, we may conclude that what is now needful is business courage and respect for fundamental economic principles. Time will be required for the operation of economic laws, and some

distress will follow as a consequence; but if we look at business over a five-year instead of a one-year period, we may find current losses more than counterbalanced by earlier gains. Attempts to forestall by artificial means the inevitable readjustment now going on, or failure to understand the reason for it, or stubborn refusal to yield to it will only delay the revival of business. Psychologic as well as economic forces are at work. The latter are outside the scope of our influence, but to the former we want to add our note of courage, confidence and optimism, supported in tangible form by the judgment and testimony of leaders in the chemical and allied industries. By giving a little thought even a short period of adversity can be turned to useful purposes.

A Noteworthy Year

In the Steel Market

THE steel trade is one that has a habit of breaking precedents and records. The changes occurring in the market have been likened to the view obtained in a kaleidoscope. It is not the changes that occurred in the steel market during 1920 that constitute the most noteworthy thing about the year, but the character of the market itself, with its flight of prices on the part of the independents and the even line maintained by the Steel Corporation. No steel manufacturer would have predicted what occurred, and none perhaps would have admitted the possibility of such a thing occurring. A few might have admitted the possibility, at the same time asserting that the actual event was so improbable as not to be worth considering.

It was at the end of 1919 that the independent steel makers as a whole were primed for a substantial advance in steel prices. Some had advanced their prices, but the appearance was that of charging premiums for early delivery and merely refraining from selling for later delivery at base prices. It was expected that the Steel Corporation would advance its prices, and when the corporation did not take the initiative it was thought that at any rate it would follow the independents on the up track. To many independents if not the majority the remarkable thing seemed to be, not that the independent market advanced, but that the Steel Corporation did not make advances.

It was not a case, however, of the independents abandoning an established philosophy, of holding prices steady. No similar conditions had obtained in the past. There was a new state of affairs in connection with which there were no precedents. It was the Industrial Board prices of March 21, 1919, to which the Steel Corporation adhered, and when those prices, representing the second reduction from the war control prices, were announced it was a common feeling among buyers of steel, and among not a few sellers, that the prices were on the whole too high. They were, as a matter of fact, shaded in the April and May following, and when eventually steel makers found that instead of its being necessary to let the whole market go down there was to be an opportunity to obtain higher prices for a time, it seemed natural enough to go while the going was good, or "make hay while the sun shines." There was a scarcity of steel, resulting from the iron and steel strike being followed closely by the bituminous coal strike, a temporary situation likely to be followed eventually by a collapse. There seemed to be no hope either of holding prices down at the time or of holding them up afterward.

One of the great difficulties of the situation was the lack of integration among some of the independents. Some steel producers must buy their pig iron, and many pig iron producers must buy their coke. The coke producer sought such profits as were obtainable, particularly when his coal had a very high market value, the amount of coal converted into merchant coke being scarcely more than the proverbial drop in the bucket when compared with the size of the coal trade as a whole. The merchant furnaceman sells more pig iron to foundries than to steel makers and could not be expected to hold down the price of steel-making pig iron. Some steel makers had to have high prices in order to meet their costs, and they could obtain the prices. Why should others not?

Profits were made, but production costs naturally rose, and a readjustment is already in progress. Costs cannot be reduced to the pre-war level, but various excrescences can be lopped off, and many have been already. Costs will now have to be regulated by selling prices, when formerly they were allowed to go where they would.

Making Plant Troubles

Pay Dividends

THE Cottrell precipitator for recovery of fume forms the classic example of making profits from what were previously regarded as wastes or public nuisances. Many industries have used this means of dust or fume recovery to their financial advantage as well as for the improvement of their reputation among their neighbors. Fire and explosion prevention has generally been regarded as a necessary but costly problem with which the chemical plant must deal. However, new methods for elimination of fire and dust or vapor explosions give promise of being profitable, as well as effective for their primary purpose. This is possible through the use of inert gas methods for control of combustible vapors and dusts.

One large industrial plant which had numerous fires and a few small explosions caused by mixtures of air with the vapor of the solvent used is affording a striking example of the advantage of this work. This company installed equipment for making an inert gas mixture—carbon dioxide and nitrogen as the purified product of fuel combustion being the gas employed. This inert mixture carries off the vapor from the process, the solvent is absorbed from the gas by an oil-scrubbing process similar to that used for recovery of toluene from city gas, and the solvent is thus recovered. The result is safe and uninterrupted operation at very low cost and even this small cost is more than offset by the financial advantage through the solvent reclaimed. It is reported that this solvent costs about four cents a gallon instead of approximately thirty cents for new material.

There are many other industries using solvents under conditions that make explosion and fire hazard serious. The fire insurance interests have long since done their best to enforce care in these matters and have in many cases made it financially profitable to eliminate the principal hazard by largely increasing the insurance rates where the plant was not operated with maximum of safety. If one may add to this insurance saving the actual income from recovered solvents, there is certainly no longer an excuse for continuance of these dangerous plant practices.

Dyes, World Peace,

And Chemical Disarmament

AFTER much controversy, during which it came dangerously near muddling the whole matter, the British Government has adopted a definite policy with relation to its dye industry. Parliament saved the industry at the eleventh hour by passing a regulatory bill, the text of which is printed elsewhere in this issue. In its principal features it prohibits, subject to a licensing system, the importation of synthetic organic dyes and intermediates used in their manufacture. The Board of Trade is constituted the licensing authority, supplemented by an advisory committee composed of manufacturers and consumers. The provisions of the bill are to apply for ten years and no longer, at the end of which time it is confidently expected that the British dye industry will be able to stand alone.

England's action holds a salutary lesson for the United States which the present Senate will do well to consider. Conditions in the two countries prior to England's recent action were almost identical. Neither nation had a well-developed, independent dye industry, both being large consumers of the German product. By the same token both nations were helpless in the early stages of gas warfare during the late conflict. Following the Armistice both nations regulated the importations of German dyes, and England announces her intention of supporting a domestic dye industry. Subsequently the famous Sankey judgment destroyed the government's authority to regulate dye imports, and as a consequence the industry was in a perilous position until the new dye bill was passed by Parliament late in December.

Our own position in respect to post-war regulation is still satisfactory, but should peace with Germany be declared prior to the passage of the Longworth dye bill by the Senate, the licensing authority of the War Trade Board Section of the State Department would be abrogated and the way would be open for unrestricted importation of German dyes. It is this critical situation which makes it incumbent upon this Senate to agree upon a measure which will protect the domestic dye industry and permit it to develop to a state of independence.

The necessity for protection of the dye industry until it can stand alone is not wholly an industrial and economic matter. Its relation to world peace is closer than is suspected at first glance. One of the steps advocated in the interest of world peace is international disarmament, but thus far the advocates of such a measure have considered physical disarmament only and have strangely neglected the greater necessity for chemical disarmament. The latter is practically impossible as long as any nation holds a world monopoly in the manufacture and distribution of synthetic coal-tar products. No thoughtful reader can peruse V. LEFEBURE's article, published on another page, without being forcibly struck with the author's logical reasoning on this subject. We commend it to the earnest consideration of our lawmakers and shall see to it that they have an opportunity to read it. It is immaterial whether LEFEBURE's complete scheme can be carried out at the present time, but it is of vital importance to recognize the fact that the United States, as well as the other leading nations of the earth, must have an independent dye industry, in the interest of chemical disarmament and world peace, if for no other reason.

Mechanical Training

For the Industrial Chemist

THE average chemist is essentially a theoretical man and without knowledge of mechanical matters, but he must acquire such information as will enable him to direct them to his purposes. The lack of the simplest knowledge of mechanics and construction details among chemists is deplorable. Instances may be cited.

A highly trained chemist, more through good fortune to himself than judgment on the part of his superiors, had secured an operating position with the responsibility, among other heavy charges, of starting the equipment in an enormous new manufacturing plant. He knew nothing about the simple need of sweating in a bearing and at first refused to run the machinery idle, preferring to wait until the material commenced to come through. He insisted that a simple turnover of a few minutes proved the readiness of the machines to handle the load. Finally, however, under the threat of dismissal from the staff chemical engineer, who had mechanical training, he was persuaded to start up without load. It developed during the three weeks' tune-up that none of the equipment was ready, that bearings burned out, shafts had to be re-aligned and in two instances entire change in design was necessary. Had these breakdowns occurred under load several months' delay would have been inevitable.

But one might say, "Call in the mechanical engineer." Unfortunately he is not always available. The mechanical engineer with a knowledge of chemical plants is, moreover, a *rara avis*. Two instances will illustrate.

A large number of steel containers designed to hold a poisonous gas under pressure were put in by mechanics. These had been pressure-tested at the factory but traveled a long distance in coming to the plant. The chemical engineer, much to the disgust of the mechanical engineer, insisted on a second test in place. He knew that leakage of the gas would suffocate the workmen in the whole plant and cause expensive shut-downs. Finally, he had his way, and on putting each under a 500-lb. hydraulic test—accomplished inexpensively with a hand pump—water spurted forth from the seams and even from the sides of the steel vessels. These leaks were soon stopped by oxy-acetylene torch and calking with a cold chisel. Many thousands of dollars and vexatious delays were saved. The risk to human life was reduced to nothing.

A Gay-Lussac acid tower stood on four brick piers erected with the footing in sand of an old river bed. Evidently two of them were located over decayed matter beneath the surface, for one day they suddenly sank several inches, tilting the structure to a dangerous angle. The manager called in a construction company to quote on straightening up the work. It returned an estimate of about \$2,000. In the meantime a practical chemical-engineer foreman asked for a chance to try before the construction company was retained and received permission from the manager.

He requisitioned two ordinary two-man timber saws from the storehouse and called in four workmen. They proceeded to saw out two courses of brickwork and mortar on each of the two high piers, working around the pier until at last a slim support of material was left in the center of each. Mortar was thrown into the spaces, the remaining material was chipped out and the tower settled back to the vertical, where it has since been standing for several years.

This chap knew that of all tools available to the industries there are very few for putting on material, most of them being "taking-off" tools, and he simply saw it was easier to saw off a leg than to put one on. This is not chemical engineering, but common sense, which carries men far in business, chemical engineers included.

Gossiping Tongues

Injure the Profession

SOME time ago we heard a veritable tale of woe in regard to a commercial laboratory in good standing. The "kicker" declared himself to have been robbed by it of large sums of money, and to have been involved in a great waste of time with no results and, as he believed, no genuine effort to show for it. The man was not a chemist, but he talked with fervor, and his bitterness aroused our curiosity inasmuch as we knew the consulting chemist against whom the complaint was directed to be scrupulously careful, very competent in science, rich in technological experience, and a man of honor. So we proceeded with a little investigation of our own, and found three chemical laboratories involved instead of one—a little fact that was not related by the complainant and which the three chemists themselves did not know. We shall designate them as A, B, and C respectively. It was B who was the butt of the manufacturer's diatribe on the occasion in question.

What happened was that A was retained to develop a process, which he did. He did not finish his work, having carried it only to the initial stage. Then Mr. Manufacturer went to B without telling him anything of A and consulted him in regard to the process of which he declared he had made an initial instalment. B took the matter up where A had left it, and designated the necessary steps to carry it to completion. For this B charged a fee of \$75 and \$6.32 traveling expenses. Considerable correspondence of a friendly nature ensued for which no charge was made, which related to what the manufacturer would do when he had his complete apparatus installed. Without purchasing the apparatus at all Mr. Manufacturer then went to C, and how C is coming along with him we do not know, but we can guess.

All three are competent men; any one of them could have developed the process and carried it through to profitable operation; but the pig-headed manufacturer cannot understand chemical consequences; he does not know the difference between work in glass and in iron, he takes his chemistry as a lot of yokels take patent medicines, and the only so-called "reason" to which he will listen must emanate from men as ignorant of chemistry as he.

What is needed is less destructive gossip and more co-operation among consulting chemists. There is no profit whatever in letting ignorant men engage in loose and libelous talk about the vain things which they imagine. A few libel suits would do no harm in this respect. When a man begins to libel a brother chemist it is a good thing to make him give facts and figures, and then to send this record in to the man against whom the complaint is made. We do not want to put anything in the way of men of affairs seeking advice and counsel where they desire to get it; but we should like to see a halt called to malicious gossip. There is too much of it going on that has no foundation in fact, and that has its origin in crass and sour ignorance. It injures the whole profession.

Chemical Disarmament

The Author Passes in Review the Chemical Armament Implied in Chemical Warfare and Shows That the Crux of All Chemical Disarmament Must Be an Internationally Legalized Redistribution of Organic Chemical Producing Capacity Throughout the World

By V. LEFEBURE

WHAT is the present disarmament situation? Chemical disarmament is the crux of all disarmament.

The League of Nations, representing most of the nationalities, with the notable exceptions of America, Germany and Russia, has instituted a definite commission to consider the question of world disarmament. Of the above exceptions acute interest must be attached to the American attitude. The initiative for any new disarmament schemes, an essential backing of any such schemes already before the world, must come from America with special weight. We may safely assume that in the block of nations represented by the League there is a desire for peace and any measures which can insure it. No doubt can exist that this feeling is common to America. On this common ground, therefore, all parties, whether associated with or hostile to the League, must welcome any new light on the critical disarmament situation.

A brief analysis of armament reveals the fact that disarmament must cover three essential factors in warfare—the combatants, mechanical types of armament and war chemicals. Mechanical armament covers all projectile-throwing weapons, or projectors as we will call them, tanks, aircraft, appliances for transportation, warships, etc.

CHEMICAL ARMAMENT

Chemical armament, very generally, represents the actual death-dealing constituents of projectiles. This must, however, be qualified by the statement that although all pre-war chemical armament—that is to say, explosives—required a special projectile to convey it to the enemy—that is to say, was dependent on a shell—the new type of chemical armament has become in some cases and may increasingly become independent of any special projectile. This is a most important item from the point of view of disarmament. It means that the limitation of projectiles may not carry with it limitation of the chemical weapon.

It is fairly safe to assume that any world organization devising disarmament schemes could cover with a fair degree of certainty the first two forms—that is, the combatant and the mechanical type of warfare. It can be claimed that the component parts of mechanical armament can be produced rapidly in easily-converted peace-time factories. This applies, for example, to machine-gun parts; but all of these weapons, if produced in quantity, necessitate huge assembly plants, and these without doubt can be subjected to inspection and control.

But how do normal disarmament schemes apply to

the chemical type? This type of weapon covers, roughly, two classes—explosives and the so-called poison gases. Now we must at once correct any false impression as to the relative importance of these two sections of chemical armament. The recent war has witnessed a gradual change in this matter. Explosives which at the commencement of the war represented nearly 100 per cent of all projectile fillings can no longer claim more than 50 per cent of that capacity. This can be substantiated in many ways. It is sufficient, however, to point to the fact that in the last great German retreat their huge ammunition dumps which we captured contained at least and in many cases more than 50 per cent of shell which were filled not with explosives but with the other type of war chemical, commonly called poison gas. There is no doubt that another year of war would have seen this percentage greatly increased.

CONVERTIBILITY OF DYE PLANTS FOR POISON GAS PRODUCTION

Pursuing our analysis, we must face the following question: Is there any essential difference in the disarmament aspect of explosives and the other types of war chemical? They have one common characteristic. This is their peace-time use. This refuses to any disarmament scheme the right to disarm in the simplest fashion—that is, by the total destruction of producing capacity. The world must have for normal development a large producing capacity for explosives and for the other types of chemical armament. This is self-evident for explosives, but may not be so for poison gas. We can readily establish the point, however, that the poison gas or chemical warfare campaign was initiated, fostered and most thoroughly exploited by Germany of all the belligerents. This country produced practically every ounce of her hundreds of thousands of tons of poison gas in dye plants, in dye factories. The examination of German gas production leaves no doubt whatever that the infinitely flexible, almost instantaneously converted dye plants are a logical means of production of all organic chemical weapons, including explosives.

FACTS TO BE CONSIDERED IN CONNECTION WITH CHEMICAL DISARMAMENT

We must now stop to lay emphasis on a general principle. There are two methods of disarmament. In the first class you can disarm very simply by destroying all the means of production and preventing their renewed growth. In the second class, because the means of production—the factories—have a peace-time function, you cannot disarm by destruction. How then can you disarm in this case?

There is only one way—it is to insure that no one country possesses a monopoly in the means of produc-

EDITOR'S NOTE—The author was British liaison officer with the French forces from the inception of chemical warfare until after the Peace Conference and is especially qualified to speak with authority on this subject.

tion. The brightest and most telling war chemical invention has no value for and no incidence upon warfare unless it can be produced rapidly and in quantity. Production is the key to its war use. Let us examine very briefly, therefore, the world distribution of the means of production for this new type of weapon. The facts are too well known to demand more than a brief reference. Before the war Germany held the almost absolute monopoly of world organic chemical production. Through this monopoly she launched the poison gas campaign, and for more than two years the Allied reply was relatively feeble. This was not due to Allied lack of invention, but to lack of producing capacity. Production occurred in improvised plants which weakened Allied resources and, most important of all, introduced no essential change in the German monopoly position.

During the war, however, for economic rather than military reasons, dye-producing industries sprang up in France, America and England. Their development was relatively feeble, owing to numerous obvious reasons. They could not make their just demand upon the research forces of the countries concerned. The erection of the plants suffered at the expense of the other great munitions industries which were developing, and in some cases as soon as a plant was erected the dire needs of the situation diverted its production from that of dyes to that of explosives and other organic chemicals. From the point of view of our argument this development left the world in the following situation regarding organic chemical producing capacity:

The German dye industry, the source of her war chemical production, was considerably strengthened. She had a world monopoly before the war, and in every way from the point of view of production, research forces, government support, etc., she was strengthened by the war in her bid for post-war world monopoly. Other countries than Germany were left with promising but relatively feeble organic chemical resources which could not immediately, even under normal commercial conditions, hope to break the German monopoly. In other words, although for most types of armament the pre-war balance in favor of Germany was decreased, yet for this one type of chemical armament the German monopoly was strengthened.

WHAT THE GERMAN ORGANIC CHEMICAL MONOPOLY IMPLIES

We are, therefore, left in face of the following situation: For most types of armament the war has led to a redistribution of producing capacity in the direction of an equilibrium. We can reasonably hope, by materially diminishing this capacity and suitably controlling and inspecting it, to obtain international disarmament; but in one particular, in chemical warfare, for which the means of production is organic chemical capacity, the final situation is just as remote from any equilibrium as it was before the war. Now we cannot, for the reasons already given, urge the complete destruction of the German producing capacity. On the other hand, disarmament in all other weapons will leave the war importance of chemical warfare greatly enhanced.

The conclusion is obvious. The world must have organic chemical producing capacity, but it cannot tolerate a monopoly of that capacity, especially if that monopoly be held by those who so drastically abused its possession. There must be a redistribution of organic chemical producing capacity throughout the world before we can claim to have even approached

disarmament. It would be farcical to proceed with general disarmament schemes and to leave untouched this monopoly in chemical armament. It can, therefore, be claimed without any exaggeration that the chief question before those who wish to see the world on a peace footing is the redistribution of this capacity throughout the world. In other words—and to ignore this issue is dangerous—we must break the German organic chemical monopoly.

How can this be achieved? There are two main avenues of approach. The new-born dye industries of France, America and England, and if you wish, other countries, must be supported nationally through legislation, and internationally through some such organization as the League of Nations; or, for those who oppose the latter, support must come on the common grounds of disarmament toward stable world peace.

INTERNATIONAL MEASURES NEEDED TO REGULATE CHEMICAL DISARMAMENT

In America and England legislation designed to protect the dye industry is before both countries. The issue is likely to be fought out on purely national grounds. This alone is entirely unsatisfactory. It must be realized by all concerned that they are legislating on a matter which has infinitely more than commercial significance. They are legislating on world peace. If that be so, they deserve the active support of those whose chief business is the promotion of this peace by definite international measures. From this point of view it is imperative that in France and England the League of Nations representatives should bring the matter strongly to the notice of the League of Nations, where it should be dealt with by their special Disarmament Commission. America can be a strong factor in this connection. A recent request has been made by the League for the appointment of an American representative to attend the disarmament conferences at Geneva. Although America is not a member of the League, and even if she be hostile to it, this representative will have great weight in these conferences.

Chemical disarmament is a matter which, unfortunately, non-technical people do not fully understand. They think it sufficient to issue an edict against the use of poison gas, not realizing that this alone is absolutely futile as an effective measure. You cannot prevent any discoveries in chemical warfare, because, unlike the development of mechanical invention, such chemical discoveries can occur, when directed by a trained mind, with the mere use of a few pots, pans, beakers, in any unguarded and unsuspected locality. The redistribution of producing capacity is therefore critical. It is, therefore, very important from the point of view of disarmament that any American representative proceeding to Geneva should have a clear view of the fundamental principles of chemical disarmament and make strong representations on this matter.

A LEAGUE OF NATIONS OUGHT TO STUDY THE REDISTRIBUTION OF THE WORLD DYE INDUSTRY

The present League or any league cannot fairly demand and expect a satisfactory answer to its request that governments should cease to support chemical warfare research and chemical military establishments unless that league be ready to support in its turn the essential chemical disarmament measure—that is, the redistribution of the world dye industry and the break-

ing of the German monopoly. From another point of view, essential action has been neglected on this matter and should be taken up again by the League of Nations, by those making representations to it or having any weight with it, by those responsible for the execution of the Treaty of Versailles and by America in any new treaty which she may make with Germany.

Articles 168 and 169 of the Treaty of Versailles are specially concerned. The former provides for the restriction by the Allied and Associated Powers of the manufacture of war material and of the approval of those Powers for the continued existence of factories and works for such production in Germany. On these grounds it is logically possible to limit seriously that capacity of the German dye industry which produced poison gases during the war and may continue to do so. Article 169 provides for the surrender to the Allied and Associated Powers of any special plant intended for the manufacture of military material, except such as may be recognized as necessary for equipping the authorized

strength of the German army. The execution of this clause, if a proper interpretation of chemical armament be used, would imply the closing down of many of the German dye plants which produced those huge quantities of poison gases during the war.

We repeat that the crux of all disarmament is the redistribution of organic chemical capacity throughout the world, and that, interpreted into action, this implies the serious reduction of the producing capacity of the German dye monopoly and the international support by the League of Nations, or any other similar bodies which may be established, of the legislative measures about to be brought before such countries as America and England for the protection of the growing dye industries, replacing the reduced German dye-producing capacity in those two countries. This is, without any doubt, one of the most important measures now before the world and in addition one of the few measures with regard to which immediate action can be taken toward the stabilization of world peace.

Election of Officers and Directors of the Allied Chemical & Dye Corporation and Subsidiaries

Personnel of the Allied Board—New Interlocking Directorate Elected by Barrett and National Aniline Companies—Changes to Make Boards of Active Executives

AT THE organization meeting of the Allied Chemical & Dye Corporation, Dec. 21, the following directors were elected:

Chairman of Board, Dr. W. H. Nichols of General Chemical
President, O. F. Weber, National Aniline

Vice-presidents, H. H. S. Handy, Semet-Solvay

W. H. Childs, Barrett

E. L. Pierce, Solvay Process

W. H. Nichols, Jr., General Chemical

Secretary-treasurer, C. S. Lutkins, General Chemical

Assistant secretary-treasurer, T. E. Casey, Barrett

The Barrett Trail for January comments as follows on the chief executives of the Allied corporation and the new directorate of The Barrett Company:

"In Dr. Nichols, this great corporation has a worthy chairman, a man who has given fifty years of his busy life to service in a field in which he is still active; a man—it is not exaggeration to say it—who brought an industry into being, nursed it through infancy, endowed it with the dreams of boyhood, the ambition and strength of manhood, the foresight and wisdom of maturity, and who now sees the fruition of all his hopes and expectations from his post of high honor.

"One need not look far to realize what manner of man is Dr. Nichols. President of the American Chemical Society, in which he holds charter membership; president of the Society of Chemical Industry, president of the Eighth International Congress of Applied Chemistry—he has had every mark of distinction his contemporaries can give him. The Allied corporation is indeed fortunate in having such a man as its chairman.

"Orlando F. Weber brings to the presidency of the corporation every quality necessary for the successful conduct of its affairs. Leader in and organizer of America's dyestuff industry, he is peculiarly fitted to take up the tasks that await him.

"The first board of directors of the Allied corporation consists of the following men:

"W. H. Nichols, Sr., chairman; W. H. Nichols, Jr., E. L. Pierce, H. H. S. Handy, Eversley Childs, William Hamlin Childs, O. F. Weber, W. J. Matheson, Rowland Hazard, Armand Solvay, Roscoe Brunner, Emanuel Janssen.

DIRECTORATE CHANGES IN BARRETT CO.

"At a special meeting of the board of directors, held Dec. 17, Eversley Childs, chairman of our board of directors, and William Hamlin Childs, president of the company, tendered their resignations, coincident with the incorporation and organization of the Allied Chemical & Dye Corporation.

"Vice-President W. N. McIlravy was elected to succeed Eversley Childs, and Vice-President and General Manager T. M. Rianhard was elected to succeed William Hamlin Childs, who was made chairman of the executive committee.

"As was true of the retiring heads of the company, their successors are men who have been identified with the coal-tar industry—and therefore with The Barrett Co. or its predecessors—all their lives. Mr. McIlravy was associated with Mr. Childs in the Mica Roofing Co. practically from the start. Mr. Rianhard came to the company by way of the Warren Chemical & Manufacturing Co.

"At the same meeting, ten of the members of the board of directors resigned and eight men were elected to replace them. Those resigning were as follows: H. W. Croft, president Harbison-Walker Refractories Co., Pittsburgh; J. H. Fulton, vice-president National City Bank, New York; W. S. Gray, president William S. Gray & Co., New York; Dr. A. C. Humphreys, president

Stevens Institute of Technology, Castle Point; I. B. Johnson, vice-president Isaac B. Johnson & Co., New York; Powell Stackhouse, director Cambria Steel Co., Philadelphia; Hamilton Stewart, vice-president Harbison-Walker Refractories Co., Pittsburgh; J. H. Staats, New York; H. D. Walbridge, H. D. Walbridge & Co., New York, and H. S. Wilkinson, chairman Crucible Steel Co., Pittsburgh.

"The new members of the board include the presidents of three of the merging companies and five Barrett men, to whom, as with Mr. McIlravy and Mr. Rianhardt, their honors come as fitting recognition of years of loyal and efficient service.

"E. L. Pierce, president of the Solvay Process Co.; W. H. Nichols, Jr., president of the General Chemical Co., and Orlando F. Weber, president of the National

the Barrett Manufacturing Co. in 1902 as office manager. On Feb. 10, 1903, he was elected assistant secretary and assistant treasurer, and on Jan. 25, 1911, became secretary and treasurer of the company.

"D. W. Jayne, manager of our chemical department, began his connection with our company when he joined the department in November, 1902, assisting the superintendent at the Frankford plant. He was appointed assistant manager in 1907 at the time the office of the chemical department was moved from Grays Ferry to Frankford. Upon his father's death, in 1910, Mr. Jayne was appointed to succeed him as manager, and has continued in that capacity to the present time.

"Clark McKercher was a member of the United States Department of Justice before coming to the company in 1913. He has been our general counsel for seven years."



T. M. RIANHARD

Aniline & Chemical Co., together with H. H. S. Handy, president of the Semet-Solvay Co., who for some time has been a director, give representation to each of the other merger companies on our board.

"The five Barrett men elected to the directorate are well known to the Barrett organization.

"W. B. Harris is our general sales manager. He began his long service in 1896, when he joined the Mica Roofing Co., and later became salesman for the National Coal Tar Co. He next was associated with Mr. Rianhardt in the Warren Chemical & Manufacturing Co., finally becoming its general manager. In January, 1913, Mr. Harris was appointed manager at Birmingham, and in December of the same year he became Mr. Rianhardt's assistant in New York, later taking up his present duties.

"M. H. Phillips, manager of the New York branch of the company, has one of the longest if not the longest service record among our active employees, a brief account of which appears elsewhere in this issue in connection with the occurrence of Mr. Phillips' thirtieth Barrett birthday, Nov. 19.

"E. J. Steer is our secretary and treasurer. He joined



W. N. McILRAVY

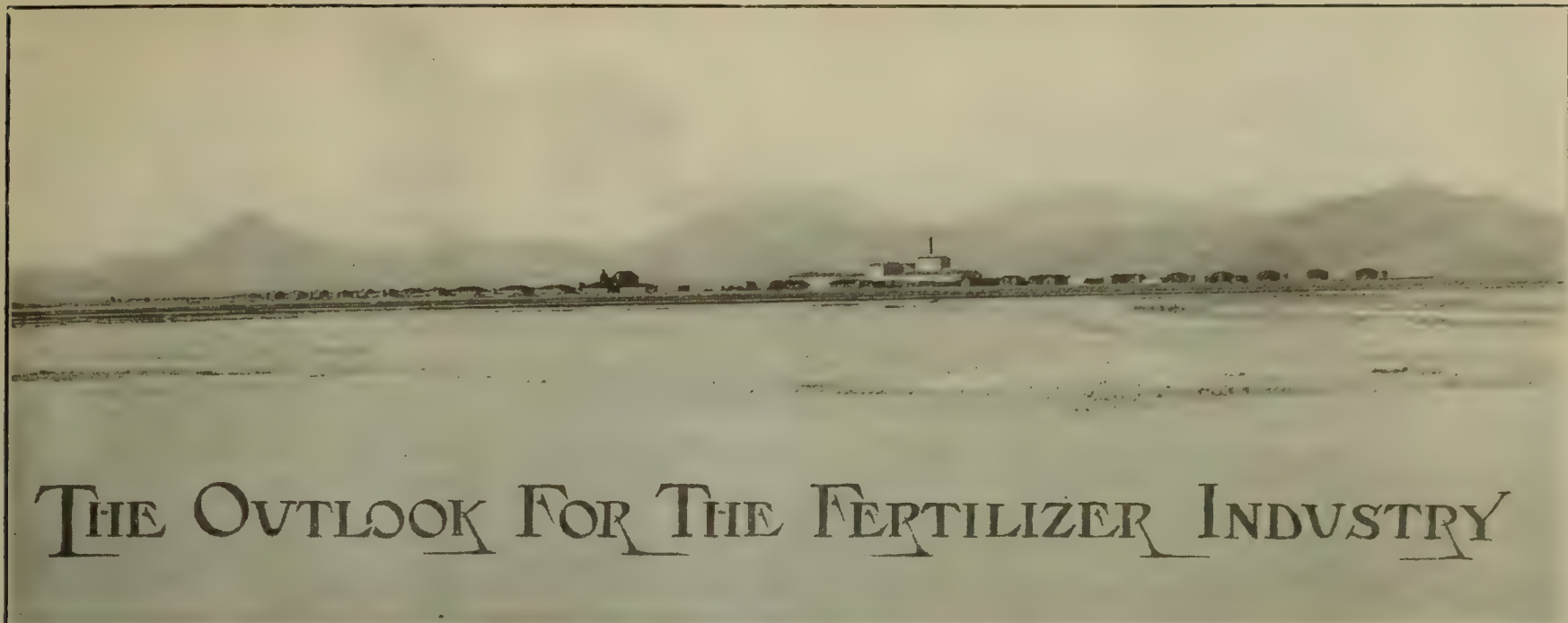
At a meeting of the board of directors of National Aniline & Chemical Co., Inc., held Dec. 21, Orlando F. Weber offered his resignation as president. J. W. Newlean was elected president of the company and Mr. Weber continues as chairman of the board of directors.

F. M. Peters resigned from the board and E. L. Pierce, president Solvay Process Co., was elected a director. B. A. Ludwig, C. F. Weber and Dr. L. H. Cone were elected vice-presidents of the company.

Judge Gary Sees Prosperity Ahead

Judge Elbert H. Gary, chairman of the board of the Steel Corporation, in a recent interview with newspaper men, reiterated his faith in the prosperity of the United States. He held the war responsible in great part for present economic conditions, but said that capital is also responsible in some measure, due to its use of "unreasonably, if not unfairly" increased fortunes.

Despite all these conditions and the alarmist views held by some, Judge Gary affirmed that prosperity is coming, just when he could not say, but surely coming.



THE OUTLOOK FOR THE FERTILIZER INDUSTRY

A Broad View of Both the Consumption and the Production Side of the Fertilizer Situation — Industrial Agriculture and Professional Farmers—Expansion in the Western States—
Inoculated Sulphur—Phosphate Rock—Potash and Nitrogen

BY FRANK K. CAMERON

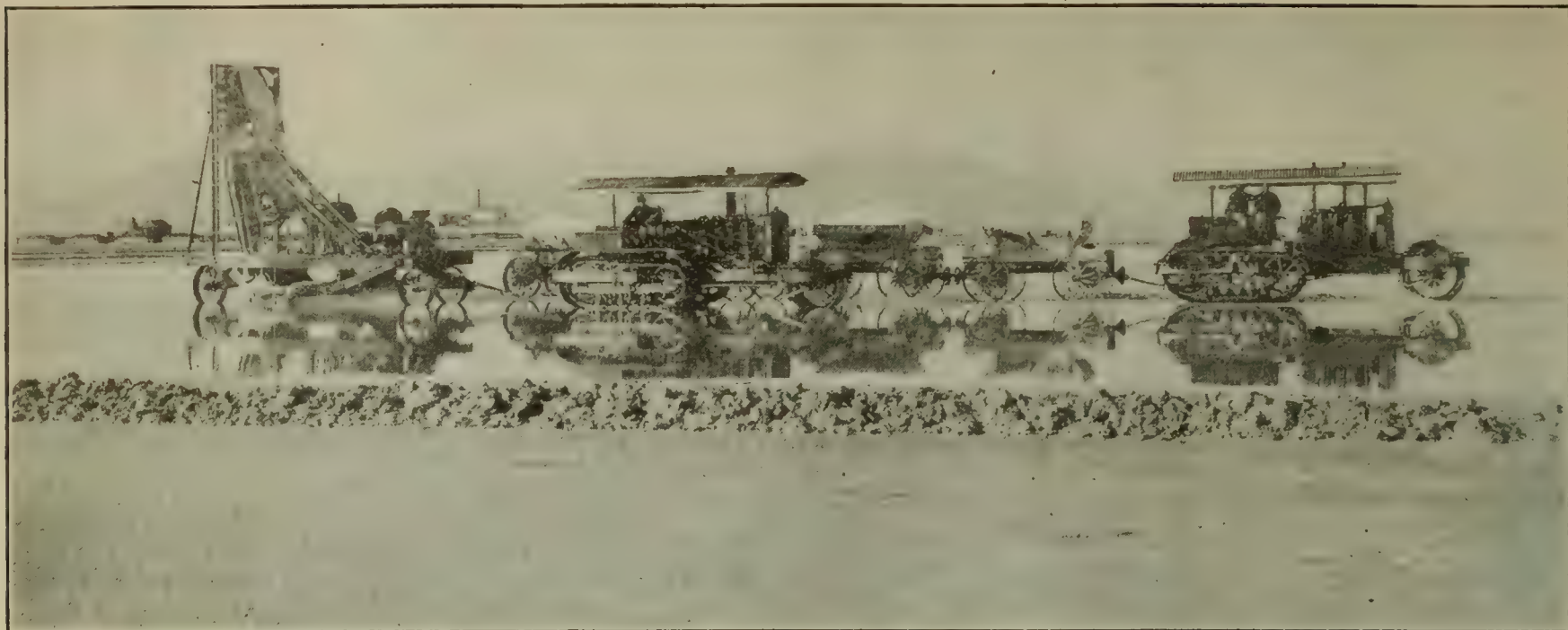
THE present status of the fertilizer industry is very favorable and the outlook is, on the whole, as alluring as for any other industry in the country. The fundamental needs of civilized man are food and clothes. Food and clothes are directly dependent on the management of the soil. In the conditions of society which have developed in the United States, cultivation of crop plants and therefore management of the soil imperatively must be far more intensive than hitherto. Of the primary instrumentations for these purposes, that which is most directly under man's control and susceptible of modification is the use of fertilizers; and fertilizers, to be economically used, must be manufactured or prepared for the user. Hence the industry is on a firm, sound, fundamental basis of universal human need.

The industry now possesses the public confidence. This is its greatest asset. It is worth while to accent the fact, for it has not always been the case. It is not proposed to discuss the mistakes of the past, for this is not a historical retrospect, but to attempt to analyze and visualize the present and immediate future. The reasons for the present gratifying relation of the industry to the public are many. Only a few of the more salient can be recounted within reasonable limits for a magazine article. Undoubtedly, the services of the industry during the war, especially that rendered by many of its prominent personnel, and in turning over sulphuric acid and other plant equipment to munition production, have been potent factors. But perhaps rather more or less consciously the industry has undergone a revolution during the war years and the succeeding period. Many of the changes were initiated before the war, it is true, but were hastened to actualities under its stress. We are only concerned, however, with the results and not their history.

In this day and generation, in the United States the old time-honored concept of farming is rapidly disappearing, being replaced by a recognition of a consid-

erable group of agricultural industries or distinct businesses, some of them very highly specialized, with highly developed technology, served by a highly trained corps of professional advisers with the same type of cultural training called for in the engineer, lawyer or physician, and requiring skilled labor. In fact the unskilled laborer is relatively of no more value today in farming occupations than in the mechanical industries or factory operations. Yokels do exist, it is true. So do cobblers. Both have their fields of usefulness as yet, but the one is of no more significance in American farming than is the other in the boot and shoe industry.

The fertilizer industry in the United States, now recognizing the average American farmer in his true aspect, is rapidly reorganizing to give him the service he requires. The older propaganda, deliberately founded on ignorance and prejudice and involving an enormous multiplicity of brand names regarded as the pride but really the curse of the industry, has been abandoned, the end hastened or forced by the inability of the manufacturers to obtain the necessary supplies of raw materials during the war. Most fortunately they have been replaced by a limited number of standard mixtures recognized by the trade as a whole and by state and federal agricultural authorities as well. And the industry has founded and supports soil improvement associations officered by highly trained specialists who, co-operating with other recognized authorities, public and private, truly and conscientiously endeavor to determine the needs of the individual or the community and, so far as the industry can, to supply these needs. In other words, the industry recognizes that true service pays better than merely pushing a brand name, and is profiting thereby. Again, the war conditions in this country brought the farmers generally a command of cash credit, enabling them to escape from the pernicious practice of purchasing their fertilizer on deferred credits based on crops yet to be



LOADING POTASH SALTS DEPOSITED FROM BRINE AT SALDURO, UTAH

planted, and at the same time enabled the industry to reorganize its selling methods so as to avoid as much as possible a resumption of this economically unsound system.

EXPANSION IN THE WESTERN STATES

Within recent months well-founded rumors have been current that factories for the production of commercial fertilizers are to be erected in Kansas City, in Sioux City, perhaps in Denver and Salt Lake City, and several new plants are definitely planned for the Pacific Coast. Recent tests in the intermountain regions by disinterested observers have shown that commercial fertilizers have markedly favorable results with sugar beets, canning crops and alfalfa. Even more remarkable, because unexpected, are preliminary reports on the use of fertilizers in dry land agriculture where the crops are small grains. Quite significant are the quite numerous inquiries for fertilizers during the past two years by farmers on Western lands, and the interest in them manifestly developing in the Dakotas, Colorado, Utah, Oregon and Washington will surely crystallize into active demands as soon as there is a reasonable prospect of the demands being met at reasonable cost figures. Credible observers in the business estimate that together with California they will probably require 150,000 tons of phosphate rock the coming year, and potash and nitrogen carriers in proportion. A noteworthy development in California is the long staple cotton. This year there are reported to be more than 400,000 acres planted to this high-priced crop in California, Arizona and New Mexico, and experimental acres throughout a large part of the San Joaquin Valley have proved uniformly successful, so that a very largely increased acreage is to be expected next year. In fact, this type of cotton promises soon to rank with citrus fruits in importance in California. Many planters from the Southern States are being attracted, men thoroughly imbued with the knowledge of the value of fertilizers in cotton culture, and a large market in that area seems assured. Therefore a much extended use with other crops, as familiarity of the community with fertilizers increases, seems very probable.

The supply of raw materials is the chief specter on the horizon, but only because of the difficulties of bringing them to the plant, for in amount they appear illimitable and of sufficiently diversified origin to pre-

clude any long-continued stoppage. The market demands are insistent and greater than the prospective production. So far as anyone can now intelligently guess the future, this condition is to prevail, so that ready sales and good prices seem assured for many seasons ahead.

INOCULATED SULPHUR

While the most striking feature of the present situation is the remarkable and happy reversal of public sentiment toward the fertilizer business, and the general improvement in the technology of the manufacturing operations is not much less striking, it must not be lost to sight that a third development has assumed very great importance in the immediate past—namely, a sympathetic consideration of possible new fertilizers and new forms of older established constituents.

Of the new proposals, attention must be called to sulphur. That sulphur might have an importance as a fertilizer has often been suggested, but these suggestions have been sporadic and commanded no general attention until Lipman's experiments with sulphuric acid in California. O'Gara's observations in connection with his investigations of the effects of smelter fumes on soils and vegetation and those of the Oregon State Experiment Station served to excite interest in the value of different forms of sulphur carriers and to prepare the public mind for the announcements of the elder Lipman at New Brunswick, who has shown what others had suspected but left for him to find the proof—that the value of elemental sulphur and presumably of combined sulphur is probably dependent upon the presence of particular bacterial organisms, and that these organisms are most efficient when other particular substances are present in desirable amounts such as organic debris and basic phosphates of lime.

These investigations have led to patented processes, and it is reported that one of the large sulphur producers in the Gulf fields expects to put on the market in the near future a mixture of elemental sulphur, phosphate rock and suitable organic matter impregnated by special strains of bacteria artificially bred to extraordinary efficiency in making effective the mixture when applied to the soil. There has been accumulated a sufficient body of apparently irrefutable evidence in the near past to make it appear that sulphur in various forms is sometimes very valuable as fertilizer on some

soils and with certain crops. As to how generally it may profitably be used probably no one knows today. Serious and capable technical studies are under way, supported by adequate commercial backing, and the interested public will in due time be properly advised as to the value of the new fertilizer.

CONCENTRATED FERTILIZER

For years, particularly by the Federal Bureau of Soils, attention was called to the necessity of considering the use of more condensed forms of fertilizers than those in common use. The continued rise in freight rates and in the costs of farm labor were the potent arguments, although there were others which appealed but little less strongly to the technically minded man. Uniformly, the foremost manufacturers of "complete fertilizers" took the ground that they favored higher grade goods than were then on the market, although their actual output did not lend much credit to this statement. But quite uniformly they always opposed putting mixtures of pure salts on the market by the statement that the farmer wished only the goods diluted with "filler" because he possessed neither the machinery nor the wits to devise means of distributing the very high-grade or pure salt mixes.

Times have changed. At least they are changing. *Double* superphosphates are on the market and are bought eagerly. A long step further, ammonium phosphates are in the fertilizer market and it is not a wild surmise that a few years hence will see most of the phosphorus marketed in this form. Eighty or 90 per cent potassium chloride is eagerly absorbed by the fertilizer trade when it can be obtained. Two of the largest chemical manufacturers in the country, it is reported, have made a combination which will put on the market during the coming year an enormous tonnage of ammonium chlorides, which they expect to be absorbed by the fertilizer trade on the ground that it contains a higher percentage of "available" nitrogen than any other compound made in sufficient quantity to use as a fertilizer.

SULPHURIC ACID

The aggregate production of sulphuric acid is probably now greater than 6,000,000 tons, calculated to a 50-deg. Bé. basis. If one is to credit all the current reports, this production will be greatly increased in 1921, for war stock accumulations will have totally disappeared by then, and there is to be a much increased production of phosphate rock, which will call for an increased production of acid to convert it into more soluble phosphates.

Certainly there have been erected some new and large sized plants, and others are more or less definitely promised in the near future, especially on the Pacific Coast. There are several large plants, notably those connected with the zinc smelters of the Middle West, which were practically completed when the armistice brought a sudden halt to munition manufacture, but which have not yet been put in operation.

The development of the Louisiana and Texas sulphur mines has been followed by an increasing use of this material in making sulphuric acid. Just what proportion of the acid produced in the country is from this origin is not definitely known as yet, but it is certainly large and probably will remain large. The domestic consumption of sulphur is approximately 875,000 tons. How much is used for making insecticides and products

other than sulphuric acid seems not to be known definitely, but the bulk of the production goes into the manufacture of the acid. Probably 50 to 60 per cent of the sulphuric acid now going on the market is made wholly or in part from elemental sulphur. On the average the acid now produced is better than hitherto. Another feature of the present development is that a very much larger proportion of the acid made now is in the form of 60 deg. Bé. or stronger, because it must be shipped in tank cars to the mixing plant. Increased skill in the handling and mixing with rock has resulted.

PHOSPHATE ROCK

In the United States the use of bones, basic slag, etc., is too limited to have any particular significance for the industry as a whole. The chief sources of supply for the phosphate of fertilizers are the rock deposits of Florida, Tennessee, the Western field and perhaps Charleston.

Florida easily holds the first place. It produced about a million and a half tons in 1919, or less than half the tonnage for 1913. The production was considerably curtailed by strikes and transportation difficulties, and of course exports were greatly reduced. If more rock could have been produced, the domestic market would have absorbed it. It is confidently expected that returns for the present year will show a considerable increase and that the industry will soon resume its former proportions. A noteworthy fact is that the restricted exports have sent much of the highest grade rock to the domestic manufacturers and these latter will probably insist on using it in the future.

Like Florida, the Tennessee field has had its labor difficulties, and claims to have suffered particularly from inadequate transportation facilities. Its production in 1919 was about 460,000 tons and it is expected to show an increase for the present year.

The Charleston field, which appeared about to be abandoned because of mounting costs of operation and low grade of rock recovered, showed an increased production in 1919. About 100,000 tons of 60 per cent b.p.l. rock was marketed. Because of continued shortage in the Florida supplies it is expected that Charleston may do as well the current year.

DEVELOPMENTS IN THE WESTERN FIELD

The important developments have been in the Western field. The Anaconda Copper Co. is now producing double superphosphate, making sulphuric acid from smelter fume in a Larison packed cell plant, and obtaining the rock from the company operating at Paris, Idaho. The Anaconda company has added to its phosphate rock holdings at Melrose and Garrison, Mont., a large deposit in Soda Springs Canyon, Idaho, and is assembling a large mine and milling equipment, and a railroad is being built from the main line of the Oregon Short Line at Soda Springs to its proposed workings.

The Western Phosphate Co.'s mine, about three miles from Paris, Idaho, is connected by rail with the Oregon Short Line main line at Montpelier. The rock taken from this mine is white or light gray in color and appears to be very uniform in composition, the dried rock analyzing better than 72 b.p.l. It is claimed that the vein from which this rock is taken is 6 ft. in width and it has been traced for nine miles on land owned or controlled by the company. The other rock in the Western field is brown or black in color, usually harder

than the Paris rock and lower in phosphorus content, although there are some very large veins much higher in phosphorus content.

The Western Phosphate Co.'s main tunnel has now been driven about 2,000 ft. on this vein. The company has established a camp with large mining facilities, has a mill for crushing and drying with a daily capacity of 350 tons, another under construction with a daily capacity of 400 tons and a fine grinding mill with a capacity of eighty tons daily. The company has been shipping continuously since April of the current year to the Middle Western States, to the Pacific Coast and to the Orient. For the latter trade large loading bins have been constructed at Portland, which has handled the bulk of the export trade. The Western Phosphate Co. is associated with the interests controlling the large high-grade deposits near Border, Wyo., and in the Crawford Mountains, Utah, the largest reserves of high-grade rock in the world. The American Phosphate Co. is working a deposit about five miles from Montpelier and is reported to be producing about sixty tons a day with an augmented production promised at an early date, and there are several other shippers of small tonnages in the area. The total shipped from this area in 1919 was about 16,000 tons. The current year will probably see this figure quadrupled, the bulk of the material being taken from the mine at Paris, and as the black rock is rapidly winning friends as its merits become known to the trade, a steadily increasing production from this field can be expected. The long delayed but apparently now assured future of this industry will be a potent factor in developing the early manufacture and greatly increased use of mixed fertilizers in the Western States.

EXPORTS OF PHOSPHATE ROCK

The export of phosphate rock, which approximated 1,500,000 tons in 1913, gradually fell to less than a tenth of this during the war, but commenced to pick up as vessels for its transport became available, being 143,455 tons in 1918, about 380,000 tons in 1919, and will undoubtedly show a substantial increase for the current year. The bulk of the exports are from Florida, and go at present mainly to northern European ports. Japan has become a large buyer, and promises to increase its demands, especially upon the Western field.

The continued high price of sulphuric acid has served to direct more attention during the past year to other possible means of producing phosphoric acid. Volatilization of the pentoxide from the electric furnace, it is now pretty generally accepted, is technically simple and efficient, but not commercially practicable without much cheaper power than is now available. Waggonman's experiments at the Washington laboratory of the Bureau of Soils, in volatilizing from a furnace similar to an ordinary iron blast furnace, appear to promise that a commercially economical process can be developed. While the process has been devised with the waste phosphatic materials of Florida in mind as the raw material, it would seem to lend itself particularly well to the phosphates of the Western field and the conditions there encountered.

There has been a very considerable interest in more concentrated forms than the ordinary superphosphate containing 16 to 18 per cent soluble phosphoric acid. Several organizations are now marketing "double" supers containing as much as 50 per cent soluble phos-

phoric acid (P_2O_5) and approximating pretty nearly the composition of pure monocalcium phosphate. Some confusion has arisen because certain interested parties have described these more highly concentrated phosphates as "treble" superphosphates because they contain three times as much "available" phosphoric acid (P_2O_5) as do ordinary superphosphates.

AMMONIUM PHOSPHATES

There is a growing interest in ammonium phosphates. The American Cyanamid Co.'s several grades of "amophos" have proved that such compounds are very valuable from technical considerations, but the relative scarcity and high price of ammonia since the armistice has checked the developments in this direction. It would appear to be far more advantageous to market ammonia as phosphate rather than as a sulphate. Naturally, the coke-oven installations, which are the principal producers of ammonium sulphate, hesitate to make the change, largely because they fear that it would involve a more or less complete scrapping of their present equipment. The writer's own experiments have convinced him, however, that only very slight modifications would be desirable and that it will be but a short time before much of the phosphoric acid used as a fertilizer will be supplied the trade in the form of ammonium phosphates.

THE POTASH SUPPLIES

Supplies of potash are yet far below the demand, and at the present writing there is a tendency toward higher prices, although there is a prospect of improvement in the quantity coming from abroad and produced from domestic sources. During 1919 about 112,000 tons of potash salts was imported, practically all of it in the second half of the year, and the importations for the present year will undoubtedly show a very considerable increase. But in the writer's opinion it will be some years yet before imports can be expected to reach pre-war figures, or before prices will be materially lowered. He does not expect that prices will approach pre-war levels for many years, if ever.

Neither France nor Germany has any interest in furnishing potash to the United States, other than the money return or its equivalent in commodities. They are likely to recognize no other inducement than a large money return. The money value of the total potash imports of the United States in 1913 was just about \$15,000,000. At present prices this importation would be worth just about \$50,000,000. But present prices would certainly not exist if such quantities were actually available. Probably \$30,000,000 would be a liberal estimate of the value of the importation to the United States, and it would cost more than half this figure to mine and land the salts in the United States. To one who has kept in touch with the actual operations in the French and German fields it seems quite unlikely that either could command much more than half the American market if the other chose to compete.

The total probable realizable return from the American market is not, therefore, particularly attractive to either the French or the German authorities, and under the internal conditions in both countries it is more desirable, from their viewpoints, to maintain high prices and furnish a much restricted tonnage. France desires above all things in an industrial way to become Europe's master producer of iron and iron products,

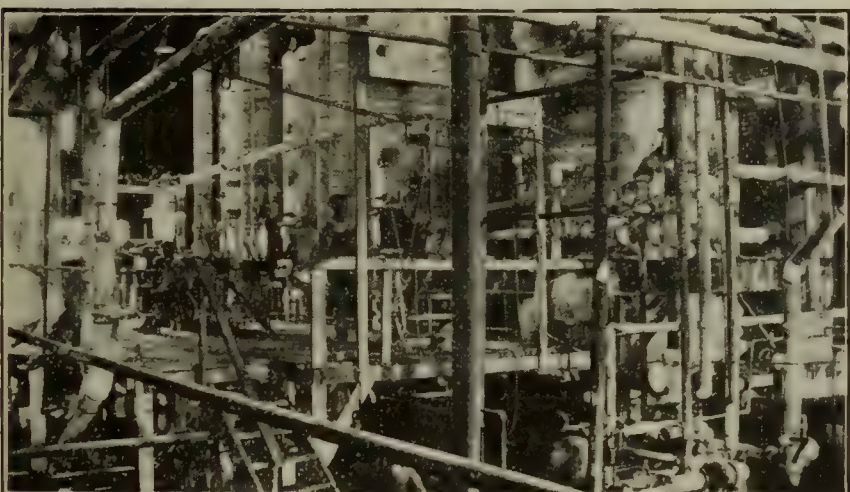
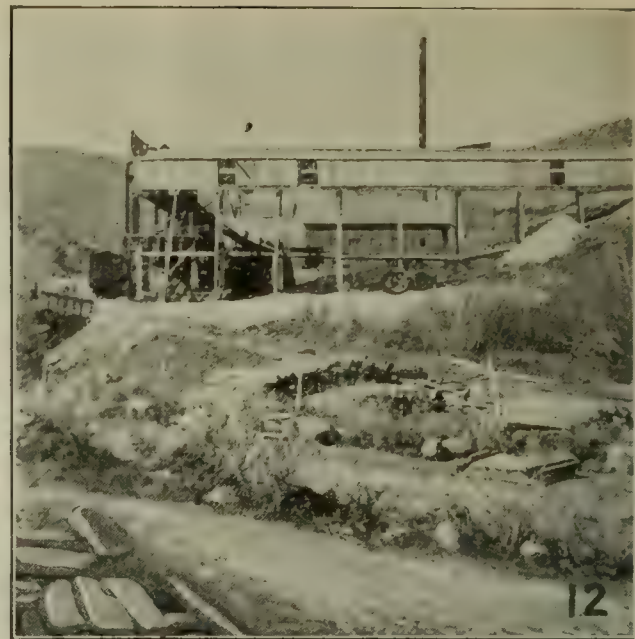


Fig. 1. Plant Lake, Standard Potash Co. Note spiral draw-to and solar evaporation by slow flow of water.
 Fig. 3. National Potash Co.
 Fig. 5. Rotary kilns in operation.
 Fig. 7. Evaporators, Standard Potash Co.
 Fig. 9. Nebraska Potash Co.

Fig. 2. Typical lake, sand dunes in foreground.
 Fig. 4. Western Potash Co. Antioch works.
 Fig. 6. American Potash Works.
 Fig. 8. Evaporators, Hord Co.
 Fig. 10. The Hord Co. Lakeside plant.



WESTERN PHOSPHATE CO., PARIS, IDAHO

Fig. 11. Snow shed, mine portal to mill.

Fig. 13. Mill and bins.

Fig. 12. Loading bins.

Fig. 14. Fine ground rock bagged.

and she is woefully short of man labor. She does not, therefore, look with favor on permitting any miner to work in the potash mines of Alsace who can be employed in the iron mines of the Briey, Lorraine or the Saar, or the coal mines of Lens. At the same time she is not going to permit Germany to build up the potash export trade at her expense. On the other hand, Germany has troubles of her own. The potash mines are now largely in the control of the laborers themselves. Production is not particularly remunerative or attractive. Repairs and renewals have not been kept up. Transportation facilities are wretched. Labor appears more necessary to other industries and the other industries appear more attractive and remunerative. The old trained crews are broken up.

On the whole, it seems probable that for years to come both countries will produce their own requirements and small surpluses for export, but that America's hopes of obtaining any large part of this surplus is only by paying what appears to us as exorbitant prices. Consequently, we shall have to develop our own resources or remain content to use much less potash than appears to be the plain requirements of the country.

DOMESTIC PRODUCTION OF POTASH

In 1919 our domestic production was approximately 120,000 tons of salts containing 32,418 tons of actual potash (K_2O), this being less than 60 per cent of the production of 1918. The falling off was due mainly to

the apprehension of a great influx of foreign potash at cheap prices. Many enterprises were completely abandoned; but, as the expected flood of foreign salts failed to materialize, the stronger and better organized enterprises resumed operations and the current year will probably show a production equivalent to more than 100,000 tons of actual potash (K_2O). If the writer's judgment continues to be confirmed by the size and cost of the foreign imports through the coming fall season, it is reasonable to predict a greatly increased development of domestic resources during the coming year, and it would not be surprising to see the 1921 production approach an equivalent of 250,000 tons of actual potash, the pre-war annual requirements of the country. It is certainly true that the interest in American "potash" is much more keen today among the larger fertilizer manufacturers and that the prejudice that formerly existed against it, largely because some of the Western salts contained appreciable quantities of borax, is fast disappearing, since the producers have learned how to avoid this objectionable constituent.

POTASH SALTS FROM SALINES

The principal interest in the domestic production during the current year has been in the recovery of potash salts from salines. In Nebraska some of the ponds which had been pumped out and apparently exhausted in 1919 filled again with the snow and rains of the following winter and were found to contain again

workable quantities of potash salts to an extent little or no less than formerly. All theories that this field will be exhausted within a few years have been abandoned, and there is greater activity there than ever before. The practice in the larger plants has become standardized. The brine from the outlying ponds or lakes is pumped to a near-by "plant pond" through wooden pipe lines and discharged in such a way that there is a current produced in the pond, the surface is kept in motion and there is more or less spontaneous evaporation. Evaporation by sprays and towers is not attempted, as the consensus seems to be that drift losses would be too great. The brine is taken from the bottom of the plant pond, through ordinary sand points with ordinary iron centrifugal pumps, to multiple effect evaporators and is concentrated to a solution of about 31 deg. Bé. hot, when it flows or is forced into a revolving iron tube, countercurrent to an oil flame and desiccation completed. Dust losses appear to be small and recovery of them efficient. A serious trouble is the sticking of the drying salts to the shell of the rotating tube. Rails are sometimes inserted to break the salts loose. Common practice is to have a workman walk back and forth on a platform and strike the rotating tube or kiln with a sledge. The desiccated salts are shipped as they come from the drier. They consist of a mixture of the sulphates, carbonates and chlorides of potassium and sodium with more or less organic and siliceous matter. Sulphate of potash is the predominating component, the potash content running generally from 27 to 30 per cent, sometimes higher. The operations are, it must be admitted, quite crude and readily susceptible of improvement. What has been accomplished elsewhere with American brines makes it reasonably certain that a phase rule study of the brines would soon and easily lead to modifications of the process that would produce a high-grade potassium sulphate and a merchantable sodium carbonate, with an increased value to the plant output.

OPERATIONS AT SALDURO, UTAH

At Salduro, Utah, the brine is gathered in an extensive series of ditches and conducted to shallow ponds, where it evaporates spontaneously, depositing a crystalline mass of potassium and sodium chlorides and leaving a concentrated mother liquor containing magnesium chloride with a very little of the chlorides of the other two bases. When the mother liquor has reached the desired concentration the deposited salts are harvested. A tractor pulls through the brine a buggy fitted with a scraping device which harrows the salts and draws them to the foot of an elevator. A second tractor draws, at the same time, a line of buggies into which the elevated salts are discharged, being washed and drained in the operation. The harvested salts are drawn to a stockpile at the near-by refinery. Accumulated mother liquors nearly saturated with magnesium chloride are stored in special ponds. The refining of the potassium chloride is effected by treating the mixed chlorides with a hot saturated solution of sodium chloride, the resulting clear liquor being then run into crystallizers, which are shallow iron pans fitted with brine pipes so that cooling can be hastened by artificial refrigeration. The surface of the brine pipes is kept clear by mechanical scrapers, which also gather the precipitated potassium chloride. A product of practically any desired commercial degree of purity can

thus be prepared. The reputed operating costs per unit of potash produced are low as compared with other enterprises in this country.

DEVELOPMENTS AT SEARLES LAKE, CAL.

At Searles Lake, San Bernardino County, Cal., there are three operating plants and another is in early stages of construction. One of the operating plants is following a solar evaporation scheme, and treating the resulting salt mixture. It is offering salts to the market, hence one may infer that it has developed a successful technique. The principal producer is the plant of the American Trona Corporation, which appears to have passed successfully a long and expensive pioneering campaign and emerged with a good economical process founded upon a careful, comprehensive, scientific investigation of the possible equilibria conditions in the brine which impregnates the twelve square miles of salt body in the lake. Although the level of this brine varies from a depth of a few inches above the level of the salt body in winter to a few inches below in summer, the brine does not vary in composition appreciably, if drawn from near the bottom of the salt body, the latter reaching a depth of 100 ft. or more in places. The brine contains chlorides, sulphates, carbonates and borates of potassium and sodium, being presumably saturated with respect to these salts and such combinations of them as can exist at the temperature of the bottom of the lake or salt body. On evaporation, which is carried out countercurrent to the stream flow in a multiple effect, sodium chloride, with other salts, is precipitated. The resulting hot mother liquor is then cooled quickly and quietly by artificial refrigeration, when potassium chloride is precipitated as a crystal meal. This meal is then washed and dried in a centrifuge, yielding a salt of 90 to 95 per cent purity and containing not more than a trace or inconsequential amount of borax. The mother liquor from the potassium chloride crystallization is then agitated, when a crystal mass is precipitated, which, when dissolved in a minimum amount of water, filtered and cooled, deposits a crop of very high-grade borax crystals. This last crop is augmented by passing air containing carbon dioxide through the liquor. It is possible that high-grade carbonates of soda will be added to the regular output of the plant. At present the grade of potassium chloride produced by this plant is so high that the entire output is absorbed in the alkali industry. Its output will shortly be tripled following plant readjustments now in progress, and it will then probably be an important factor in the fertilizer industry.

OPERATIONS ELSEWHERE

The production of potassium sulphate of a very high grade by the plant of the Armour Fertilizer Works at Marysvale, Utah, where the mineral alunite is roasted and leached, is now reported to be about fifty tons daily following enlargements and improvements of plant equipment. There is a renewed activity in alunite projects the past few months, but no other development worth recording.

Aside from cement mill operations, there is little to note in the production of potash salts from silicate rocks. The great hopes of last year that this one would see a large production of soluble potash salts from leucite have not materialized. The process tried out on a large scale at Green River, Wyo., was found to

be unsuited to plant operations as planned, although a number of carloads of a high-grade muriate were produced and shipped before an accumulating deficit in their financial resources forced its backers to suspend further efforts to modify it to meet equipment limitations. New methods for utilizing this source of potash are known to be under investigation by at least two large commercial organizations. Kelp as a source of potash is of vanishing importance at present, but not necessarily permanently. Other domestic sources of potash are not at present of sufficient relative importance to call for special notice or comment.

THE NITROGEN SUPPLY

The nitrogen supply will, in the main, continue to be cottonseed meal for some time to come, but it seems to be inevitable that this material will more and more be consumed as an animal food as feeders learn better ways of so using it. The same thing will be true of blood, tankage and fish scrap. Base goods or that indefinite conglomeration produced by treating organic waste such as leather scrap, feathers, etc., with sulphuric acid, will, however, continue to be used to greater and greater extent. Such ingredients are now frequently incorporated directly with superphosphate as the rock is mixed with the acid. There are prospects of an increased production of ammonia from byproduct coke ovens and it seems reasonably certain that there will be a much increased importation of nitrates from South America. But the greatest interest is and will continue to be in the artificial production of fixed nitrogen from the illimitable stores in the atmosphere. It may be frankly admitted that the high hopes developed during the war have not been realized by a wide margin. It would be foolish to assume that they will not be so realized sooner or later, and it seems only reasonable to expect that means will be found to continue the investigations of the last few years until it can be determined which of the various processes can properly survive under ordinary peace conditions in the United States.

To discuss satisfactorily the recent work on the various processes for fixing atmospheric nitrogen and the apparent merits or demerits would require a separate article and will not be attempted here. So far as the immediate interest of the fertilizer trade is concerned, two instances are apparently of dominating importance. A way must be found to proceed with actual production at Muscle Shoals, Ala., which will not involve unjust or injurious competition between the Government and established private enterprises. It should not be difficult for reasonable men to devise a plan which would ultimately redound to the interests of all concerned.

WORK ON MANUFACTURE OF AMMONIUM CHLORIDE

Perhaps the most striking announcement of the year is that the General Chemical and the Solvay companies have united to build a large plant for the production of ammonia by the Haber process, a desirable and economical adjustment of products of the Solvay and Haber processes having been worked out. As a result a very large tonnage of ammonium chloride will soon be on the market, which will readily be absorbed, it is expected, by the fertilizer manufacturers. A similar development is going on in England, where the Mond and Solvay interests are united for the purpose. It is reported that in France, where the scheme of adjust-

ing the two processes to each other's needs was first worked out, the problem of disposing of the large production of ammonium chloride as a fertilizer was carefully studied with pot and plot tests, with quite satisfactory results.

POSSIBILITIES FOR USE OF AMMONIUM CHLORIDE

Possibly there are some crops with which it would be inadvisable to use ammonium chloride. Tobacco is a case where one would be suspicious until actual tests are made. But for crops in general there seems to be no reasonable doubt that ammonium chloride would serve as well as any other salt as a carrier of nitrogen. An advantage is claimed for ammonium chloride, that it is the most concentrated form of ammoniacal nitrogen that can possibly be made commercially available. Of course ammonium nitrate contains an even higher percentage of nitrogen, all available for plant nutrition, but there is no prospect of this salt coming into use extensively in this country until there is much cheaper power than is now available, or ocean freights from Norway far lower than now seems probable. Whether the new salt will delay the development of plans to put ammonium phosphates on the domestic market is also an interesting question which can not be answered immediately.

SUMMARY

The most important developments of the current year, for the fertilizer industries, are:

The very great gain in public confidence.

An increased use of fertilizers in the Western States.

The opening of the Western phosphate deposits.

The revival of domestic production of potash.

The preparation for an early production of fixed nitrogen on a large scale as a byproduct of the soda industry.

The resumption of an export business.

The trials and tribulations of a reconstruction period have been met satisfactorily, on the whole, and the industries will be the stronger in the future for the lessons forced upon them.

Development of Egg-Products Industry in China

Perhaps no single industry has developed more rapidly in China than has the production of egg products during the war period. The eggs were collected in small factories formerly, but now these have become larger and are situated in the commercial centers, to which places the raw egg is brought in very large quantities. In 1913 there were exported from all of China 20,796,400 lb. of albumen and yolk and 30,266,845 dozen eggs, while in 1919 there were exported 80,824,267 lb. of albumen and yolk, 28,843,416 dozen eggs and 25,094,133 lb. of frozen eggs. These exports were valued at \$4,350,290 in 1913 and \$33,883,259 in 1919.

Many factories with the most modern equipment have been located in the various parts of China, Shanghai being the most important point, and Nanking, Hankow, Suchow and other places having manufacturing plants of considerable consequence. The exportation of frozen eggs is going forward in increasing quantities, and this article reaches the American as well as the European market. It cannot be shipped to the American market in the quantities that the desiccated egg can be, as it requires refrigerating vessels, which are not frequently run on the Pacific.

Notes on Nickel

Brief Notes on the Metallurgy of Nickel, and Data on the Uses and Applications of Various Grades—Information on the Limitations in Rolling, Annealing, Welding and Electrodeposition

BY PAUL D. MERICA*

FOR the past two years the author has been interested in the collection of accurate information and data concerning nickel and its alloys and in view of the increasing importance of this metal both in the pure form and as an alloying element in the composition of many interesting alloys has deemed it of sufficient value to present some of this material in a series of articles. Although certain phases of this subject have previously been presented in a very satisfactory manner,¹ much information which should be very useful is still in such scattered form as to be rather unavailable. It has been the attempt to pay particular attention to those chapters of which this was true as well as to include a great deal of data particularly on nickel and its alloys other than nickel steel which has hitherto been unpublished.

Much assistance has been had in the collection of this material, for which the author wishes to make grateful acknowledgment: to A. J. Wadhams and J. F. Thompson of the International Nickel Co., to W. H. Bassett of the American Brass Co., to W. B. Price of the Scovill Manufacturing Co., to W. Blum of the Bureau of Standards, and to the Driver-Harris Co., the Electrical Alloys Co. and the Hoskins Manufacturing Co.

SOURCES

The ores from which commercial nickel is obtained are of three classes: (1) *Sulphides*, represented by the pyrrhotite-chalcopryite ores of Sudbury, Canada, and of Norway, and which contain from 1 to 3 per cent each of copper and nickel, with the mineral pentlandite as the nickel carrier. (2) *Silicates and oxidized ores*, which are found principally in New Caledonia and contain from 5 to 6 per cent of nickel (plus cobalt), with garnierite as the principal nickel carrier. (3) *Arsenical ores*, which are found in Canada and on the Continent, in Saxony, and elsewhere. Of these, the first two classes only are of much commercial importance, and the first class furnishes by far the greater proportion of the present output of this metal. In addition to the metal produced from these ores, a small amount of nickel is recovered annually from blister copper.

SMELTING

Sulphide ores are first roasted and then smelted in blast furnaces to a matte containing approximately 24 per cent of nickel plus copper, 45 per cent of iron,

and the remainder sulphur. This matte is then blown in a converter to a mixture essentially of nickel and copper sulphides, which is ready for the refining.

Although the smelting practice of the companies operating with sulphide ore of the Sudbury type is essentially the same, as well as the product (which is usually known as bessemer matte), the refining of this matte to metal and the separation of the nickel and copper are accomplished by quite widely different processes, of which the following three are the most important:

REFINING

(1) The Hybinette process, which is in operation in Norway, is essentially an electrolytic one. The matte is roasted to remove the bulk of the sulphur and leached with 10 per cent sulphuric acid, whereby a large proportion of the copper with very little nickel is dissolved out. The residue is melted and cast into anodes, containing about 65 per cent nickel and from 3 to 8 per cent sulphur. These anodes are then treated by electrolysis, with cementation of the contained copper by anode scrap. In this manner nickel cathodes and both cement and cathode copper are obtained.

(2) In the Mond process (which is operated in England) the bessemer matte is first roasted and the copper removed in part by leaching with sulphuric acid with the formation of a solution of copper sulphate. The residue, containing nickel oxide with some copper oxide and iron, is reduced at a low heat to a finely divided metallic powder. This is carefully protected from contact with the air, and carbon monoxide is passed over it at from 50 to 80 deg. C. At these temperatures nickel-carbonyl vapor is formed, later to be decomposed by passing it through a tower containing shot nickel heated to about 200 deg. C. A layer of nickel is formed on the shot and the carbon monoxide is regenerated and returned to the volatilizing towers. The nickel shot is alternately exposed to and withdrawn from the action of this gas and in this way a series of concentric layers of nickel are built up around the original nucleus, like the coats of an onion, a means of ready distinguishment.

(3) The Orford process, which is the oldest process for the separation of copper and nickel, is being operated in this country. The bessemer matte is melted with salt cake, or niter cake, together with coke in the blast furnace. The sodium sulphide formed by the reduction of the sodium sulphate by the coke together with the copper sulphide forms a matte of low specific gravity. The product of the blast furnace is allowed to cool in pots, in which a separation occurs, the upper portion or "tops" containing the greater part of the copper sulphide together with the sodium sulphide, the lower portion or "bottoms" containing the greater part

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¹"Physical Properties of Nickel," by D. H. Browne and J. F. Thompson, *Bulletin*, A.I.M.E., August, 1919. Report and Appendix of the Royal Ontario Nickel Commission, A. T. Wilgress, Toronto, 1917. "Manufacture and Uses of Alloy Steels," by H. D. Hibbard; John Wiley & Sons, N. Y., 1920. "Die Spezialstähle," by G. Mars; Ferdinand Enke, Stuttgart, 1912. "Steel and Its Heat Treatment," by D. K. Bullens; John Wiley & Sons, N. Y., 1918.

of the nickel sulphide. The "tops" and "bottoms" are readily split apart when cold. Several treatments are required to effect a sufficiently complete separation. The "tops" go to the copper cupola and converter, where they are blown to blister copper. The "bottoms," consisting essentially of nickel sulphide or matte, are roasted and leached alternately until they have been completely changed to nickel oxide. This is reduced with charcoal in crucibles or reverberatory furnaces to metallic nickel at a temperature above its melting point such that the resulting product may be cast into ingots or blocks or poured into water to form shot. Electrolytic nickel is also produced by casting this reduced metal at once into anodes, and obtaining pure nickel cathodes from them by electrolysis with an electrolyte of nickel sulphate.

The silicate ores of New Caledonia, which contain no sulphur, are first mixed with sulphur-bearing materials such as gypsum or pyrites and smelted in the blast furnace to a matte, which is shipped for refining, which in this case, in the absence of copper, consists merely of roasting the nickel matte to oxide and reducing the oxide with charcoal.

COMMERCIAL GRADES

Nickel appears on the market in the following forms:

(a) Grains, cubes, rondelles or powder reduced at a low temperature from nickel oxide and not fused in the process of manufacture.

(b) Nickel deposited in concentric layers from nickel carbonyl and not fused in the process of manufacture.

(c) Nickel deposited electrolytically in the form of cathode sheets.

(d) Nickel in the form of blocks or shot made by reducing nickel oxide above the melting point of nickel and casting the resulting molten metal or pouring it into water.

(e) Malleable nickel made in the same manner as (d) but treated with some deoxidizer before pouring into ingots. This nickel appears in the usual commercial forms—i.e., rods, sheet, wire, etc.

Most of the commercial production of nickel falls in class (d).

The International Nickel Co. has described the grades of material which it produces and contributes the average analyses of these materials found in Table I.

"A" shot nickel is a high-carbon nickel used by manufacturers of anodes for nickel plating.

"X" shot nickel is a purer material used by the manufacturers of crucible nickel steel and of nickel silver.

Ingot or block nickel is almost identical in composition with "X" shot. It is sold in 25- and 50-lb. blocks or ingots and is used in the manufacture of open-hearth and electric steel.

Electrolytic nickel in the form of cathodes 24 x 36 in., weighing about 100 lb., or in smaller squares, is used in the manufacture of high-grade nickel silver and cupro-nickel alloys.

Malleable nickel intended for rolling into sheets or rods or for drawing into wire is made in various grades according to the purpose for which it is destined. All malleable nickel is treated before casting into ingots with some deoxidizer, generally magnesium, for the purpose of removing the nickel oxide present and making the metal suitable for rolling or forging. Manganese is also added both for the purpose of cleaning the metal and as an alloying element. Nickel cannot in general be rolled or forged without this preliminary treatment with a deoxidizer.

Grades A and C malleable nickel ingots are produced by the International Nickel Co. for rolling into rods and sheets and drawing into wire.

Grade D malleable nickel is high-manganese nickel having practically the same analysis as grade C

TABLE I. COMPOSITION OF VARIOUS GRADES OF COMMERCIAL NICKEL

Name	Source	Form	Cu	Ni and Co	Co	Fe	S	Si	C	Mn	As	Sn and Sb	Insol.	Remarks
Nickel rod.....	H. Boker & Co.....	Rods	0.18	97.58	.....	0.38	0.012	0.13	0.19	1.60	.....	.....	.....	
Malleable nickel A.....	International Nickel Co.....	Rods	.....	99.00	.....	0.55	0.025	0.10	0.15	0.15	.....	.....	.....	Typical analyses Orford Works
Malleable nickel B.....	Int'l Nickel Co.....	Rods	.....	98.75	.....	0.50	0.025	0.20	0.15	1.75	.....	.....	.....	Typical analyses Orford Works
Malleable nickel C.....	Int'l Nickel Co.....	Rods	.....	96.75	.....	0.75	0.03	0.20	0.15	1.75	.....	.....	.....	Typical analyses Orford Works
Nickel castings.....	Int'l Nickel Co.....	Castings	.....	98.95	.....	0.50	0.035	.....	0.16	.....	.....	.....	.....	Typical analyses Orford Works
Nickel sheet.....	Fleitmann Witte & Co.....	Sheet	0.12	99.37	.....	.....	.....	.....	0.019	.....	.....	.....	.....	
Malleable nickel.....	Krupp (Germany).....	Sheet No. 1	0.12	99.26	.....	0.40	0.024	0.17	0.045	trace	.....	.....	.....	
Rolled nickel sheet.....	Boker and Co.....	0.0001 x 12 in.	0.12	97.99	0.88	0.49	.....	.....	.....	1.32	.....	.....	.....	
French 25 centimes.....	France.....	Coin	0.083	99.26	1.36	4.05	0.05	0.07	0.042	trace	0.018	0.021	.....	
20 centesimi piece.....	Italy.....	Coin	0.089	99.23	.....	0.31	.....	.....	.....	0.17	.....	.....	.....	
Arthur Krupp.....	Berndorf Austria.....	Wire rod	0.10	99.20	0.54	0.40	0.01	0.02	0.07	0.22	.....	.....	.....	
Nickel rod.....	England.....	1/4 in. wire	0.23	99.13	0.62	0.30	0.022	0.06	0.16	0.66	.....	.....	.....	
Electro malleable nickel.....	Driver-Harris.....	0.081 in. wire	.....	98.47	.....	0.80	0.06	0.16	0.13	0.30	.....	.....	.....	
Malleable nickel.....	Fleitmann Witte & Co.....	Wire	.....	98.60	trace	1.22	.....	.....	.....	0.16	.....	.....	.....	Royal Ontario Nickel Com's'n
Metallic nickel.....	U. S. Nickel Co.....	Various	0.05	99.02	0.12	0.21	0.025	0.21	0.39	.....	trace	.....	.....	Royal Ontario Nickel Com's'n
Pure nickel.....	Kalmus & Harper.....	.....	.....	99.29	nil	0.48	0.025	0.042	nil	.....	.....	.....	.....	Royal Ontario Nickel Com's'n
Nickel.....	New Caledonia.....	.....	0.50	98.00	.....	1.60	.....	0.13	.....	.....	.....	.....	.....	Royal Ontario Nickel Com's'n
Nickel.....	Basse & Selve.....	.....	0.10	97.87	1.45	0.45	0.05	0.19	trace	.....	.....	.....	.....	Royal Ontario Nickel Com's'n
Nickel.....	Deloro Mining.....	.....	0.05	98.00	1.60	0.75	.....	.....	.....	.....	.....	.....	.....	Royal Ontario Nickel Com's'n
Norway nickel.....	V. Hybinette.....	Electro	0.06	99.52	0.89	0.36	.....	.....	.....	.....	.....	.....	.....	
Orford nickel.....	Intern'tl. Nickel Co.....	Electro	0.01	99.84	.....	.....	0.005	.....	0.005	.....	0.01	0.01	0.003	Analyzed by Orford (1908)
Electrolytic nickel.....	Hybinette process.....	Electro	0.10	98.75	.....	0.50	0.01	.....	.....	.....	.....	.....	.....	Royal Ontario Nickel Com's'n
Nickel shot.....	U. S. Nickel Co.....	Shot	0.06	98.98	1.01	0.58	0.006	0.19	0.16	.....	trace	0.003	.....	
Mond nickel.....	L. Mond (England).....	Shot	0.03	99.36	0.06	0.39	0.002	0.11	0.11	0.09	.....	.....	.....	
Mond nickel.....	Mond Nickel Co.....	Shot	None	99.80	None	.....	0.006	None	0.05	.....	.....	.....	.....	Analyzed by Hadfield (1899)
Nickel shot.....	Intern'l Nickel Co.....	A shot	0.15	98.65	0.80	0.50	0.06	0.15	0.45	.....	0.015	0.015	.....	Analyzed by Orford (1914)
Nickel shot.....	Intern'l Nickel Co.....	X shot	0.15	99.05	0.80	0.47	0.04	0.10	0.18	.....	0.015	0.015	.....	Analyzed by Orford (1914)
Nickel cubes.....	U. S. Nickel Co.....	Cubes	0.065	99.16	.....	0.32	.....	.....	0.41	.....	.....	.....	.....	
Metallic nickel.....	Le Nickel.....	Cubes	.....	99.41	.....	.....	0.015	0.04	0.176	.....	.....	.....	.....	
Grain nickel.....	Am. Nickel Works.....	Grain	0.13	99.17	.....	0.51	.....	.....	.....	.....	.....	.....	1.06	
Mond nickel.....	Ludwick Mond.....	Grain	0.014	99.57	.....	0.133	0.003	.....	0.23	.....	trace	trace	0.03	
Metallic nickel.....	Le Nickel.....	Grain	.....	99.38	.....	.....	0.010	0.109	0.048	0.01	.....	.....	.....	
French nickel.....	Le Nickel.....	Rondelle	0.112	99.01	.....	0.43	0.024	.....	0.037	.....	.....	.....	.....	
Nickel ingots.....	Intern'l Nickel Co.....	Ingots	0.11	99.09	0.32	0.65	0.04	0.01	0.04	.....	0.02	0.02	.....	Analyzed by Le Nickel (1905)

NOTE.—The nickel values of some of the samples mentioned by the Royal Ontario Nickel Commission include nickel only, while in other cases they include nickel plus cobalt. International Nickel Co. metal contains about 0.4 per cent cobalt, which is usually included in the copper analysis.

(Table I) except manganese varies from 2 to 5 per cent. This is used principally for spark plug wire to resist the action of high temperatures and combustion gases.

Table I gives the results of a number of chemical analyses of samples of commercial nickel, including that of foreign manufacture.

Besides the commercial forms of nickel described above, the metal is on the market in the form of anodes for the metal-plating industry. These cast anodes are quite variable in composition and contain from 88 to 95 per cent nickel together with iron, aluminum, tin, silicon, sulphur, and carbon. A typical analysis of a commercial anode is the following:

Graphitic carbon	1.70	Copper	0.15
Silicon	0.50	Aluminum	0.03
Iron	0.80	Nickel	96.82

USES OF NICKEL

The principal commercial application of nickel is in the manufacture of nickel steel, and this industry absorbed fully 75 per cent of the total nickel production during the war and probably 65 per cent normally. Nickel steels will be discussed briefly later.

Besides its use in steel nickel is used quite extensively as an alloying element with non-ferrous metals, principally copper; many of these alloys will be discussed in more detail. About 15 per cent of the production is utilized in the manufacture of alloys of nickel, such as cupro-nickel and especially nickel silver, the former series of alloys having come into prominence during the war. Nickel coinage and the electroplating industries may each absorb from 3 to 5 per cent of the production, the latter requiring the metal both in the metallic form and in the form of nickel salts; the single salts $\text{NiSO}_4 \cdot 7\text{H}_2\text{O}$ and the double salt $\text{NiSO}_4 \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$.

The production of malleable nickel, although never relatively large, has amounted to about 5 per cent of the total production and is steadily growing in volume as the properties of the metal in this form because better known. Malleable nickel is produced in all commercial forms and is used principally for coinage, cooking utensils (chiefly abroad in Germany and Austria) and other ornamental and household stampings and fittings. In the form of wire it is much used for motor ignition spark plug points, for the suspension wires in electric light bulbs, for electrical resistance pyrometers, electrical instruments, and recently in the construction of the audion amplifier.

Some malleable nickel is produced in the form of castings for apparatus such as digesters and evaporators for the chemical industry, for which its resistance to corrosion in sulphuric and other acids make it peculiarly suitable.

The Edison storage cell contains nickel both in the form of nickel oxide and as nickel anodes. Finely divided nickel is much used as a catalytic agent in the hydrogenation or hardening of oils, following the discovery of this property by Sabatier and Senderens. Nickel oxide is used in the ceramic industries for the production of under- or holding-coats of enamel on steel and also for coloring glazes on pottery.

Nickel castings have been used with much success as rabble shoes by the International Nickel Co., in calcining furnaces roasting nickel matte. The shoes are exposed to oxidizing and to sulphurizing gases at temperature from 600 to 1,000 deg. C. and to severe mechan-

ical abrasion; they have stood up in this severe service for nine months, whereas iron shoes would last no more than from six to eight weeks.

CASTING PRACTICE

Nickel is cast from the furnace into open molds to produce blocks for remelting, into ingot molds after deoxidation with manganese and magnesium for the production of malleable nickel and into sand molds for nickel castings. It is also poured directly into water to form nickel shot.

For the production of castings, the metal in the form of blocks or shot may be remelted in crucibles or in an oil-fired or electric furnace with the addition of charcoal to reduce the oxide which is present and which is formed during remelting. When at the proper temperature, it is poured into a ladle and deoxidized in the same manner as for the production of malleable ingots and poured into molds. The chief difficulty in the remelting of nickel is in the proper adjustment of carbon and oxide content of the molten metal prior to deoxidation, and which is known as bringing the metal to pitch.

Platers' anodes are melted with carbon and may be poured at a much lower temperature than malleable nickel and do not require deoxidation of any kind; they are consequently much easier to handle in the foundry than low-carbon metal.

The molding of nickel castings follows the practice used for steel castings, generally speaking, an allowance of $\frac{1}{4}$ in. to the foot being made for shrinkage.

Other than the process of deoxidation, which is absolutely essential, the production of malleable nickel ingots requires no novel operations not known, for instance, in the steel industry. Deoxidized nickel solidifies without blowholes but with a pronounced pipe, which renders necessary the use of proper risers or hot-tops and properly designed molds.

ROLLING, FORGING, ANNEALING

In the hot-working of nickel, both the temperature and the condition of the heating flame should be subject to careful control. The temperature for preheating and rolling should be from 1,100 to 1,180 deg. C. Ingots should not be subjected to temperatures much in excess of this, as they then become somewhat hot-short. Below this temperature the metal may be too hard to roll satisfactorily. The flame used for heating should be as nearly neutral as possible and a low-sulphur fuel (oil) is essential for successful heating.

For hot-rolling bars and rods of the usual cross-sections, the same designs of rolls as are used for steel may be and are employed with success. Pure nickel and nickel alloys of high nickel content are very easily guide-marked when hot.

The remarks of the first paragraph above apply also to the forging of nickel. Nickel is much more successfully forged under the hammer than under a press; in fact, the metal has a pronounced tendency to crack under the slow action of the press, which may be due to the fact that the surface cools more readily than under the quick blows and short contact of the hammer.

In order to soften nickel which has been worked cold it must be heated to at least 750 deg. C., the minimum temperature of the annealing range, and allowed to remain in the furnace until thoroughly heated throughout. It may be cooled rapidly or slowly, as desired, as there is no alteration in the properties of the metal

produced by cooling after annealing. For the commercial annealing of nickel a temperature of 900 deg. C. should be used, as this will insure a more thorough and homogeneous anneal.

Price and Davidson² have studied the annealing of nickel of commercial pure grade (A) and their results are shown in the accompanying figure. The annealing range for the metal is from 600 to 800 deg. C.; commercially the metal is usually annealed at 900 deg. C.

Whenever possible the metal should be annealed in tight boxes to prevent the formation of oxide, and any oxide formed may be reduced by the creation of a reducing atmosphere in the box, either by the presence of a small amount of charcoal or by the admission of some reducing gas. When annealing is done in this manner no pickling is required and on account of the difficulty and expense pickling should be adopted only as a last resort.

If necessary, pickling may be accomplished by the use of sulphuric acid with some oxidizing agent, such as ferric sulphate or chromic acid, at a temperature around 60 to 70 deg. C., but it is a slow and tedious process.

WELDING AND SOLDERING

Nickel cannot be smith-welded owing to the formation of a coating of nickel oxide which cannot be fluxed and which prevents the adherence of the two surfaces to be welded. On the other hand, under a reducing atmosphere the metal may be welded, such as by the use of the oxy-acetylene torch, or by electric-resistance welding. It is by the latter process that nickel wire is welded to iron wire to form tips or points for spark plugs.

Under suitable reducing conditions nickel may be plastically welded to steel, and an interesting process, invented by Dr. Fleitman about thirty-five years ago, of producing nickel-coated steel sheets is based upon this possibility. A steel sheet bar, about $\frac{3}{4}$ in. thick, is cleaned and pickled and placed between two thinner plates of clean nickel. Around the whole is wrapped a thin steel sheet, which protects the nickel against oxidation and is dissolved off by later pickling. The compound sheet bar is heated in a reducing atmosphere and then rolled and crossrolled into a solid, compound sheet. Needless to say, the nickel coating so produced is thicker and more durable than electrolytically deposited metal.

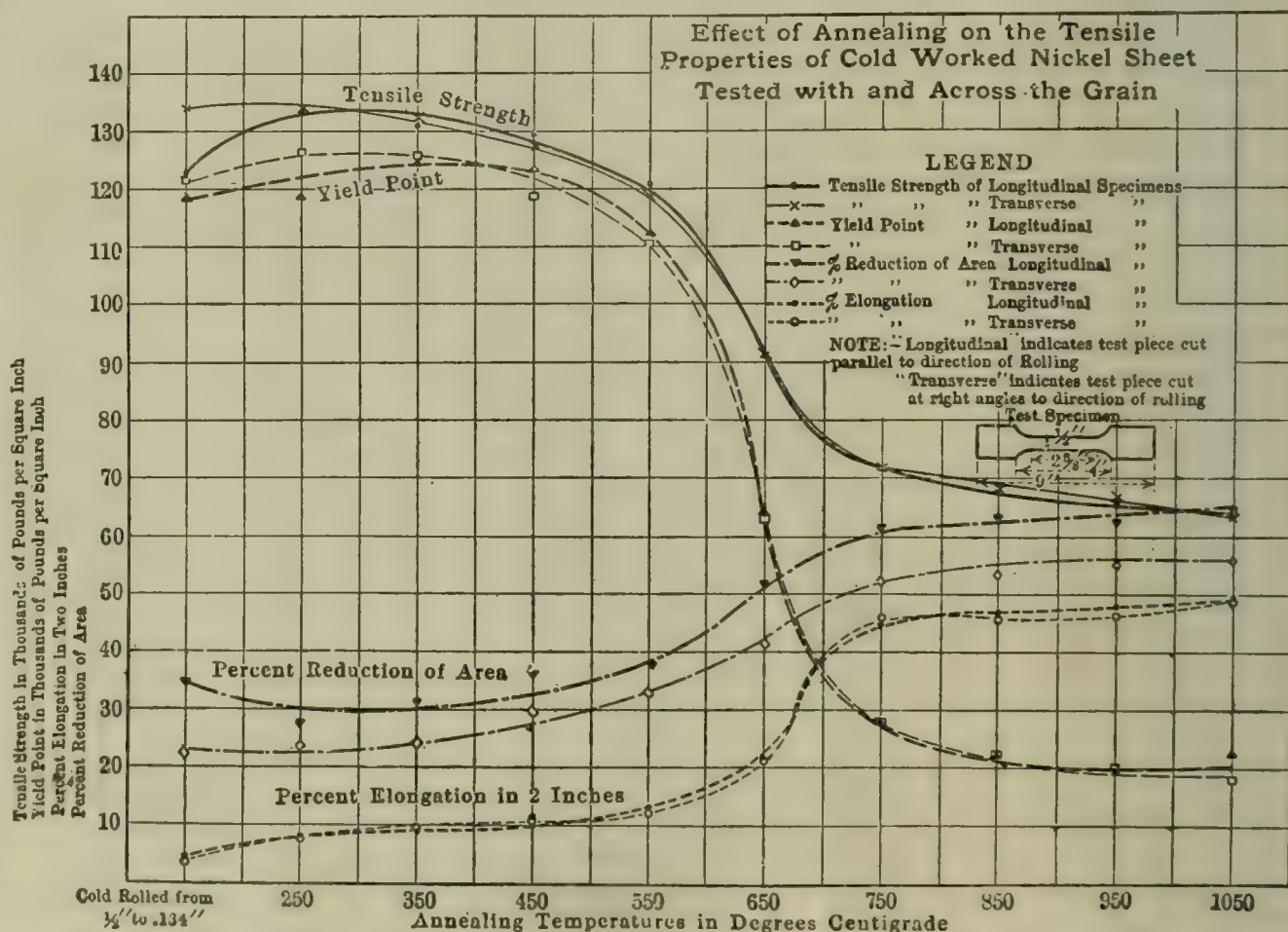
ELECTRODEPOSITION

Outside of the production of electrolytic nickel, the chief chemical application of nickel deposition is in the nickel plating of steel, brass, zinc and numerous alloys, generally in the form of castings or stampings, partly

for protection against corrosion but primarily for the improvement of appearance. Its chief value for this purpose lies in its relative hardness and its resistance to abrasion and atmospheric corrosion. Nickel is used to a limited extent in electrotyping, in which case it may be deposited directly upon the wax or lead mold, producing a true nickel electrotype; or it may be deposited upon the face of a finished copper plate, making a nickel plated electrotype. In general, the function of the nickel upon electrotypes is to give a harder wearing surface; which is also more resistant than copper to the action of the colored inks frequently employed. The production of nickel articles such as tubes by deposition upon wax or other fusible molds has never been commercially successful, though processes recently devised for this purpose appear promising.

PRINCIPAL SALTS OF NICKEL USED IN PLATING AND ELECTROTYPING

The principal salts of nickel used in plating and electrotyping are nickel sulphate and nickel ammonium sulphate (known commercially as "single" and "double" salts respectively). The nickel-ammonium sulphate has the advantage of better conductivity but the disadvantage of lower solubility. Mixtures of the two are frequently used. In 1878 Weston patented the use of boric acid in nickel baths, which has come into quite general use. Boric acid appears to favor more uniform



operation of the baths, and to produce brighter deposits. Experiments of L. D. Hammond³ indicates that the essential function of boric acid is the maintenance of a uniformly small hydrogen-ion concentration in the solution. He found that good deposits can be obtained from solutions slightly acidified with strong or weak acids, none of which, however, is so suitable as boric acid for continued service.

Pure nickel exhibits in a marked degree the phenomenon of passivity when it is made the anode in most acids or salts. In consequence the use of pure nickel anodes

²Discussion of paper by Browne & Thompson, *Transactions, A.I.M.E.*, 1919.

³"Electrodeposition of Nickel," *Trans., Am. Electrochem. Soc.*, vol. 30, p. 201 (1914).

in nickel sulphate solutions would soon bring about an impoverishment in nickel and the liberation of free sulphuric acid. It has hence been customary to add to nickel anodes appreciable amounts of iron, carbon and tin, which by local action increase the solution tension of the nickel. Incidentally they lower the fusing point, and thereby facilitate the casting of the nickel anodes, and contaminate the solution with an accumulation of slimes. This may be prevented to a large extent by the addition of chlorides, or more recently of fluorides, to nickel baths, both of which reduce anode passivity and increase the corrosion of purer metal. Chlorides of sodium, ammonium, nickel or magnesium are frequently added. The fluorine is usually added in the form of hydrofluoric acid, though it is preferable first to neutralize this acid with nickel carbonate, thus forming nickel fluoride.

In addition to aiding in anode corrosion, the presence of sodium or ammonium chloride increases the conductivity of the solutions. Other salts are sometimes added to nickel solutions to increase the conductivity—e.g., ammonium sulphate (in the form of or in addition to nickel ammonium sulphate) and magnesium sulphate. Salts of organic acids, such as tartrates, citrates, etc., which have also been added, may serve, (1) to regulate the acidity, (2) to dissolve basic compounds, especially of iron, and (3) to reduce the rate of chemical deposition of nickel by more positive metals. The latter function is especially useful in the nickel plating of zinc and zinc alloys.

In general, nickel plating has been conducted at low temperatures, but Watts⁴ has shown that in solutions containing nickel chloride and sulphate, and boric acid, hot solutions may be employed to advantage, and may permit the use of much higher current densities.

FORMULAS OF VARIOUS TYPES OF NICKEL BATHS IN COMMERCIAL USE

The following formulas illustrate the various types of nickel baths in actual commercial use. It is not implied, however, that these formulas will always be satisfactory, much less that they are the best for a given class of work.

	Grams per Liter	Ounces per Gallon
<i>Nickel Electrotyping</i>		
Nickel ammonium sulphate...	45	6
Nickel sulphate	15	2
Sodium chloride	7.5	1
<i>Nickel Plating—Double Salt Solution</i>		
Nickel ammonium sulphate...	90	12
Ammonium chloride	22.5	3
Boric acid	15	2
<i>Nickel Plating—Single Salt Solution</i>		
Nickel sulphate	120	16
Ammonium chloride	22.5	3
Boric acid	15	2
<i>Nickel Plating (Watts)⁴—For High Current Density, or in Hot Solutions</i>		
Nickel sulphate	240	32
Nickel chloride	15	2
Boric acid	30	4
<i>Nickel Plating on Zinc (Hammond)⁵</i>		
Nickel sulphate	240	32
Nickel chloride	15	2
Boric acid	30	4
Sodium citrate	175	23

⁴Trans., Am. Electrochem. Soc. vol. 29, p. 395 (1916) and vol. 23, p. 99 (1913).

⁵"Electrodeposition of Nickel," Trans., Am. Electrochem. Soc., vol. 30, p. 201.

The Chemical Industry of Switzerland

BY DR. A. LANDOLL*

SWITZERLAND is exceedingly poor in raw materials and has to import practically everything (with but few exceptions) from abroad.

Switzerland's wealth of water power and the favorable position of the waterfalls made conditions somewhat easier for the chemical industry of the country after the problem of the transportation of electric power had been solved in the '80s and large power stations had been built on the Rhine, the Aar, the Doubs, the Rhone, etc. In particular a foundation was laid for electrochemistry and electrometallurgy which led to an enormous development, so that the condition of relatively cheap motor power could be fulfilled.

The second condition—namely, the existence of trained and skilled chemists, together with technical and commercial staffs—the chemical industry owes in the first instance to the high development of our federal and cantonal educational establishments, particularly the Federal University and Polytechnicum, and above all, the chemical institutions, which have always understood how to keep up an active and intimate contact between science and technics. All these factors have enabled the chemical industry of Switzerland to attain great prosperity in spite of the difficult circumstances in which it is placed.

The most important export branches of the Swiss chemical industry are the Basel aniline dye factories and the electrochemical and electrometallurgical works.

This comprises all the Swiss concerns which are occupied with the manufacture of artificial organic dyestuffs (aniline dyes) and the preparation of dyestuff extracts.

THE CHEMICAL-PHARMACEUTICAL INDUSTRY

Closely connected with the dyestuffs industry is the chemical-pharmaceutical industry, in which the Basel concern also participates. This branch made extraordinary progress during the war.

The chemical-pharmaceutical industry of Switzerland was established at a time when a number of chemical-pharmaceutical enterprises were already in existence abroad, especially in Germany. A great deal of courage and a keen spirit of enterprise were necessary in order to take up competition with the foreign industry, the reputation of which was already established. The plan thus tenaciously grasped and carried out with far-seeing vision prospered exceedingly, and today we may look with pride and happiness on the rapid and successful development of our native chemical-pharmaceutical industry. The factories were soon in a position to venture on independent labor in certain domains of pharmaceutical chemistry, and the preparations they have turned out have acquired a good name all over the world.

The export figure for pharmaceutical articles and drugs, which was 17,687,385 fr. in 1913, went up to 26,533,000 in 1919.

TAR DYES

The production of tar dyes increased from year to year and the Basel firms were keen competitors on the international markets. Since 1911 the Society for Chemical Industry, Basel, has taken up the manufacture

*President of the Swiss Society for Chemical Industry.

of artificial indigo and thus become a competitor of Germany. In order to be able to keep their place on the world's markets during the transition period and to compete successfully with Germany in future, the three leading Basel factories, the Society for Chemical Industry, the Chemical Works, formerly Sandoz, and the firm of J. R. Geigy, Ltd., formed an amalgamation in 1918 similar to that of the German factories, which provides for a community of interests for a period of fifty years. About 90 per cent of the total production of these firms goes abroad.

Founded in 1864 and transformed into a limited liability company in 1885, the Society of Chemical Industry at Basel now has a capital of 20,000,000 fr. and gives employment to more than 2,700 hands and 530 commercial and technical employees. Hence it occupies a not unimportant rank in the chemical industry of this country both as regards the manufacture of dyes and the preparation of pharmaceutical and photographic products.

During the last few years (from 1913 to 1919) the exports of aniline dyes went up from 25 to 123.6 million fr. The export value of artificial indigo rose in the same time from 3.9 to 12.2 million fr.

SYNTHETIC PERFUMERY

The synthetic perfumery industry was introduced into Switzerland in 1895, at first only on a small scale. The industry made rapid progress, however, and flowered in a comparatively short time. The six important firms which make these articles turn out natural perfumes by synthetic methods. The main business is done in exportation. The exports of perfumes and soaps totalled 16.1 million fr. in 1919.

The extension of the use of water power in Switzerland during the last two decades has contributed enormously to the development of the electrochemical and electrometallurgical industries. The oldest and at present the largest is the Aluminium Industry Co., Ltd., Neuhausen, with works on the Rhine Waterfall and at Chippis (established in 1888), which was the first in the world to produce pure electrolytic aluminum according to its own process. Nearly all electrochemical manufactures produced abroad are turned out in Switzerland too. The old methods based on chemical processes have been replaced by the electrolytic process, such as the manufacture of metallic sodium, caustic soda and chlorine, chloride of calcium, together with a number of other inorganic and organic derivatives of chlorine. We may further mention the manufacture of oxygen, hydrogen, nitric acid, hydrocyanic acid, nitrate of urea and their derivatives, then the persulphates, perchlorates, calcium metal, silicon, ferrosilicon, ferrochrome, etc.

EXPORTS

Thanks to the enormous demands on the part of foreign countries during the war for electrochemical and electrometallurgical products, the exports of these articles from Switzerland increased considerably, as may be seen from the following table:

	1913	1914	1915	1916	1917	1918	1919
	In 1,000 Tons						
Calcium carbide..	32	36	55	58	59	76	37
Ferro-alloys.....	16	17	19	23	23	16	10
Raw aluminum...	7	7	9	11	11	10	5
	<u>55</u>	<u>60</u>	<u>83</u>	<u>92</u>	<u>93</u>	<u>102</u>	<u>52</u>

The exports of these three articles reached their maximum in 1918, but they went down to almost half in

1919 after the demands of the belligerent countries had ceased. At the present time there are about eighteen electrochemical works in Switzerland. The manufacture of varnishes and paints, mineral and pigment dyes, printing and lithographing colors, glue, etc., has also taken a remarkably strong development.—*Swiss Exporter*, Special Edition for North America, p. 25.

The Removal of Nitrates by Means of Alcohol

BY R. SCHNEIDEWIND

Many analytic procedures demand the absence of nitrates. For instance, most methods for the electrolytic determination of nickel require that all nitric acid be expelled; in the determination of zinc in brasses, copper must be removed either by metallic aluminum or by sodium thiosulphate. Nitrates in the first case seriously affect the completeness of the separation; in the second case they oxidize the sulphur, hinder the copper precipitation, and if precipitation is completed there is a large quantity of colloidal sulphur that is very inconvenient to work with. In the separation of Zn and Al by means of H_2S in acid solution, in some electrolytic methods for determining Co, Fe, Cd and in many other cases nitrates must not be present.

Common practice is to add 10 to 15 c.c. of concentrated sulphuric acid and boil down until white fumes of SO_3 are evolved. This method gives rise to various objections. Considerable time is required to concentrate a solution of, say, 200 to 250 c.c.; there is always danger of bumping and spattering when a quantity of salts crystallize out; and as in the case of nickel, for instance, under some conditions complex sulphates are formed which are soluble only with difficulty.

The writer has used ethyl alcohol to remove nitrates in routine work—none remaining to interfere with any succeeding operation which would be incomplete in the presence of nitric acid. To a solution containing 20 c.c. concentrated HNO_3 and about 150 c.c. H_2O , 15 c.c. concentrated H_2SO_4 is added and then heated. When nearly boiling, 5 c.c. ethyl alcohol is added, taking care not to pour in too rapidly so that the solution boils over. From time to time 3 to 5 c.c. C_2H_5OH is cautiously added until further addition no longer causes an evolution of NO , fumes. It is then boiled five minutes longer to expel the excess alcohol. This will not give a positive test for nitrate with the usual brown ring reagent and does not oxidize the S in H_2S . The writer has found copper only to be affected when treated in this manner, some being precipitated as a cuprous compound.

About twenty minutes is required for the whole operation, including the time for boiling off the excess alcohol, thus effecting a great saving of time over the concentrating to SO_3 fumes method and without the danger of loss through spattering.

Laboratory, Studebaker Corp.

Sulphur Refinery to Be Erected in Portland

The Stauffer Chemical Co. has purchased a site in Portland, Ore., upon which to erect a plant for refining sulphur. Because of the increased railroad freight rates, great quantities of sulphur are moving from the Gulf of Mexico to Portland by the all-water route. Three full cargoes of crude sulphur in bulk have already been discharged at Portland for the Texas Gulf and Union Sulphur companies, and two more steamers have been booked to move sulphur cargoes from Sabine and Galveston, Tex., to Portland.

Survey of the Physics and Chemistry of Colloids*

Physical and Chemical Properties of the Colloidal Phase—Formation by Condensation and Dispersion—Symmetrical Structure—Resistance to Displacement in Solution—Viscosity and Colloidality—Aggregation and Other Structural Changes

By THEODORE SVEDBERG

THE science of colloids is a science of the micro-structure of matter. In it is reflected the tendency of modern natural science to deal more and more intensely with the problem of structure in its full extent. In the great science of the structure of matter, the science of colloids forms the domain that lies above molecular dimensions and beneath microscopic dimensions. In this domain we have a great number of those systems which are the basis of our material culture and the basis of life as a whole. All living beings are built up of colloids—almost all our food, our articles of clothing, our building materials, are colloids. Or, to mention some special systems, protoplasm, proteins, glue, starch, all kinds of fibers, wood, brick, mortar, cement, certain kinds of glass, rubber, celluloid, etc. The importance of colloid science for many industrial questions is, therefore, beyond all doubt.

The science of colloids is a rather young one. The field of study which it concerns has for a long time been disregarded. In order to be able to treat with success all the questions presented to us by industry, there is still much to be carried out in the department of pure colloid science. In what follows, I will try to give a short review of the scientific results so far obtained and of the problems which, in my opinion, need especial attention.

The various branches of colloid science are connected to such an extent that it is very difficult to treat the different questions separately. We will try to fix our attention on two principal problems: (1) The formation of colloids, and (2) the changes of structure in colloid systems. Connected with both these is the problem of the properties of colloids and the changes in these properties during the processes mentioned under problem 2.

The formation of a colloid may be effected in two ways, different in principle—viz., by condensation and by dispersion, according as one tries to obtain a micro-structural system, a colloid, from a molecular structural or a macrostructural system.

FORMATION BY CONDENSATION

In the case of a condensation process, the degree of "graininess" or the degree of dispersion will become higher as the degree of supersaturation increases, which must, of course, always precede condensation. This is the case when fogs are formed by adiabatic expansion of gases—e.g., cloud-formation in the atmosphere—when metal colloids are prepared by condensation of the vapors of metals from the electric arc, or when a slightly soluble substance—e.g., barium sulphate—is precipitated by means of a reaction between ions. The condensation

always proceeds from certain heterogeneities in the medium's condensation centers or nuclei. As such nuclei, we may have particles of the substance which is to be formed by the condensation—e.g., precipitation of gold on small gold particles when preparing gold hydrosols or gold ruby glass—or gas ions—e.g., fog formations in cases at low degrees of supersaturation—or complex molecules—e.g., fog formations in gases at high degrees of supersaturation. The manner in which these nuclei are introduced into the system under condensation is of great importance for the degree of dispersion of the colloid resultant. If the nuclei are not introduced into the system all at once, but gradually in the course of the condensation process, the particles will be very unequal in size.

The biologically important colloids—e.g., the proteins—are evidently all formed by condensation, but no details of this process are known. The tendency toward condensation manifests itself in the fact that even the protein molecules are, from a purely chemical point of view, condensation products.

FORMATION BY DISPERSION

In case of a dispersion process, there is always work to be performed against the surface tension or the cohesion force. Accordingly, such a process is, in contradistinction to a condensation process, a forced and not a spontaneous one. We know very little as to the relation between degree of dispersion and experimental conditions. When emulsifying fats and hydrocarbons, the surface tension may be lowered by the addition of small quantities of alkalis or soaps. Grinding, in general, does not lead to a very high degree of subdivision; but it is possible to increase the latter by adding an indifferent solid diluent which can easily be dissolved and removed, leaving the disperse phase suspended in the solvent used. Thus, colloid sulphur has been prepared by grinding sulphur with urea and putting the substance in water. A combination of grinding and chemical effects on the material may also be used. It seems that, in many cases, a prevention of the aggregation of the particles by means of suitable additions ought to render possible the preparation of high disperse systems by pure grinding.

Bubbles and foam might be regarded as a kind of colloids formed by dispersion. On spontaneously breaking up they form new disperse systems in which the phase that was previously the continuous one becomes the non-continuous one, and *vice versa*. The system "soap foam—air," with the soap solution as the continuous and the air as the non-continuous phase, is transferred on account of surface reduction—i.e., condensation—into the system "soap solution drops—air," with the air as the continuous phase. Mercury foam

*Read before the Faraday Society and the Physical Society, London, Oct. 25, 1920.

in water (produced by means of pumping water through mercury) breaks up into a mercury hydrosol partly very fine-grained.

CHANGES IN STRUCTURE

A newly-formed colloid may, immediately after its formation, undergo changes of structure of a more or less profound nature. On the other hand, it is nearly always possible to prevent the occurrence of such changes and therefore we have a right to distinguish and investigate the primary structure as the direct result of the colloid-forming process. Colloids with primary structure may conveniently be called primary colloids.

We have at our disposal several methods for the closer study of the structure. Almost every property of a colloid depends on the structure, and therefore, conversely, from the study of the properties of colloids we may draw conclusions as to their structure.

The most important and most obvious means is the microscope and the ultramicroscope. With their aid it is often possible to settle whether the colloid under investigation is of a grainy structure—e.g., a colloid gold solution in water—a gold hydrosol, or of a foamy structure—e.g., high disperse soap foam—or of a fibrous structure—e.g., soap solutions of a certain concentration. The number and approximate size of the discontinuities—e.g., the particles—may also be determined in this way. One may, for instance, count in the ultramicroscope the number of particles observed in a certain volume of gold hydrosol, and by means of analysis determine the content of gold present in the sol. From these figures we get the mass and approximate size if, for instance, we make the assumption that they are spherical. On the other hand, the ultramicroscope gives little or no information about the form or structure of the particles.

SYMMETRY

A means of deciding whether the particles are symmetrical is to be found in the study of the behavior of the colloids in magnetic or electric fields. Non-symmetrical particles are oriented by such fields and thereby impart to the colloid a certain, though in general very slight, degree of double refraction, which may easily be measured with great accuracy. In this way we have been able to settle that the particles in common sulphur hydrosols, prepared by oxidation of hydrogen sulphide, are spherical; but sulphur hydrosols, prepared by grinding sulphur with urea, are dissymmetrical. The particles in gold hydrosols prepared by reduction are dissymmetrical to a high degree.

OPTICAL PROPERTIES

Two other optical properties, viz., the light absorption and its accompanying phenomena, the scattering and polarization of light—the Tyndall phenomenon—may also in certain cases be used for structure studies. Theory, as well as practice, proves that these phenomena are, for instance, dependent to a great extent on the degree of dispersion of the sol. The form and structure of the particles also influence the said properties, but in a manner hitherto unknown. The emission of light from illuminated particles especially—the Tyndall light cone—varies to a great extent with the size of the particles or the degree of dispersion. Colloid solutions that contain very small particles—e.g., Faraday's gold hydrosol—give only a slight emission; the light cone is scarcely visible. Those with large particles—e.g., gold

sols made from Faraday's gold sols by allowing the particles to grow in a reduction-mixture—emit very much light; the Tyndall cone is very prominent. The optical properties of the particles also play a great part. Thus metal particles emit much light, particles of silicic acid or of gelatine only a little.

RESISTANCE TO DISPLACEMENT IN SOLUTION

The resistance exerted on the particles by the surrounding medium when they move under the influence of a force is a means of investigation that is now often used for the determination of the size of the particles. In some cases—e.g., when a sol is filtered through a membrane of collodion or gelatine (ultrafiltration)—the connection between the resistance and the size of the particles is not known in detail, but we are justified in assuming that the resistance rises with the size of particles. The small particles are more rapidly pressed through the filter than the large ones. Certain kinds of filters transmit molecularly dissolved substances, but not colloids; an important method of separation, especially in biochemistry. If a colloid is separated from a great quantity of dispersion medium by such a membrane, the molecularly dissolved substances—the crystalloids—diffuse through the membrane, leaving a colloid of a purer state—Graham's dialysis. If the particles are spherical and move through a liquid, the resistance is $6\pi\eta rv$, where η is the viscosity, r the radius and v the velocity. If the force that causes the movement is known—e.g., gravity—the radius may be calculated.

Thus, by measuring the velocity of sedimentation, the radius can be found. We have

$$r = \sqrt{\frac{9\eta v}{2(s_1 - s_2)g}}$$

where s_1 is the specific gravity of the particle, s_2 that of the liquid, and g the gravity constant.

Even when no exterior forces are acting, the particles in a colloid solution are in movement because of the impacts from the surrounding molecules. This is the so-called Brownian movement, which has attracted so much attention of late. According to the kinetic theory of the Brownian movement, which has been fully confirmed experimentally, each particle, whatever its size and nature, has the same translatory energy as a mole-

cule—i.e., $\frac{3RT}{2N}$, where R is the gas constant, T the

absolute temperature, and N the Avogadro constant. Because of the resistance of the surrounding medium, the mean value of the quadrate of the distance traversed in the time t by the particle is $2Dt$, where D , the dif-

fusion constant of the particles, has the value $\frac{RT}{N} \cdot \frac{1}{6\pi\eta r}$.

Thus, if the displacement of the particle is measured the radius may be found. In certain cases it is more convenient to measure D directly and then calculate r by means of this experimental value.

Owing to the fact that the size of the particles is rather great in comparison with that of the molecules, colloids diffuse very slowly compared with crystalloids. As a matter of fact, Graham, the founder of colloid chemistry, regarded this property as the fundamental difference between colloids and crystalloids. We know now that between colloids and crystalloids—so very different in their extremes—there exist all degrees of transition forms and therefore all degrees of diffusibility.

The size of particles may also be determined by measuring the sedimentation equilibrium—i.e., the distribution of the number of particles per c.c. under the joint influence of gravity and the Brownian movement. In this equilibrium, the concentration of the colloid diminishes, exponentially with increasing height, as is the case with the atmosphere surrounding the earth.

Hence

$$r = \sqrt{\frac{RT}{N} \cdot \frac{\ln \frac{n_1}{n_2}}{\frac{4}{3} \pi (s_1 - s_2) g (x_2 - x_1)}}.$$

The osmotic pressure of a colloid solution is determined, as far as the colloid in it is concerned, only by the number of particles per cubic centimeter (n).

We have

$$p = \frac{RT}{N} \cdot n$$

Consequently, the osmotic pressure is a measure of the degree of dispersion. The osmotic pressure of a colloid is often determined by means of a common osmometer, provided with a membrane permeable to crystalloids, but impermeable to the colloid particles. Now, however, owing to ion absorption, the particles are, in most cases, surrounded by an electric double-layer of ions, and the colloid thus acts as an electrolyte, one ion of which is able to penetrate the membrane, but not the other. This causes complications. A so-called membrane equilibrium is formed, and the osmotic pressure found is not a real measure of the structure of the colloid.

Owing to the Brownian movement, the number of particles in every small volume of a sol undergoes spontaneous and incessant fluctuations. Hence the value of every property of the colloid in the small volume fluctuates.

This phenomenon, predicted by the kinetic theory for colloidal as well as for molecular solutions, has been the subject of extensive investigations. The results are of importance because they show that Boyle's law holds good very exactly for dilute colloid solutions, and because of the light they have thrown on the applicability of the probability calculus to a natural phenomenon. From these studies we have also obtained a deeper comprehension of the conception of entropy. For they have shown, in a direct and experimental way, that the law of the incessant growth of entropy only holds for macroscopic systems.

It often occurs that the particles of a colloid are too small to be measured directly—e.g., by means of the ultramicroscope or by determining the velocity of sedimentation. In some of these cases one can overcome the difficulty by depositing gold on the particles, thus increasing their size. This method has already been applied to sols of almost all the metals, and to sols of some sulphides. If the quantity of gold on a particle is known, it is easy to calculate the radius in the usual manner.

In most colloid solutions and precipitates there are particles of various sizes, and the investigator should, of course, be able to determine not only the mean size, but also the real structure of the sol—e.g., the law governing the distribution of the various sizes of particles.

Finally, we will consider two phenomena, the study of which does not, it is true, enable us to carry out direct measurements of the structure, but which, in spite

of that, are of great interest in judging of the structure of colloids, viz., the viscosity on the one hand, and, on the other, the adsorption and the accompanying phenomena, viz., the cataphoresis and the electric endosmose.

RELATION OF VISCOSITY TO COLLOIDALITY

The viscosity of a sol depends, in a manner not yet known, on the size of the particles, the concentration, etc., but above all on the nature of the particles. Some sols—e.g., metal hydrosol, suspensions of barium sulphate (case 1)—have a viscosity only slightly greater than that of water, but others—e.g., silicic acid hydrosol, oil emulsion gelatine solution (case 2)—have a viscosity many times greater than that of water. From the fact that suspensions with undoubtedly solid particles come under case 1, and emulsions with undoubtedly fluid particles come under case 2, the conclusion has been drawn that the fine-grained colloids under case 1 also contain solid particles and those under case 2 fluid ones. If this be the case, measurements of the viscosity would be a capital means of ascertaining the state of aggregation of the substance of the particles. Recent investigations indicate, however, that the case is far more complicated. Small particles probably have relatively thicker water coverings than greater particles, and, accordingly, the viscosity is higher in a fine-grained colloid than in a coarser one, provided the two sols have particles of the same material and are of the same concentration by weight (e.g., sulphur hydrosols). When the potential difference between particles and fluid is altered the thickness of the water-coverings should alter and, as a matter of fact, the viscosity is altered too. As the water-covering increases, the particle will act more and more like a drop of fluid in relation to the surrounding medium and will, therefore, as far as the viscosity is concerned, approach more and more to the limiting case which is represented by an oil emulsion.

ADSORPTION

The phases—two or more in number—in a disperse system have a contact surface very largely relative to the volume of the system. It is obvious that in such circumstances, adsorption differs in strength. If an electrolytically-dissociated salt is adsorbed, cations and anions are, of course, brought together at the contact surface in equal numbers, but the adsorption of the particles in relation to cations and anions is most often unequal, inasmuch as one is present in excess nearest to the surface of contact and the other in excess some way out of the liquid. The result is the formation of an electrical potential difference, a so-called adsorption potential difference or an electrical double-layer. Because of this the disperse phase, when exposed to the influence of an electric field, will migrate toward one of the poles, provided it is freely movable, as in the case of a colloid solution (cataphoresis). If the disperse phase is immovable the liquid will move in the opposite direction (electrical endosmose). By measuring the velocity of migration of the particles or the liquid under various conditions we are able to study the changes in the difference of potential and thereby in the adsorption. At least at low concentrations the adsorption may be expressed by the formula

$$y = \alpha \cdot e^{\beta}$$

where y is the amount of substance adsorbed per grain adsorbent, e the concentration in the solution of the substance adsorbed, and α and β constants depending

on the nature of both. Now, as a rule, it happens that for the two ions of a salt both α and β have different values—e.g.,

$$\alpha \text{ cation} < \alpha \text{ anion}$$

$$\beta \text{ cation} > \beta \text{ anion}$$

In the example chosen the disperse phase will with increasing adsorption become more and more negative in relation to the dispersion medium. This charge reaches a maximum and decreases to zero, at the point where the adsorption isotherms intersect, then becomes positive and increases again.

COLLOIDAL TRANSITION

The changes of state which may occur on a disperse system, a colloid, are essentially changes of structure. Of course, purely chemical reactions, too, are to be taken into consideration, but they do not play such a prominent part here as in the molecular structural systems. The greater number of the disperse systems, and those of greatest importance, too, are the ones whose disperse phase is embedded in the other phase in the form of particles; in the sequel we will only mention the changes of state in such systems. The most important change of state is the uniting together of the single particles (primary particles) into aggregates (secondary particles). Such an aggregation often occurs directly after the formation of the particles. It may stop for various reasons after the aggregates have reached a certain size. The result is a colloid with complex particles—a secondary colloid. If the aggregation goes on further we may have two extreme possibilities—with many transition forms.

FACTORS DOMINATING IN COLLOIDAL TRANSITION

First Case.—One or more of the following factors dominate—viz., (1) low hydration of the particles; (2) low number of particles per unit volume; (3) great difference in specific gravity between particles and liquid; (4) violent stirring of the system.

The characteristic of this case is that no bridges are formed between the aggregates and that, in consequence of this, they fall to the bottom after having grown sufficiently; the colloid is precipitated (e.g., coagulation of a gold hydrosol by the addition of hydrochloric acid).

Second Case.—One or more of the following factors dominate—viz., (1) high hydration of the particles; (2) high number of particles per unit volume; (3) small difference in specific gravity between particles and liquid; (4) no stirring of the system.

In this case bridges are formed between the aggregates, and the particles arrange themselves into a three-dimensional network throughout the system; the colloid gelatinizes (e.g., the coagulation of a sol of silicic acid by the addition of hydrochloric acid, the setting of a warm gelatine solution when cooling). Owing to capillary forces the liquid is kept in the network with great strength. Measurements have shown that the liquid is under a pressure of several hundred atmospheres. In many respects, therefore, the gelatinized colloid acts as a solid.

NUMEROUS TRANSITION FORMS BETWEEN THE EXTREME CASES

There exist numerous transition forms between these two extreme cases. If the particles are not bound together by bridges into a solid, but still reach macroscopical size and possess a certain loose structure, one

speaks of flocculation of the colloid (e.g., coagulation of ferric hydroxide by addition of ammonia). It may be doubted, however, if such flocculent suspensions are not to be regarded as fragments of a gel of little mechanical resistance shattered by the stirring of the liquid. In case 1 the Brownian movements alone of the particles should suffice.

CAUSE OF AGGREGATION

The most important cause of the aggregation of the particles is the decrease or the disappearance of the difference of potential between particle and liquid. This may be effected by altering the ion adsorption. Hence one of the most important means of bringing about aggregation or disaggregation is addition or removal of ions. Because of the opposite electric and coagulating action of anion and cation and their difference of adsorption there will always exist, for certain electrolytes in relation to a certain colloid, a domain of concentration within which they have a disaggregating action. If a solely aggregating electrolyte is added to a colloid in increasing doses (e.g., hydrochloric acid to a gold hydrosol), the velocity of aggregation first rises rapidly with concentration, then more slowly and reaches a constant maximum value. Let us make the assumption that within the latter region every mutual approach of two particles to a certain limit leads to aggregation, but within the former region only a certain fraction of those approaches. Then it is possible to develop, on the basis of the laws of the Brownian movements alone, a mathematical theory for the kinetic of aggregation.

With regard to the aggregation by electrolytes it has, in addition, been found that inorganic ions of the same valency generally aggregate equally strongly if added in equivalent amounts. This is due to some extent to their being nearly equally strongly adsorbed. When the valency of the aggregating ion increases, the aggregating effect rises very rapidly. The concentrations of the ions K^+ , Ba^{++} , Al^{+++} required to aggregate particles of As_2S_3 to the same degree show the mutual relations: 1, 1/20, 1/1000. Thus the three-valent Al^{+++} has an aggregating power 1,000 times greater than the monovalent K^+ . These circumstances are closely related to the course of the adsorption isotherm, but are not yet quite clear.

The aggregation may be reversible or irreversible—i.e., in certain cases disaggregation may be effected—in others not. Some colloids (e.g., metal hydrosols) are difficult to disaggregate, others (e.g., sulphur hydrosols) are easy. Certain ions nearly always bring about irreversible, others reversible aggregation. The question of irreversible or reversible coagulation is probably closely connected with that of the hydration of the particles. Thus particles which hold much water around them are easily disaggregated. The water-covering prevents the particles from uniting too closely together.

PROTECTIVE COLLOIDS

The aggregating effect of an electrolyte may often be reduced to a very great extent by the addition of a small quantity of a suitable colloid of another kind only slightly sensitive to electrolytes, a so-called protective colloid—e.g., gelatine to a gold hydrosol. As a rule the electric charge of the protective colloid should be of the same sign as that of the colloid to be protected. The mechanism of this protecting action is still but very incompletely known. Most probably the particles of the protective colloid become attached to the particles

of the other colloid and the aggregate resulting from this obtains a good deal of the stability toward electrolyte which characterizes the protective colloid. Colloids of opposite electric charge precipitate each other mutually (e.g., the negative Sb_2S_3 and the positive Fe_2O_3) provided there is not too great an excess of either of them, in which case no precipitation will occur. This is obviously entirely analogous to the action of the ions. Such mutual colloidal reactions are of great importance in the economy of nature and in industry.

In the preparation of easily aggregated colloids a protective colloid is often added in order to maintain the primary structure. Thus the particles of a metal hydrosol, if formed in the presence of a small quantity of a protective colloid, are kept apart even when the sol is evaporated to dryness. The dry substance can be redissolved in water without any perceptible change of structure taking place (e.g., commercial colloid silver).

OTHER STRUCTURE CHANGES

A change of structure that plays a part, formerly a little over-rated, in colloid solutions with comparatively easily soluble particles is the growth of the larger particles at the expense of the smaller ones. In a suspension of calcium sulphate this change of structure is clearly visible, but in the more sparingly soluble barium sulphate the process goes on at an extremely slow rate. Formerly, aggregation, especially the irreversible process, was often interpreted as a recrystallization. In irreversible aggregates as well as in compressed powders there gradually take place association and crystallization phenomena which may greatly change the structure of the system (e.g., silver crystals in sediments from silver colloids).

Processes of the latter kind play a prominent part, especially in gelatinized colloids. On the whole, a great variety of changes in structure and accompanying processes may occur in gels. When gradually deprived of water the gel of silicic acid, for instance, goes through a series of states, some of which differ rather decidedly from others. The nature of these processes is not yet known. A gelatine gel probably consists of particles with a high percentage of "dry substance," and a liquid with a low percentage. In sol-formation water is supposed to pass over from the liquid to the particles, the particle-associations being thereby disintegrated; in the gel-formation the particles lose water.

The study of the structure of gels is a rather difficult one. The particles of most gels do not contrast optically to any great extent with the surrounding medium, and consequently the ultramicroscope is not able, as a rule, to make their primary particles visible. Moreover, these are often packed together so closely that they cannot be distinguished from one another optically. On the other hand, we have been able to study with more success the macroscopic properties of the gels in chemical and physical respects. The elastic gels, especially gelatine, collodion, celluloid, rubber, etc., play a prominent part in industry, and their investigation is, therefore, a matter of great importance.

University of Upsala, Sweden.

Leather Industry Establishes Research Laboratory

Under the auspices of the Tanners' Council of the United States the American Leather Research Laboratories will be established at the University of Cincinnati. G. D. McLaughlin will be in charge.

Legal Notes

BY WELLINGTON GUSTIN

Vessel of Paper United by Fused Cement Not Patentable

The United States Circuit Court of Appeals at Detroit has held that the Harbeck patent, No. 1,062,002, claim 1, for a vessel having walls made of layers of paper united to each other by a fused cement, was void for anticipation, the claim of invention being old in the art at the time Harbeck claimed he made the discovery.

The claim of the patent was on the use of a fused cement to unite sheets of paper into duplex board, practically impervious to moisture, grease and aroma. The court found that the use of fused cement for the purpose of uniting sheets of paper into duplex board was old in the art, having been used for similar purposes and known commercially for more than two years prior to the date Harbeck's application for patent was filed, and therefore the use of this material by a can company in the manufacture of its cans was not invention, but a matter of mechanical skill and judgment.

Salesmanager of Chemical Company May Not Alter Contract of Company Without Authority

A new trial has been awarded by the Court of Errors and Appeals of New Jersey to the Interstate Chemical Co. in its action against the James Leo Co. The chemical company brought this suit to recover for breach of contract, in writing, by which the seller, the James Leo Co., agreed to deliver 10,000 folding boxes, as per sample submitted. The buyer, the chemical company, claimed that by reason of the failure of the seller to deliver the boxes, as per the order, it was obliged to go elsewhere in the public market to purchase the boxes at a far greater price than that fixed in the contract, and that it sustained a further loss by reason of the failure of the seller to carry out its contract and make delivery of the boxes.

The seller claimed a set-off for the value of the labor performed and materials furnished in and about the boxes, and charged that the contract had been modified by the buyer agreeing to take boxes in one color instead of two, and that the buyer had refused to accept the boxes under the modified contract.

Upon trial judgment was given for the seller on its counterclaim, and the Supreme Court of New Jersey affirmed this judgment. On appeal to the Court of Errors and Appeals the first question presented was whether the salesmanager of the chemical company had any authority to alter the terms of a written contract made by his principal, the chemical company. The court said there was no attempt to prove he was so expressly authorized, and that the mere fact of his being the salesmanager gave him no such authority.

The second question was whether the salesmanager was held out by the chemical company as authorized to make this change in the original contract. Now the rule is that where one holds out another as his agent one is bound the same as if express authority has been given. It did not appear that the salesmanager had ever before attempted to change any original contract for the company.

Again it was urged that the chemical company had by its actions subsequently ratified the contract as modified by its salesmanager. The court found that it had no knowledge of the change in the contract until an attempt was made by the James Leo Co. to deliver the boxes all in one color. Ratification by principal of acts of an agent implies that the principal had knowledge of the facts and acquiesced in them.

Court Holds Seller Under the Contract Could Have Others Manufacture the Products

The Court of Errors and Appeals of New Jersey has affirmed the judgment in the action brought by the National Metal Stamping & Manufacturing Co. against the Associated Rolling Mills, Ltd., appealed from the Supreme Court.

The action arose out of a sales contract. The rolling mills contended that at the time of the execution of the agreement it was not in the contemplation of the parties that the National company would have the products called for made by other manufacturers and thus obtain the advantage of their cheaper method. And because nothing on this question appeared in the contract the rolling mills contended that the company was bound to manufacture the articles itself, though it might cost more than they were to receive from the buyer.

The court comments that the buyer must have been extraordinarily ignorant of human nature if it did not in fact contemplate that the seller would seek the cheapest possible way of fulfilling its contract. And if it did not contemplate such when the contract was made, the court said that it must be held bound under the law to contemplate that the seller would pursue the course usual with prudent business men.

United States Supreme Court Holds Virginia Tax Unconstitutional

The United States Supreme Court has reversed the judgment obtained by the State of Virginia against the F. S. Royster Guano Co. of Norfolk. The latter operates a fertilizer plant in Norfolk County, Va., and several plants in other states. During 1916, the company made net profits from the operation of its plant in Virginia amounting in round figures to \$260,000; and from its plants in other states the net profits were about \$270,000. Under the revenue law of the state the guano company returned for taxation as income the former amount, omitting the latter. Under appropriate provisions of the state law, the state officials added the latter amount, and assessed an income tax against the company upon the total.

The company then asked the court at Norfolk for relief from the tax on the \$270,000 for the reason that the state law, in taxing that part of its business which was transacted outside of the limits of Virginia, imposed upon it a burden not placed upon domestic corporations doing no part of their business in Virginia but transacting business beyond the limits thereof, such corporations being expressly exempted from a tax on income derived from business done without the state limits; the state laws thus denying to the company the equal protection of the laws, in violation of the Fourteenth Amendment of the U. S. Constitution.

The court at Norfolk sustained the tax law and this judgment was affirmed by the Virginia Supreme Court of Appeals. The guano company then appealed to the Supreme Court of the United States. This court has said the imposition of tax on income from sources out-

side the state is invalid, where corporations doing no business within the state are not taxed. It says the Virginia law (Acts Va. 1916, ch. 472) in so far as it imposes on a domestic corporation doing business both within and outside the state a tax with respect to its income derived from sources outside the state, denied such corporation the equal protection of the laws, in violation of the Fourteenth Amendment, in view of the statute (Acts Va. 1916, ch. 495) exempting domestic corporations doing no part of their business within the state from any tax on their income; the classification of the property taxed not being reasonable, but arbitrary, not resting upon any ground of difference having a fair and substantial relation to the object of the legislation, so that all persons similarly circumstanced shall be treated alike.

While the latitude of discretion is wide in the classification of property for purposes of taxation, a discriminatory tax cannot be sustained against the complaint of a party aggrieved, if the classification is altogether illusory, said the court.

Manufacturer Must Account for Royalties

An appeal from an order to render an accounting by the Belmont Packing & Rubber Co., formerly known as the Clement Restein Co., unto Norman B. Miller has been dismissed in the Supreme Court of Pennsylvania. It appears that Miller sued the company and recovered a verdict, upon which the order for an accounting was entered, and the appeal was taken.

Plaintiff alleged that he contracted orally with the corporation by which the latter was to pay him 3c. a lb. on all "piston rod packings manufactured and sold by defendant" under certain patent rights which plaintiff had assigned to it, until the expiration of such patents; that the assignments were made, first, for a square hole piston rod packing, and next, for a round hole piston rod, relying upon the oral promise of payment in royalties; that large quantities of the patent article have been sold by the company without an accounting for the royalties due.

The company admitted the assignment of the patent rights, but denied having made any oral or written promise to pay compensation therefor. Mr. Restein, president of the company, testified that both he and Miller worked on the inventions "for the benefit of the company," but it appeared that Miller was the inventor of the patented articles. The rule of law as stated is that one who accepts and continues to take and retain the benefits of an agreement cannot be heard to deny the authority of the agent who acted for him in making the agreement. Restein was thus held to have authority to make the royalty contract as alleged, and the company receiving the benefits from the assignment is liable for the royalties, and the obligation to pay the royalty subsisted so long as the company continued to sell the articles.

In the absence of a contractual stipulation to the contrary, the obligation to pay the royalty would continue, and, after a reasonable time, on demand, the company would be bound to account to the inventor for the sales made by it, the reasonableness of the time being a question to be determined by court or jury.

The assignment contract mentions the sum of \$1 as the consideration for the assignment of the patents, but the court held that such did not prevent the inventor or assignor from showing the real consideration for the patent rights.

Engineering Problems in Dust Explosion Prevention

Causes and Factors Affecting Dust Explosions — Types of Industrial Plants Affected — Ignition Temperatures — Propagation and Velocity of Flame — Pressures Developed — Relation of Humidity — Prevention

By DAVID J. PRICE*

AT THE present time the prevention of dust explosions is commanding the earnest attention of engineers of all classes both in the United States and abroad. This is quite natural, since many engineering problems have been developed in the study of dust explosions, their causes and prevention. Before these explosions can be prevented, it is necessary to understand fully their nature and behavior. This means a determination of the various causes and circumstances under which dusts may be ignited; the manner in which the explosion spreads or propagates; the ignition temperature of the various dusts; the pressure that will be developed during the explosion, and also the effectiveness of any methods which may be designed for prevention.

It is not the intention to consider in this article the simple causes that have been established since the study of grain dust explosions was undertaken by the Federal Government. It is well known that disastrous explosions have resulted from the ignition of flammable¹ dusts by matches, open flames, lanterns or torches. The attention of engineers at the present time should rather be directed particularly to the mechanical causes, especially those which occur during the handling of organic materials.

TYPES OF INDUSTRIAL PLANTS

In order to understand the nature and extent of dust explosions it is essential that consideration be given to the kind of industrial plants in which these explosions are occurring.² Dust explosions have occurred most frequently in plants where grain or grain products are either milled or handled, such as grain elevators, flour mills, feed and cereal mills and starch factories. Disastrous explosions have occurred also in sugar refineries, cocoa and chocolate plants, candy factories, spice works, wood-working establishments, paper mills and printing plants, shoe factories, fertilizer works, cork-grinding plants, drug and herb works and similar types of industrial plants where dusts are created. Explosions of aluminum and magnesium dusts have also taken place. Many disastrous smut and grain dust explosions have occurred in threshing machines in the Pacific Northwest, while a large number of fires have also occurred in cotton gins during the ginning process.

Since May, 1919, a series of very disastrous explo-

sions have occurred in the United States and Canada, resulting in the death of over eighty-eight persons, injury to a large number, and property damage in excess of \$7,000,000. Three of these explosions have occurred in grain elevators, one in a feed mill, one in a starch factory and two in flour mills. In the starch factory explosion forty-three lives were lost and over \$3,000,000 damage was done. Fourteen lives were lost in one grain elevator explosion and ten in another, both explosions being very violent and doing extensive damage to property. In an explosion of "aluminum dust"³ in a Northwestern factory six girls lost their lives and as many others were injured. A recent explosion of "hard rubber" dust in a Michigan plant resulted in the death of eight workmen and has attracted considerable attention.

IGNITION TEMPERATURES OF GASES AND DUSTS

From the experimental work which has already been conducted it appears that a dust explosion is very similar to a gas explosion. Although particles in a dust cloud are larger than the minute molecules in a gas mixture, yet the nature and behavior of a dust explosion appears to be very much the same as a gas explosion. To produce a gas explosion it is necessary that a proper mixture of gas and air and a source of ignition be present. The same condition exists in connection with producing a dust explosion. It is as impossible to produce a "spontaneous" explosion with dust as it is with gas. In both cases the explosive mixture must be ignited by some external source of heat or flame.

In order to obtain some idea as to the relation between dust explosions and gas explosions it will be of interest to note the ignition temperatures of the more common flammable gases in air as determined by Dixon and Coward.⁴

Gas	Ignition Temperature Deg. C.
Carbon monoxide.....	644 to 658
Hydrogen.....	580 to 590
Ethylene.....	542 to 547
Methane.....	650 to 750
Ethane.....	520 to 630

A series of experiments was conducted by R. V. Wheeler, chemist attached to the Explosions in Coal Mines Committee of England. In the first series of tests an effort was made to determine the temperature at which the dust would ignite and propagate flame. A second series of tests was conducted to determine the lowest temperature at which ignition could be effected. The following results were obtained:

Kind of Dust	Ignition Temperature, Deg. C.	Temperature of Flame Propagation, Deg.
Dextrine.....	540	940
Sugar.....	540	805
Starch.....	640	960 to 1035
Flour.....	650	1060
Grain.....	630	995 to 1050

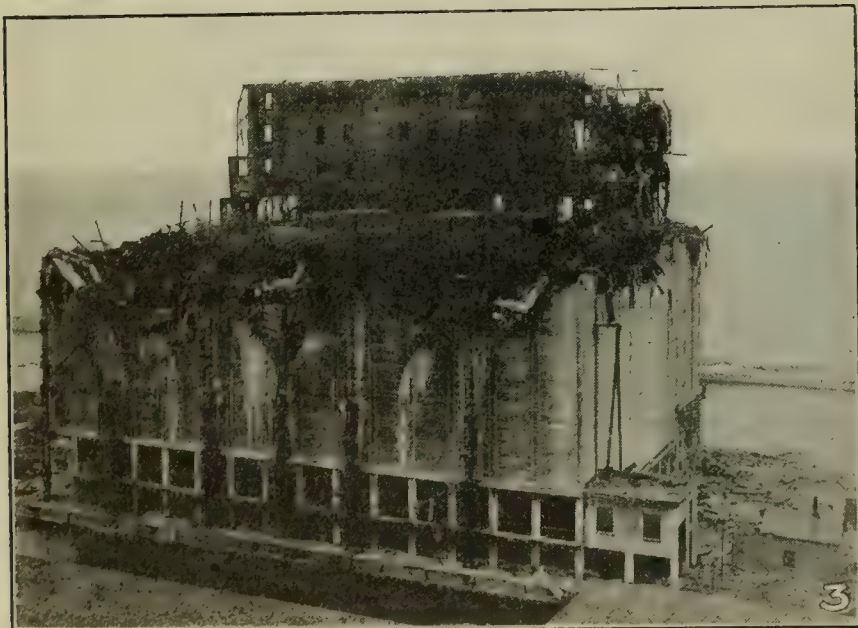
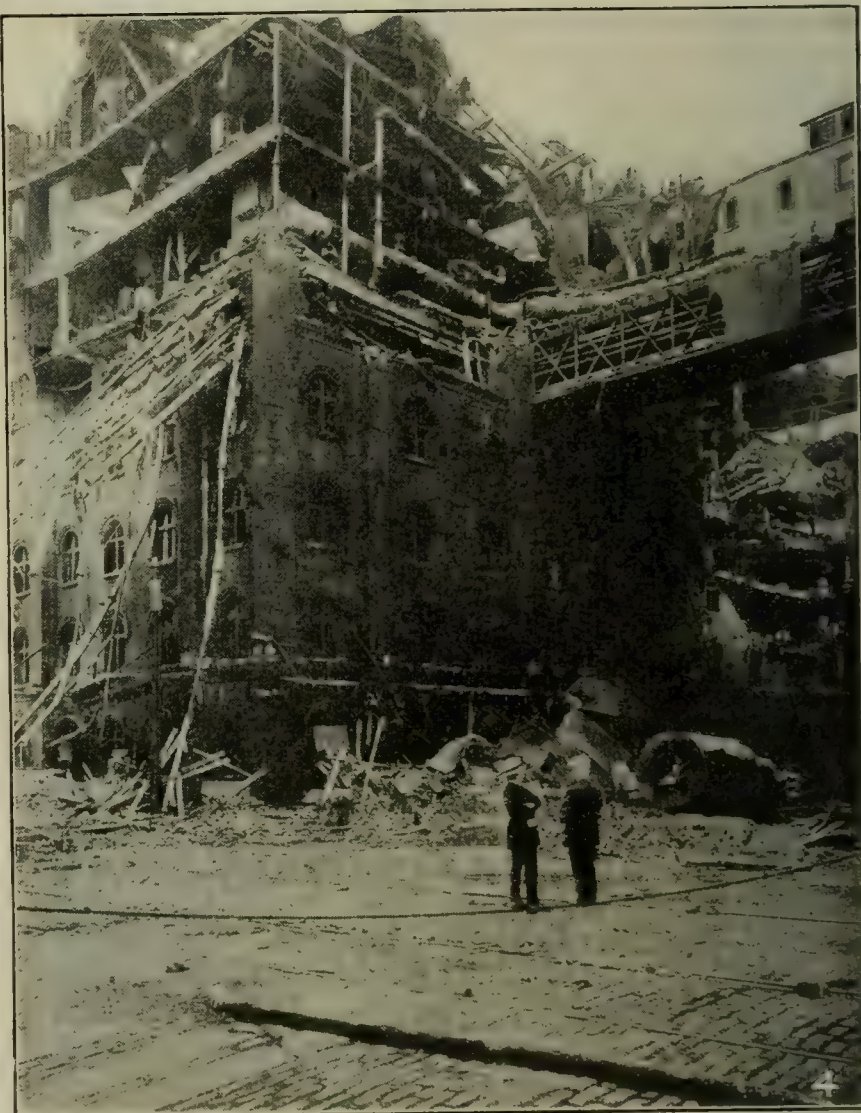
*Engineer in charge Grain Dust Explosion Investigations, Bureau of Chemistry, U. S. Department of Agriculture, Washington, D. C.

¹The National Fire Protection Association, the National Safety Council and similar organizations are now using the word "flammable" instead of the old word "inflammable." Some persons have misinterpreted inflammable, thinking of the first two letters of this word as the prefix *in* whose meaning is *not*, as in inactive (not active), or incombustible (not combustible). Flammable is shorter, more definite and cannot be misunderstood. The negative of flammable is non-flammable.

²The study of the cause and prevention of coal dust explosions is being undertaken by the Bureau of Mines, United States Department of Interior, while the work pertaining to the cause and prevention of dust explosions in industrial plants is being carried on in the Bureau of Chemistry of the Department of Agriculture.

³CHEM. & MET. ENG., vol. 23, No. 19, Nov. 10, 1920, p. 915.

⁴Trans. Chem. Soc., vol. 95, p. 517.



TYPICAL INDUSTRIAL CONFLAGRATIONS

Fig. 1. A large grain elevator in New York harbor being destroyed by fire following dust explosion. Sufficient grain was lost to supply bread rations for 200,000 men for one year.

Fig. 3. Grain elevator, Port Colborne, Canada, at entrance to Welland Canal, badly damaged by grain dust explosion, resulting in loss of ten lives.

Fig. 2. A starch factory in Iowa completely destroyed by starch dust explosion. Forty-three lives were lost and \$3,000,000 property damage was done.

Fig. 4. A sugar refinery badly damaged by explosion of sugar dust. Twelve lives were lost and sugar stocks were destroyed.

Wheeler states in his report that sugar and dextrine appeared to be the most flammable of all the dusts, the temperature at which ignition could be effected being 540 deg. C., a temperature well below red heat. It is interesting to contrast this low temperature with the ignition temperatures of the gases given above, from which it will be noted that the ignition temperatures of sugar and dextrine are lower than methane, carbon monoxide and hydrogen, ranging with ethane and ethylene. Most of the remaining dusts have practically the same ignition temperature, 600 to 650 deg., thereby ranging with the other gases.

When the Federal Government began the study of dust explosions attention was directed to a determination

of the ignition temperatures of the various dusts and the methods and conditions under which these dusts propagated flame. With the apparatus used in the tests, the following results were obtained:⁵

Kind of Dust	Ignition Temperature Resulting in Propagation
Wheat elevator dust.....	1295 C. equals 2363 F
Flour.....	1265 C. equals 2300 F
Oat and corn elevator dust.....	995 C. equals 1821 F
Oat hull dust.....	1020 C. equals 1868 F
Yellow corn dust.....	1025 C. equals 1877 F

⁵Preliminary Report on the Explosibility of Grain Dusts. Co-operative Investigation by Millers Committee, Buffalo, N. Y., under the direction of Dr. George A. Hulett, chief chemist, Bureau of Mines, U. S. Department of the Interior, by David J. Price, engineer in charge, and Harold H. Brown, assistant chemist, Grain-Dust Explosion Investigations, Bureau of Chemistry, U. S. Department of Agriculture. Copies no longer obtainable.

From the many theories which have been advanced in the effort to explain the action that takes place during the progress of dust explosions, two appear prominently: (1) That a distillation of flammable gases occurs when the dust becomes heated, resulting in an explosion; and (2) that the explosion is nothing more than a rapid communication of flame or fire from one particle to another, depending to a large degree on the fineness of the dust. That is, the finer the dust and the lower the moisture content the more rapid the propagation and therefore the greater the violence accompanying the explosion. This would seem to establish very definitely a relation between fire and explosion.

In connection with the investigation of a large number of explosions and fires in grain threshing machines in the Pacific Northwest, the Department investigators made the following determinations:⁶ In 117 cases observed 95, or about 80 per cent, were sudden, violent explosions, and the remaining 22, or 20 per cent, were merely fires. This would seem to indicate that in the majority of cases the explosions were accompanied by violence, while in the others the fire had not advanced to a point where it assumed the proportion of an explosion.

In the 95 cases referred to it was felt that the explosion might be classified either as sudden and violent, or as slight and muffled in nature. The same phenomenon has developed in connection with dust explosions in industrial plants. In many cases a primary explosion, which is nothing more than a small puff, is followed by fire in which the property is extensively damaged or destroyed. In other cases a series of explosions follows, becoming more violent as it progresses, destroying both life and property. This would seem to indicate very definitely that if the dust is present in the plant to feed the original flame, an explosion follows. In plants where little dust is in suspension and where "good housekeeping" is practiced, the occurrence merely assumes the proportions of a fire and no violent explosion results. Reference is made to this phenomenon at this time to emphasize the fact that a disastrous dust explosion may occur during the course of any fire if sufficient combustible dust is present in the plant to feed the flame and allow it to propagate. The dust that accumulates throughout the plant is thrown into suspension by slight concussion, with the result that the primary "ignition" or explosion develops into a secondary explosion of large proportions.

VELOCITY OF FLAME

Experimental work has been conducted to determine the velocity or rate of flame travel in dust explosions. It is understood that the rate of propagation or flame travel in a gas explosion depends upon two factors: (1) The flammability of the gas, and (2) the amount of gas present. For instance, the explosive limit of methane gas ranges from 5½ to 14.5 per cent,⁷ with 9.6 per cent as the most flammable mixture. With this latter percentage the rate of flame travel is the most rapid and the explosion most violent. The rate of flame travel in dust explosions depends also on (1) the flammability of the dust, and (2) the amount of dust in suspension. In some of the early reports of the Bureau of Mines it is stated that the average velocity of flame in coal dust explosions is 2,270 ft. per second. British investigators

report 2,114 ft. per second, while in French experiments 3,300 ft. per second has been obtained.

The maximum velocity of propagation of flame in many gaseous mixtures has been determined with accuracy. The following results have been obtained:

Gaseous Mixtures	Velocity, Feet per Second
Hydrogen, $2H_2 + O_2$	9,250
Ethane, $C_2H_6 + 3O_2$	7,724
Methane, $CH_4 + 2O_2$	7,616
Carbon monoxide, $2CO + O_2$	5,510

The velocity of propagation in explosions through most gas mixtures is more rapid than through most dust clouds, although in a few cases it has been found that the velocity of flame propagation in coal dust explosions has exceeded the maximum for certain gases. In only two tests has any attempt been made to measure the velocity of propagation of the flame in clouds of materials other than coal dust. One indicated that the velocity through a cloud of wheat flour dust was practically the same as through coal dust; the other that the propagation through a cloud of powdered starch was several times as rapid as through coal dust. The results, however, cannot be considered to be conclusive.

PRESSURES DEVELOPED BY DUST EXPLOSIONS

In connection with the determination of the ignition temperatures and the relative ease of flame propagation of dusts an effort has been made to determine the pressures developed during the progress of the explosion. In the large-scale tests that have been conducted the Bureau of Mines reports a pressure of 103 lb. per sq.in. with coal dust. British investigators report pressures ranging from 100 to 120 lb. per sq.in. Taffanel, a French investigator, reports pressures of 227 to 270 lb. per sq.in. He states that in one test at the steel gallery an established pressure strength of 227 to 270 lb. per sq.in. was maintained and that pieces of steel were thrown up a distance of 150 m., or 472 ft.

Much work to determine the relative flammability of the various dusts has been done by both the Bureau of Mines and the Bureau of Chemistry. After a series of extensive experiments the following results, based on the use of 75 mg. of dust in the standard laboratory apparatus, were obtained:⁸

Kind of Dust	Pressure Generated Lb. per Sq.In.
Lycopodium.....	17.5
Wheat smut dust.....	15.9
Yellow corn.....	15.2
Dextrine.....	14.6
Tanbark.....	13.3
Wheat elevator dust.....	13.0
Wood dust.....	12.8
Corn starch.....	12.7
Sugar.....	12.2
Potato flour.....	11.7
Fertilizer.....	10.5
Coal (Pittsburgh).....	10.1
Cocoa.....	9.1
Sulphur.....	8.8
Cork.....	7.4

From these results it might be concluded that the grain dusts are more flammable than Pittsburgh standard coal dust. This has been confirmed by large-scale tests which indicate that flame propagates through a cloud of grain dust more easily and with a more violent explosion than through a corresponding amount of coal dust.

In very recent tests conducted in co-operation with the Bureau of Mines in the steel galleries at Bruceton, Pa., it was found that flour and coal dusts acted similarly. Starch dust propagated more rapidly, produced

⁶U. S. Department of Agriculture, Bulletin 379, p. 5.

⁷U. S. Bureau of Mines Technical Paper 150, p. 6.

⁸Journal of Industrial and Engineering Chemistry, vol. 9, No. 3, p. 269.

higher pressures, and did a great deal of damage to the steel galleries used in the tests.

It has already been stated that dust must be present in suspension in proper proportions before an explosion can occur. Efforts are being made in the experimental work to establish these proportions, as has already been done in connection with the gas mixtures. In some of the tests conducted results were obtained when one-twentieth grain, or 0.00176 oz., of dust was put in suspension in 1,400 c.c., or 85.36 cu.in., of air. To obtain the same proportion of dust in air and render the mixture as flammable as that used in the laboratory test it would be necessary to have only 10 lb. of the dust in a closed room containing 4,466 cu.ft., or a room 10 x 30 x 15 ft.

The first dust explosion to attract attention in this country occurred at Minneapolis in 1878. Professors Peck and Peckham of the University of Minnesota conducted experimental work in the investigation which followed the explosion. In this investigation it was found that by blowing 2 oz. of dust upon an open flame in a box containing 2 cu.ft. of air sufficient pressure was developed to lift two men standing on the cover.⁹ This would mean diffusion at the rate of 1 oz. of dust to 1 cu.ft. of air space. Their report states that a sack of flour and 4,000 cu.ft. of air will generate force enough to throw 2,500 tons 100 ft. high.

The Bureau of Mines reports that explosions could be produced when only 0.032 oz. of coal dust was suspended in 1 cu.ft. of air, or 1 lb. in 500 cu.ft. It was found in order to produce complete combustion all the oxygen in 1 cu.ft. of air was required to burn 0.123 oz. of the dust used.

In the French experiments conducted by Taffanel an instance is cited when the low weight of 0.023 oz. of dust per cu.ft. of space was sufficient to produce an ignition.

Experimental work is now in progress to determine definitely the smallest amount of dust in suspension per unit area through which an explosion can propagate.

RELATION OF HUMIDITY TO EXPLOSION FREQUENCY

The relation of humidity to the frequency of dust explosions has been markedly noticeable in the investigational work. This is especially true in connection with explosions where static electricity has appeared as a probable cause. In the large number of thresher explosions in the Pacific Northwest, which comprises the inter-mountain territory between the Cascade and Rocky Mountain ranges, it was found that in 128 cases 86 explosions, or 70 per cent of the total, occurred between the hours of 1 and 7 p.m., when the humidity was extremely low. The range of humidity was usually from 6 to 17 per cent. These explosions have occurred in grain separators during the threshing of wheat containing smut dust. In 112 explosions from 1 to 35 per cent of the heads of wheat being threshed were smutted. In 108 cases the average smut percentage was 15.

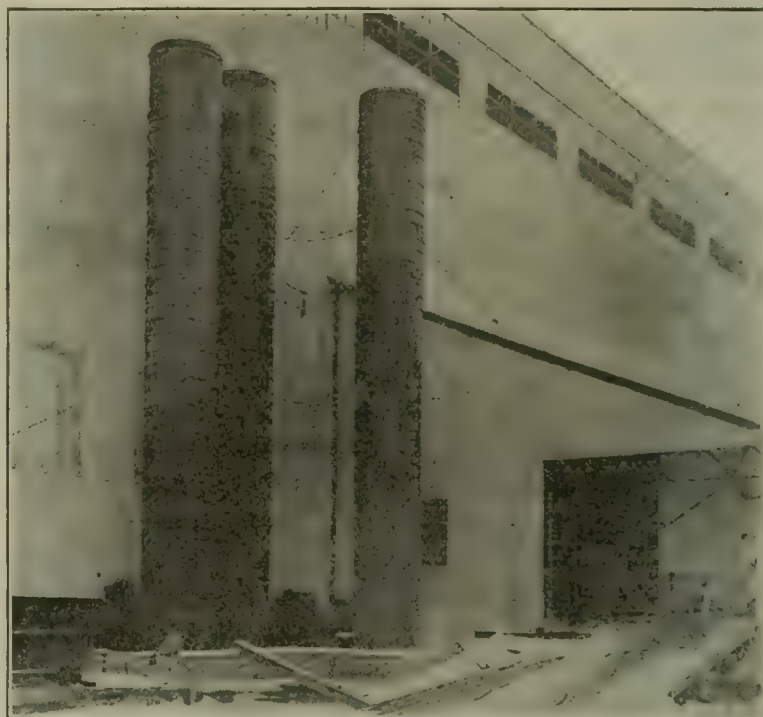
A study of fires in cotton gins in certain sections of the South developed the same relation. Although this relation has not been definitely determined in industrial plants it is reasonable to conclude that the dust explosion hazard is greater during periods of continued low humidity.

This article has been confined largely to the theory of dust explosions together with the causes and factors

affecting these explosions. An article is now in the course of preparation dealing with the methods of prevention that have been developed and proved effective, and also the chemical engineering research problems demanding attention.

Wood Pipe in the Chemical Industry

The accompanying illustration shows a system of towers for the collection of hydrofluoric acid from acid phosphate manufacture at the plant of the Jarecki Chemical Co., Cincinnati. This pipe was manufactured and installed by the Michigan Pipe Co., of Bay City, Mich. The layout is composed of three vertical towers of 48-in. inside diameter, the acid gas



WOODEN TOWERS FOR HYDROFLUORIC ACID

main being 30 in. inside diameter and the special wood elbows and tees also constructed of 30-in. pipe. The gases are drawn from the bottom of tower 1 to the top of tower 2 through a 32-in. specially mortised pipe connection. Draft is created by the exhaustor at the bottom of tower 2. This type of construction is becoming general in the fertilizer industry and pipe may be made in any lengths desired up to 16 ft., being constructed of 3-in. thick Canadian white pine staves, double-tongued and grooved on the lateral edges and molded on the inner and outer faces to conform with the inside and outside diameter of the pipe. Each section of pipe is mortised and tenoned so that it may easily be set in place. The towers are tightened by the $\frac{3}{4}$ -in. rod placed 10 in. apart, excepting at the joints, where the spacing is 4 in. to provide extra strengthening.

Glare vs. Light Diffusion in Industrial Lighting

All large industrial organizations know the necessity of coating the interior of their plants with a white finish of some type to obtain improved light distribution, lower power bills and maximum efficiency from their employees. To accomplish this it has been the custom to paint the walls and ceilings of the plants with a Gloss Mill White. This was soon found, however, to be unsatisfactory, as the shiny surfaces acted as so many mirrors reflecting the light in a glaring manner and causing eye strain to develop among the employees. The Sherwin-Williams Co. spent year

⁹*Chemical Engineer*, March, April, May, 1908.

in research and consulted with some of the leading authorities on illuminating engineering and industrial plant maintenance in an effort to overcome this difficulty. The research work was not confined to reflection values alone, but much time and money were spent in getting the proper combination of pigments and vehicle to produce the desired results. Special mixtures were necessary to get just the right finish, wearing qualities and minimum absorption. As a result the exact point between the two extremes of Gloss Mill White and Flat Matte surface was determined to give the most efficient light distribution and a new paint product known as Eggshell Mill White was evolved. This product, instead of reflecting the light, disperses and diffuses it uniformly throughout the plant, thus emitting a soft, pleasant light restful to the eyes instead of the irritating glare of the high gloss surface. Another advantage of this new product is the fact that less coats are required to give the same results, thereby reducing costs for time, labor and material.

Small Type Locomotive Crane for Industrial Use

Many of the larger companies during the past few years have found it economical to handle a large part of their materials by locomotive crane. This has been necessary because of the large tonnage handled and because the crane is so much more economical than hand labor. Up to the present time, however, most of these cranes were large-capacity machines and too big to be economical in some of the smaller plants.

The saving effected by cranes at these larger plants has created a demand for a smaller type which can be used economically where there are not so many or so



SMALL TYPE OF STEAM LOCOMOTIVE CRANE EQUIPPED WITH GRAB BUCKET

heavy loads to be handled. With the idea of filling the need for a smaller capacity high-grade crane for this work, a new Brownhoist locomotive crane has just been placed on the market by the Brown Hoisting Machinery Co. of Cleveland. This machine can be changed in a few minutes' time to handle grab bucket, bottom block or magnet. With these attachments almost all kinds of materials can be handled.

Experience with the larger type locomotive cranes has proved them to be well fitted to handle ore, coal, crushed stone, etc., by bucket. With bottom block

all kinds of sling loads are handled. With magnet the cranes handle pigs, scrap, bars or castings. This new crane will do the same work as the larger types within its capacity. It is built to handle a 1-yd. bucket, hook loads of five tons, or a 36-in. magnet.

In order to meet the different working conditions, these new Brownhoists are made to operate by steam, electricity or gasoline engine. They are built for use on railroad trucks, traction wheels or creeper trucks.

Synopsis of Recent Chemical & Metallurgical Literature

Electric Purification of Fumes and Gases.—A lengthy description of the Electric Purification of Fumes and Gases is given by A. DELASALLE in the September, 1920, issue of *Chimie et Industrie*.^{*} The theory of electric purification is summarized: When a very small spherical particle of radius r suspended in a gas of viscosity a and possessing an electric charge e is placed in an electric field of intensity H , this particle will be displaced in the direction of the field with a velocity which depends on the intensity of the field and the mobility of the particle in the gas, and whose value, according to the author, is given by $V = KH$ in which K is the coefficient of mobility.

Prof. Pascal conducted a series of experiments to determine the values of K for the case of sulphuric acid particles. The tests were made with electrodes of smooth wire and with asbestos thread covered wire so as to increase the emissive power of the electrodes.

He found that K varies with the temperature as shown in the following table:

Temp. Deg. C.	Value of K
24	2.4×10^{-4}
32	4.9×10^{-4}
52	13.6×10^{-4}
55	15.1×10^{-4}

He also found the values of the radius r of the droplets as being between 0.8×10^{-4} and 5.5×10^{-4} cm. The conclusions reached are:

The gradient of a convenient potential corresponding to the point where the intensity begins to increase rapidly is in the neighborhood of 4,000 volts per cm.

The phenomenon is independent of the wave frequency; at least the result was the same for frequencies between fifteen and forty-five periods per second.

The separation of the acid in the fumes is especially a function of the wave amplitude.

Asbestos-covered electrodes do not present any advantages, especially with liquid particles, due to the fact that the humidity soon nullifies the effect of the downy surface.

It is advantageous to have the emissive electrodes of very small radius of curvature and the receptive electrodes of high radius curvature and as smooth as possible.

The use of chambers of masonry is to be avoided in treating fumes containing acid droplets.

After describing the apparatus used for the produc-

^{*}"L'Épuration électrique des fumées et des Gaz dans le service des poudres pendant la guerre," A. Delasalle, *Chimie et Industrie*, September, 1920, pp. 291-316.

tion of rectified current and the Gaillard precipitator, the author outlines the calculations of an appropriately sized apparatus and how he applies these calculations mathematically and graphically to compare the action of tubes of different diameter. He arrived at the conclusion that there is no great advantage in using very high potentials and cites the fact that even in America where potential differences as high as 250,000 volts are employed, in treating sulphuric acid fumes not over 70,000 is used. (War time conditions in France limited the experimentation voltage to about 42,000 volts.)

Tests were also made to determine the influence of the radius of curvature of the emissive electrode, and it was found that the precipitation increases gradually when the radius of curvature of the axial electrode decreases.

A series of tests on the influence of the tension and polarity of electrodes with tubes of varying diameter are also described and tabulated. The reinforcement of the intensity of the field for a given tension by approaching the electrodes has also been studied so as to verify certain points of the Badische Anilin- and Soda-Fabrik and G. A. Krause patents.

Tests were made with precipitation tubes having electrodes of small diameter (30/10 mm.) at the entrance of the gas and then 80 mm. tube concentric in one of 200 mm.

The reinforcing of the axial electrode was obtained by a cylinder having a rounded form at both extremities sliding on the 30/10 wire. This arrangement was decided upon in order to determine the length giving the maximum of precipitation and to find out whether it was possible to diminish the length of the receiving tube.

With a receiving tube of 3 m., 42,000 volts and with the same velocity of the gases the results obtained are shown in the following table:

Length of the Wire 30/10 mm.	Length of 80 mm. Cylinder Concentric to the 200 mm. Cylinder	Visual Percentage of Precipitation
3.0	0.00	90
2.7	0.30	95
2.5	0.50	97
2.0	1.00	95
1.0	2.00	90
0.5	2.50	80

Tests with stoneware receiving cylinders were made with a 150 mm. diameter tube constituted of five sections each of which was 0.65 m. high gave the following qualitative results:

Efficacious Rectified Potential Volts	High Tension Intensity Amperes	Approximate Velocity of the Gas Meters per Second	Visual Percentage of Precipitation
28,200	4.5×10^{-3}	4.6	55
29,200	4.5×10^{-3}	3.0	85
32,200	4.5×10^{-3}	3	90

The apparatus used for the experimentation and their modifications are fully described and illustrated, and the results of fifteen general tests tabulated. The author then describes the research work as applied to the purification of the sulphurous gases in roasting pyrites, giving the apparatus used, the testing conditions and the tabulated results. He concludes with the statement that the coefficient of mobility of the dust is about 40×10^{-4} at 230 deg. C. and 57×10^{-4} at 310 deg. C. with a negative electrode of 20/10 mm., and that it is absolutely necessary to have the gases at a temperature as high as possible.

Purification of Acetone.—It is known that acetone forms with carbon disulphide a mixture whose boiling point is about 39 deg. C., the boiling point of acetone being only 22 deg. C., and that the impurities in the acetone, with the exception of methylal and methanol, do not form such mixtures with carbon disulphide. J. DUCLAUX and A. LANZENBERG have used this property for the purification of acetone. (*Bulletin de la Société Chimique de France*, Oct. 5-20, 1920, pp. 779-782). The acetone to be purified is mixed with carbon disulphide in the proportion of 1 vol. acetone and 1.7 vol. CS₂ (by weight 1 acetone to 2.8 CS₂). The mixture is submitted to fractional distillation. The elimination of methylal is based on the property that the boiling point of the mixture methylal-CS₂ is 31 deg. C., whereas the boiling point of methylal is 42 deg. C. The fraction passing at about 31 deg. is the mixture methylal-CS₂. The fraction passing between 38 and 40 deg. C. contains the mixture acetone-CS₂ and some methanol-CS₂, as the boiling point of this last mixture is about 37.5 deg. C. The methanol is separated by treating the fraction with potassium carbonate. A compound, probably methyl-xanthogenate, is formed which when dissolved in water is precipitated by copper sulphate. A mixture containing 90 acetone and 10 methanol when thus treated gave a mixture containing only 4 methanol. By repeating the operation the separation of the methanol can be practically complete. The remaining pure acetone-carbon disulphide mixture is washed well with water to extract entirely the acetone. The wash water is rectified and the product obtained is practically pure acetone.

Contribution of Chemistry to Aeronautics.—The September, 1920, issue of *Chimie et Industrie* contains an excerpt of Prof. CHARLES MOUREU's work on chemistry and the war, with reference to the contribution of chemistry to the aeronautic industry. The author passes in review the production of the various materials used. Thus:

Hydrogen. The hydrogen used for filling balloons was obtained by three methods, namely: (1) By electrolysis. The resulting 98 per cent pure hydrogen was passed over palladium in quartz tubes heated to 650 deg. C., giving a 99.97 per cent pure hydrogen. (2) By the action of silicon on alkaline solutions. Captain Lelarge has used the principle, first given by Berzelius (1823), that silicon is attacked by caustic soda or potash, giving the acid silicate NaHSiO₃ with liberation of hydrogen. The hydrogen he obtained was very pure. Although the cost of production by this method was higher than by electrolysis, it had the great advantage that it could be produced where needed. (3) By fermentation. In the biochemical process for the production of acetone great quantities of hydrogen and carbon dioxide are formed. The carbon dioxide is separated by liquefaction or absorbed by an alkaline solution and the remaining hydrogen is ready for use.

Helium. After passing in review the history of helium since its discovery during the sun eclipse in 1868, he describes the advantages it presents for filling balloons and the work done in the United States for the extraction of helium from natural gas. At present a French commission headed by Prof. Moureu is studying the thermal gases of Bourbon-Lancy, Maizières and Santenay, which contain respectively 2, 6 and 10 per cent helium.

Special Steels. The steel used in the construction of aeronautic machinery has to have special properties

which can be realized only by the help of chemistry and metallurgy. Among the special steels found is that of Colonel Grard, a self-hardening nickel-chrome steel of the composition of C 0.25-0.40, Mn 0.40-0.60, Si 0.20-0.30, Ni 3.5-5.00, Cr 1.2-2.00. He describes briefly the properties of this special steel as well as those of nickel steel, chrome steel, tungsten steel, silicon steel, manganese-siliceous steel and chrome-tungsten steel.

Aluminum and Its Alloys. France has the advantage of possessing bauxite mines located near hydro-electric plants so that aluminum can be produced practically cheaper than anywhere else. During the war the growth of the use of aluminum has been very marked. A number of aluminum alloys have been used to advantage to replace steel in the manufacture of different parts of machinery. The alloy most used was duralumin of the composition Al 93.9, Cu 3.70, Mn 0.61, Zn 0.25, Mg 0.43, Si 0.58, Fe 0.53.

Motor Fuels. Motor fuels presented many difficult problems, especially when it is considered that the quality of the fuel is of prime importance in the efficient working of the motors. The fuels used were grouped into two classes—namely, Asiatic and American. He describes their characteristics and the care taken to free them of sulphur compounds, acids and water and to lower the proportion of unsaturated hydrocarbons.

Lubricating Oils. Special lubricating oils being required for the motors, extensive chemical studies were made to obtain oils that maintain their lubricating properties even when submitted to the very great variations in temperature encountered in aëronautics. He mentions that shortly before the war Prof. Hemptine of Liège obtained lubricating oils of very high viscosity, called polymerols, by circulating slowly a mixture of a mineral oil with a semi-drying oil between the armatures of a high-tension condenser. This product was used advantageously to increase the viscosity of fluid mineral oils. During the war the Germans confiscated the plant and worked this process for their needs.

Non-Freezing Liquids for Cooling the Motors. The usual method of making the cooling water non-freezing by the addition of alcohol or glycerine was rendered difficult by the lack of these last products. Chemical work on this problem resulted in the adoption of sodium formate as proposed by Messrs. Simon and Darmois. The addition of 270 g. per liter lowers the freezing point to below -20°C . and the solution does not attack the metals used in the radiators. Calcium chloride, a waste byproduct of the Solvay soda process, can replace advantageously the sodium formate.

Dopes. Extensive work was done to manufacture dopes appropriate to the needs of the aëronautic industry. Practically all the dopes used by the French were of cellulose acetate base; the Allies made partial use of dopes with nitrocellulose as base. Tests proved that cellulose dopes are far better than glue, gelatine, albumin, casein, bakelite, algin, alkaline glycosilicates and similar products. He passes in review the manufacture of cellulose acetate and outlines the work done to determine the appropriate mixtures used as solvents. For camouflaging dopes triacetin mixed with eugenol was utilized. Different colors were obtained by direct incorporation into the ordinary dopes of a mixture of aluminum powder, colored lakes and mineral matter.

Varnishes. Cellulose acetate being hygroscopic, the dried doped fabrics have to be varnished to protect them against atmospheric humidity. The two groups of

varnishes used were nitrocellulose varnishes and fat varnishes. Varnishes with synthetic resins as base have been developed but not used industrially. Inert or organic coloring matter was incorporated in the varnishes used for camouflaging.

Fabrics for Balloons. The material used in France was cotton fabric (seldom of silk) covered with rubber, generally two layers of cotton fabric alternating with rubber layers. Vulcanizing was done with sulphur chloride at 35°C . The problem of the influence of light on the fabrics had to be solved. The best solution found was the use in France of a lead chromate dye; Italy and Great Britain used dopes in which aluminum powder was incorporated. Tests were made to use rubber substitutes and by the end of the war France was experimenting with cotton fabrics treated with dopes having cellulose acetate as base. Even now the problem of a good material for balloons has not been solved. This problem deserves to be still further studied, especially when it is considered that helium, which is bound to become of general use for filling balloons, is too expensive a product to be wasted through the use of fabrics which are not sufficiently impermeable.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Synthetic Anthraquinone Derivative.—Anthraquinone derivatives such as alizarine may be made from phthalic anhydride by first preparing p-chlorbenzoyl-o-benzoic acid, and condensing this with concentrated sulphuric acid to form chloranthraquinone, from which alizarine may be made by treatment with caustic alkali in the presence of an oxidizing agent. JOHN M. WEISS of New York, GEORGE C. BAILEY of Woodcliff-on-Hudson, and RALPH S. POTTER of Grantwood, N. J., suggest the following method for making the chlorbenzoyl benzoic acid: A mixture of 100 parts of finely ground phthalic anhydride with 180 parts of coarse freshly sublimed aluminum chloride is added to 1,000 parts of chlorbenzene at 120°C . After a short time the temperature is reduced and water or ice is added prior to the introduction of 80 to 90 parts of 60 per cent H_2SO_4 . Excess chlorbenzene may now be removed by steam distillation. Crude chlorbenzoyl benzoic acid is filtered from the cooled mass, dried and washed. The addition of the proper amount of H_2SO_4 to the filtrate will give (upon concentration) about 230 parts of aluminum sulphate as a byproduct. (1,255,100; assigned to The Barrett Co.; Oct. 5, 1920.)

Zinc Oxide and Hydrogen.—By vaporizing carbon-free metallic zinc in a suitable retort and treating the zinc in the vapor phase with an excess of superheated steam RALPH H. MCKEE of New York is able to produce zinc oxide free from blue-powder, with hydrogen as a byproduct, according to the reaction:



The zinc oxide is recovered by cooling the reaction

product and filtering through bags. The steam:hydrogen mixture is then further cooled to condense the steam, leaving the hydrogen in a substantially pure state. (1,355,904; Oct. 19, 1920.)

Alloy for Chemical Apparatus.—An alloy of iron, molybdenum and chromium low in carbon and silicon is especially adapted to the manufacture of chemical apparatus, being sufficiently strong to resist accidental breakage and soft enough to permit being machined to shape. Iron may be replaced by cobalt or nickel; molybdenum by tungsten. Indeed, the very best alloy from the chemical standpoint is composed of nickel and tungsten, each of which is the most resistant chemically of the members of their respective groups, combined with enough chromium to constitute a mutual solvent, but the composition is comparatively expensive and somewhat more difficult to machine. Certain typical formulas are as follows, the proportions being by weight:

	A	B	C	D
Chromium.....	60	55	60	40-60
Iron group metal.....	20	25	30	10-40
Molybdenum-like metal.....	20	20	10	10-20
Carbon.....	Less than 1 per cent			
Silicon.....	Less than 1 per cent			

Column A gives the alloy that appears to be the most resistant chemically of any investigated. Columns B and C give the compositions which are most easily made when the iron group metal employed is iron. Column D indicates the limits of favorable composition. (1,357,550; FRANK A. FAHRENWALD, of Cleveland, Ohio; Nov. 2, 1920.)

Dicyandiamide as Stabilizer for Nitrocellulose.—The lower nitrates of cellulose, particularly pyroxylin soluble in ether-alcohol, may be stabilized by the addition of 0.1 to 2 per cent of dicyandiamide, $\text{NH}:\text{C}(\text{NH}_2)\text{NH}:\text{CN}$. (1,358,653; CHARLES L. REESE, of Wilmington, Del., assignor, by mesne assignments, to the Arlington Co.; Nov. 9, 1920.)

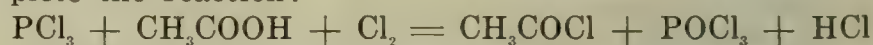
Coking Process and Apparatus.—The Wallace oil-shale retort, which has been described in *CHEM. & MET. ENG.*, vol. 22, p. 809, April 28, 1920, may be used for the distillation of coal provided certain modifications are introduced. This retort is a vertical cylinder externally heated and provided with a central perforated eduction pipe through which the vapors are removed by suction. In treating coal, coke formation proceeds in vertical concentric rings from the wall toward the center. The passage of gases or vapors through the newly formed coke must be prevented, since this causes minute cracks which develop into fissures during the final shrinkage of the coke. Two methods for overcoming this difficulty are described. (1,358,663 and 1,358,664; GEORGE W. WALLACE, of East St. Louis, Ill.; Nov. 9, 1920.)

Diaphragm for Electrolytic Cells.—Mineral wool is mixed with paraffine oil as a binder and compressed to form an osmotic diaphragm—that is, one which not only allows the free passage of ions liberated during electrolysis but also permits the diffusion of liquids by osmosis. According to MILO W. KREJCI, of Chicago, and GUNNARD E. JOHNSON, of Hammond, Ind., such a diaphragm is particularly adapted for use in the electrolytic manufacture of white lead by the Harrington process (U. S. P. 1,308,948; July 8, 1919). In this process it is essential that CO_2 ions should pass from the catholyte to the anolyte at the same rate at which lead acetate

is formed in the anode compartment, so that the precipitate of white lead may be formed in the solution away from the anode and thus settle to the bottom without any danger of coating the anode. (1,358,858; Nov. 16, 1920.)

Chlorination Process.—Saturated hydrocarbons such as petroleum naphtha are treated counter-currently with chlorine in the absence of light, yielding a solution of chlorine in the hydrocarbon mixture, which is then passed through heated coils in which chlorination takes place. After cooling, the liquid is recirculated through the chlorine absorption tower and this cycle is repeated until the desired degree of chlorination is reached. Vapors which escape during chlorination are treated in condensers and absorption towers for the recovery of valuable constituents. (1,358,851; ARTHUR E. HOULEHAN, of Wilmington, Del., assignor to E. I. du Pont de Nemours & Co.; Nov. 16, 1920.)

Acetyl Chloride and Phosphorus Oxychloride.—Glacial acetic acid is mixed with phosphorus trichloride and the temperature maintained at about 10 deg. C. while sufficient cold, dry chlorine is introduced to complete the reaction:



The reaction products are easily separated by fractional distillation since acetyl chloride boils at about 51 deg. C. and phosphorus oxychloride at 106.5 deg. C. The still residue consists largely of phosphoric acid. (1,359,071; FREDERICK J. KAUFMANN, of Charleston, W. Va.; Nov. 16, 1920.)

Chloroform From Isopropyl Alcohol.—Isopropyl alcohol gives good yields of chloroform when distilled in the usual manner with chloride of lime and water. The isopropyl alcohol may be obtained by absorbing vapors rich in propylene in sulphuric acid, followed by hydrolysis of the propyl hydrogen sulphate to give isopropyl alcohol (see *CHEM. & MET. ENG.*, vol. 23, p. 1230; Dec. 22, 1920). (1,359,099; MAX PHILLIPS, of Evansville, Wis.; filed under the act of March 3, 1883; Nov. 16, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Treating Vegetable Fibers.—Vegetable fibers of all kinds and in any stage of manufacture are treated by fixing thereon the products of the hydrolysis of proteic substance to impart to the fibers the character of wool, both physically as to feel, appearance and calorific qualities, and chemically as regards their affinity and absorbent capacities for dyestuffs. The treatment of the fibers is also a preparation for the usual printing processes. The fibers, whether in the mass or in the state of lap, cops, card-ends, twistings, yarns or fabrics, are treated with the liquid obtained by the action of strong acids, alkalis or other hydrolyzing agents on proteic substances to which oxidizing agents may be added, and are then washed with water with, if desired, a preliminary washing with a dilute acid or alkali, or a saline solution. The fibers may finally be treated with formaldehyde, alone or with ammonia, or with phosphoric acid. In a modification of the process, the fibers are impregnated with a proteic solution, the deposit being treated, if desired, with formaldehyde and tannin. The fibers may then be dried and are subsequently treated with a hydrolyzing agent, with or without the addition of an oxidizing agent, and are finally washed with water, after the preliminary washing if desired. Casein, egg

albumin, serum albumen and gelatine are mentioned as suitable proteic substances, and nitric, sulphuric, hydrochloric, phosphoric and formic acids, zinc chloride and caustic soda are given as examples of suitable hydrolyzing agents. (Br. Pat. 150,665, not yet accepted; SOC. GILLET ET FILS, Lyon, France, Nov. 24, 1920.)

Pulverizing Metals.—Zinc or other metal is reduced to powder by heating the metal to the highest possible temperature it can attain without volatilization, and pouring it in a thin stream upon a steam jet issuing at high pressure in a horizontal direction from an orifice, elongated horizontally so as to give a flattened formation to the jet. A convenient form of apparatus comprises a small furnace with a melting pot for heating the metal and a chamber, inclosed except for a space in the top, beneath which an inch steam pipe, flattened at the end to an opening, $\frac{1}{8}$ in. deep, enters, and long enough to allow the jet to expand itself in traveling its length. The molten metal poured by a ladle on to the jet a short distance from the orifice is instantly disintegrated and blown along the chamber, and may subsequently be collected, dried and screened. (Br. Pat. 150,490—1919; J. P. MILLER, Uplands, Swansea, Nov. 17, 1920.)

Granular Calcium Cyanamide.—Granular calcium cyanamide is produced by treating calcium cyanamide with more than enough water to slake the lime, etc., under such conditions of temperature and pressure that the excess water is immediately evaporated. Temperatures of 70 to 80 deg. C. and a reduced pressure are mentioned. The water may contain dissolved or suspended matter which may enter into reaction with the calcium oxide or may have a binding effect. The substances mentioned are sodium sulphate, ferrous sulphate, clay, cyanamide and potato meal, and urea. Carbonic acid may be introduced with a salt solution and may serve to spray the solution over the cyanamide. (Br. Pat. 150,979, not yet accepted; AKT. GES. FÜR STICKS-TOFFDÜNGER, Knapsack, near Cologne, Nov. 24, 1920.)

Sulphuretted Dyes.—Sulphuretted dyes, which are probably thiazines, are obtained by sulphurizing β -oxynaphthoquinonearylamides ($O:OH:NR = 1:2:4$); suitable sulphurizing agents are sulphur, alone or in presence of catalysts, solvents or diluents, disulphurdichloride, sulphur sesquioxide or alkali polysulphides, preferably in alcoholic solution at temperatures not exceeding 150 deg. C. The resulting products, if they contain sulphonic or carboxylic acid groups, are acid mordant dyes, or if they are free from such groups are vat dyes; the vat dyeings may be aftertreated with metal salts, preferably chromium salts, giving fast green to black shades. According to examples: (1) The condensation product from *p*-chloraniline and 1:2-naphthoquinone-4-sulphonic acid is heated with sulphur, naphthalene and sulphur iodide or iodine, and the product is worked up by removing the naphthalene by solvent naphtha and free sulphur by sodium sulphide solution, then dissolving the dye in concentrated sulphuric acid, pouring on ice, filtering and washing; the paste gives a yellow hydrosulphite vat dyeing wool violet-black shades which turn to claret-red on treatment with acid, and bluish-green on treatment with chromium salts in acid solution; similar dyes are obtained by the above treatment from the condensation products of 1:2-naphthoquinone-4-sulphonic acid with aniline, *o*-, *m*- or *p*-toluidine, *p*-anisidine, or *p*-phenetidine; (2) the condensation product from 1:2-naphthoquinone-4-sulphonic acid

and *p*-anisidine is treated at ordinary temperature with disulphurdichloride and acetic acid; the product dyes wool in a vat violet shades becoming green on after-treatment with sodium bichromate in an acid bath; similar products are obtained by the action of disulphurdichloride on the condensation products of 1:2-naphthoquinone-4-sulphonic acid with *m*- or *p*-toluidine; (3) the condensation product from *p*-toluidine and 1:2-naphthoquinone-4-sulphonic acid is treated with a solution of sulphur in fuming sulphuric acid; the product is a sulphonic acid dyeing wool from an acid bath green shades with chrome mordants; similar green to greenish-black acid mordant dyes are obtained from the condensation products of aminosalicic acid or aminocresotinic acid with 1:2-naphthoquinone-4-sulphonic acid by treatment with disulphurdichloride or sulphur sesquioxide, and a black acid mordant dye by treating with sulphur sesquioxide the condensation product from *p*-nitraniline and 1:2-naphthoquinone-4:6-disulphonic acid; (4) the condensation product from amino-N-ethylcarbazole and 1:2-naphthoquinone-4-sulphonic acid is boiled with alcoholic sodium polysulphide; the product gives a yellow hydrosulphite vat dyeing wool or cotton green shades which may be afterchromed. (Br. Pat. 151,000, not yet accepted; L. CASSELLA & Co., Frankfurt-on-Main, Germany, Nov. 24, 1920.)

Rubber Sponges.—Rubber sponges are formed so as to have large and small pores in different parts of the sponge, either by vulcanizing together superposed layers of two different compounds which will yield on vulcanization portions having large and small pores, or layers of the same compound one part of which has been masticated more than the other and forms larger pores on vulcanization. Alternatively, a mixture of the two compounds is vulcanized while supported in a shallow vessel of water with its lower part dipping into or just above the water. A compound which yields on vulcanization small pores consists of para rubber, milk of sulphur, lithopone, crimson sulphide of antimony or vermilion, ceresin wax, pine oil, together with ammonium carbonate or amyl acetate. In a compound for yielding large pores, larger proportions of carbonate or amyl acetate are used, precipitated chalk and zinc oxide are used in place of lithopone and turpentine may partially replace pine oil. (Br. Pat. 151,084. G. W. BELDAM, London, and A. U. B. RYALL, Brentford, Middlesex; Dec. 1, 1920.)

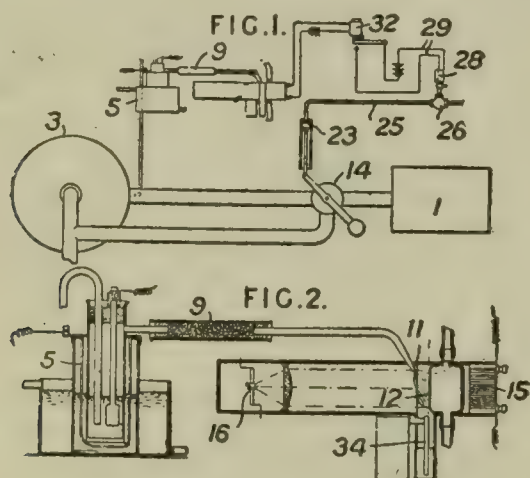
Cyanides.—In the production of cyanides by the reaction of free nitrogen or a mixture of an alkali or alkaline-earth metal or compound, carbon and a catalyst, the catalyst, such as iron manganese, nickel or copper, is introduced in the form of a compound not containing any element other than carbon, hydrogen, oxygen and nitrogen, and is reduced at a temperature below 550 deg. C. Iron hydroxide prepared by precipitating ferrous sulphate with ammonia, and iron oxalate are mentioned. (Br. Pat. 151,098. C. T. THORSSELL and H. L. R. LUNDEN, Gothenburg, Sweden; Dec. 1, 1920.)

Retting Flax.—In obtaining fibers from flax, the straw, prior to retting, is treated in one stage, or in a number of stages extending over successively increasing periods of time, with an alkaline solvent to remove the whole or a greater portion of the gum and resin compounds, and the retting operation is carried out in an alkaline medium. A natural soda, such as Magadi soda, occurring in East Africa, may be used, and in the

retting operation, which is preferably effected at 80 to 95 deg. F., the liquid is continuously aerated and circulated. (Br. Pat. 151,143. L. A. JOHNSON, Uasin Gishu, East Africa Protectorate; Dec. 1, 1920.)

Alumina; Basic Aluminum Nitrate.—A solution of aluminum nitrate is evaporated to distil off dilute nitric acid, and water, steam or fresh solution is added so as to keep the temperature constant (about 140 deg. C.) until the bulk of the alumina is precipitated as a crystalline basic nitrate which is practically free from iron even if the solution is ferruginous. It is advantageous to treat solutions containing calcium or sodium nitrate, which remains in solution in the mother liquor. Such solutions may be obtained by adding some base or salt such as limestone to the nitrate solution before heating. Alternatively the solution of nitrate to which such a base or salt has been added or from which some acid has been distilled off may be heated under pressure in an autoclave to effect the precipitation of the basic nitrate. The basic nitrate obtained as above described is heated to obtain alumina and nitrogen oxides which are converted into nitric acid. The mother liquor is treated with nitric acid to convert the alumina content to normal nitrate and the solution is evaporated until aluminum nitrate crystallizes out and may be returned to the original solution and the remaining mother liquor is evaporated to dryness to recover the sodium or calcium nitrate. (Br. Pat. 151,259, not yet accepted. NORSKE AKTIESELSKAB FOR ELEKTRO KEMISK INDUSTRI, Christiania; Dec. 1, 1920.)

Automatic Detector for Arsenic in Gases.—In apparatus for regulating production, a sample of the initial material is withdrawn and is passed to the testing apparatus which acts in such a manner that the presence of an undesirable substance in the sample causes a variation in the quantity or character of radiant energy



ARSENIC DETECTOR

such as light projected through the apparatus, and the variation so produced is utilized to operate means controlling the process of production. The invention is described with reference to the manufacture of sulphuric acid by the contact method, the control depending on the presence of arsenic in the reaction gases. Thus, a sample of the gases is passed to an electrolytic Marsh apparatus 5, the gases from which, after purification in a tube 9, are burned at the jet 11, the flame impinging on a quartz glass or like transparent screen 12 arranged between a source of light 16 and a light-sensitive cell 15; if arsenic is present, a mirror is formed on the screen 12 and serves to cut off more or less the light falling on the cell 15. The latter is in circuit with a relay 32, and the increase in resistance in

the cell 15 consequent on the cutting off of the light actuates the relay to close a circuit 29 and to energize a solenoid 28 controlling through a valve 26 the supply of fluid under pressure in the pipe 25; opening of the valve 26 actuates a piston 23, which in turn operates the main three-way valve 14, so that if arsenic is present in the gases these are bypassed back to the purifying apparatus 3. The screen 12 is periodically cleaned by a wiper 34, and if the impurity is no longer present, the relay 32 comes into action to open the circuit 29 and to de-energize the solenoid 28, and the valve 14 then returns to its original position to pass the gases to the contact apparatus 1. In other instances—for example, in the case of liquids—the control may be based on the extent to which the plane of polarization of light is rotated, or on variations in the refractive index, or it may depend on the fact that the objectionable constituent yields a colored product on treatment with a chemical indicator, in which case a source of light of the complementary color would be employed. (Br. Pat. 151,328; L. LOGAN, Arlington, Mass., Dec. 8, 1920.)

Cyanamide.—Cyanamide practically free from dicyandiamide is obtained in solution by supplying successive quantities of calcium cyanamide to water or a cyanamide solution while supplying enough carbon dioxide to maintain the solution neutral or only slightly alkaline. By starting with a cyanamide solution very strong solutions can be obtained. The reaction is effected at a temperature not above 70 deg. C., and the carbon dioxide is preferably supplied under pressure, being blown into the solution by nozzles; or other means of bringing the gas into intimate contact with the liquid may be employed, such as beaters; or the solution containing calcium cyanamide may be sprayed into an atmosphere of carbon dioxide. The carbon dioxide may be pure or mixed with other gases, as, for instance, combustion or lime kiln. (Br. Pat. 151,583, not yet accepted; WARGONS AKTIEBOLAG and J. H. LIDHOLM, Wargon, Sweden; Dec. 8, 1920.)

Alkali Silicates.—In order to obtain a soluble alkali silicate of high silica content, the product obtained by the fusion of alkali and silica is dissolved in water and an acid then added, whereby gelatinous silicic acid is thrown down, and this precipitate by continued agitation is made to re-dissolve in the solution. The acid, preferably sulphuric acid, may be added in the form of spray; and after the subsequent operation of agitation or grinding, the solution may be evaporated to dryness. Moreover, to increase the fusibility of the alkali and silica, a little borax may be employed in the fusion process. (Br. Pat. 151,339. F. J. PHILLIPS, London, and E. J. ROSE, Therwood; Dec. 8, 1920.)

Calcium Phosphate.—Natural tricalcic phosphates are mechanically treated to obtain two fractions, one of rich granules containing a high percentage of phosphate, and the other of a mixture containing calcium carbonate and phosphate in so fine a state of division as to be assimilable by the roots of plants. The nodules of natural phosphate are first broken down and then treated in a rotary disintegrator through which a blast of air is directed. By this means the granules of phosphate are freed from the carbonate dust which covers them and the mixture is carried away to chambers where the two fractions separate out according to density. (Br. Pat. 151,684. W. P. THOMPSON, Liverpool, Compagnie des Phosphates de Constantine, Paris; Dec. 8, 1920.)

Current Events

in the Chemical and Metallurgical Industries

Patent Office Bill Hearings This Week

Hearings on the Patent Office bill, with its rider authorizing the Federal Trade Commission to administer Government patents, will begin Jan. 5. The hearing is before the conference committee of the two houses of Congress. The Patent Office bill proper has passed each house. The rider was attached by the Senate.

Representatives of chemical industries are to be heard as to the possible effects of extending a reward to Government employees for such inventions as they may develop. Some are afraid that the effect of this reward will be detrimental to the outside inventors, in that the Government employee could pursue his inventive work while on the Government payroll and with the Government's facilities. It is argued that the tendency among Government employees would be to neglect the regular research work and concentrate on a device or a method which promised personal pecuniary reward. The conference committee expects to hear each side of the case before taking action on the bill.

Progress of American Engineering Council

The Executive Board of American Engineering Council met in New York on Dec. 17, with all members present excepting A. M. Greene. Two new members of the Board were elected, W. B. Powell, Buffalo Engineering Society, representing District 1, New York and New England States, and Gardner S. Williams, Grand Rapids Engineering Society, representing District 2, Michigan, Wisconsin and Minnesota.

President Hoover appointed the following standing committees:

Procedure.—Calvert Townley, chairman; Herbert Hoover, ex officio; W. E. Rolfe, D. S. Kimball, J. Parke Channing, L. W. Wallace, L. P. Alford.

Constitution and Bylaws.—W. B. Powell, chairman; C. F. Scott, D. S. Kimball.

Publicity and Publications.—L. P. Alford, chairman; H. W. Buck, H. E. Howe.

Membership and Representation.—J. F. Oberlin, chairman; L. W. Wallace, A. S. Dwight.

Finance.—William McClellan, chairman; E. Ludlow, C. Townley, L. W. Wallace, ex officio.

Public Affairs.—J. Parke Channing, chairman; Fred J. Miller, L. B. Stillwell.

In discussing the immediate program of Council, Mr. Hoover announced that he had called together engineers in various cities and found that while they were favorably disposed toward the Federation, there was a strong trend toward territorial as distinguished from national organization. One of the obstacles to uniting territorial organizations in the Federation is the question of dues. Another complication is the membership of numerous individuals in more than one society. Deeming the question of territorial organization of vital importance, Mr. Hoover suggested the appointment of a committee to canvass the situation carefully. After considerable discussion the matter was referred to a special committee which will include the six district delegates.

Necessary action was taken to make it possible for certain activities of Engineering Council to be taken over by the new organization as soon as the United Engineering Societies has passed officially on the proposed transfer. In this event President Hoover will appoint the necessary committee of American Engineering Council to take over and continue the uncompleted work of Engineering Council's committees.

Action was taken to amend section 9, paragraph 6, of the bylaws so that committee members can be selected from societies other than those now belonging to the Federation, thus making it possible for civil engineers and others not now affiliated with the Federation to co-operate in committee work.

Council voted not to affiliate with the United States Chamber of Commerce. It also appropriated \$1,000 as an initial fund for publicity work, and authorized the committee on publicity and publications to establish a board of engineering editors. It was voted to pay the expenses of members of the Executive Board for attendance at meetings. A special committee reported on candidates for executive secretary of the organization, but no action was taken. The place of the next meeting, which will be held Feb. 11, was left to the discretion of the president.

Patents Obtained by Department of Agriculture Employees During 1920

During the last fiscal year thirty-five patents were allowed for inventions by employees of the United States Department of Agriculture the benefits of which are dedicated to public use. Thirty applications for patents were prepared by the department's office of the Solicitor during the year, some of which were pending at the close of the fiscal period.

The patents allowed cover a wide scope and some of them are believed by the department to be highly valuable to the public. The list of those allowed during the year includes cane stripping comb, manufacture of cymene sulphonic acid, synthetic ammonia (2), photographic sensitizing dyes (2), new insecticide, production of ammonia, curing tobacco, atmometer, phosphorus and phosphorus acid, dextrine, process for removal of hydrofluoric acid from phosphoric acid, bleaching wood, improvement in the synthetic manufacture of thymol, vanillyl amine, vanillyl acyl amides and production thereof, and fruit grader and sizer.

Applications for patents on the following inventions were pending at the close of the year: Method of manufacturing decolorizing carbon, process for the manufacture of naphthalene sulphonic acids, tree trimming and harvesting machines, panoramic camera attachment, process of sublimation, adhesive, apparatus for controlling reactions between gases (2), ammonium nitrate, insecticide and fungicide, grain samplers, malt sirup (2), process of extracting soluble albumen from whey, manufacture of furfural and volatile organic acids from corncobs, manufacture of furfural and volatile organic acids from corncob pentosan, preserving

apples, grain sampler, apparatus for sterilizing fruit juices, new and improved types of bread, manufacture of sweet potato sirup, new process for preparing sirup from sugar beets, protosensitizing dyes of the isocyanine type, gelatine or glue free from mineral matter, acids, or alkalis, and a process for preparing same.

The Government and the people of the United States are entitled to make use and sell the inventions disclosed by these patents freely and without the payment of royalty to the patentees.

No Appropriation for Chemical Industries

The Committee on Appropriations of the House of Representatives used the knife relentlessly on the requests made by the Bureau of Mines for funds for its work during the next fiscal year. The \$125,000 asked for non-metallic and chemical industries research went out altogether, as did the \$30,000 for low-temperature research and the \$29,920 requested for aluminum research. For the most part, the committee allowed no increases over the appropriations for the current fiscal year. The only new item in the bill, as reported on Dec. 29, was \$50,000 for enforcing the oil land-leasing regulations. The bureau had requested \$132,390 for that work. The total appropriation carried by the bill for the Bureau of Mines was \$1,357,300.

In addition to the carefully written justifications prepared in support of these estimates, Dr. F. G. Cottrell, the director of the bureau, argued in person before the Committee on Appropriations.

In support of the aluminum research, Dr. Cottrell pointed out to the committee the possibility of obtaining aluminum production from sources and ores not now being utilized. He also emphasized the need for better and cheaper methods of aluminum production.

The failure of the committee to allow \$30,000 for low-temperature research is regarded as particularly lamentable, since the entire installation for that work has been turned over to the Bureau of Mines, without expense, by the War Department.

The War Department purchased complete equipment for the cryogenic laboratory, which was set up by the Bureau of Mines in its own offices. The co-operative agreement provided that the laboratory was to become the property of the Bureau of Mines after the War Department work had been completed.

The committee allowed \$200,000 for the operation of the mining experimenting stations. This is the amount of the current appropriation. The bureau has requested \$270,000 for its work in this direction during the next fiscal year.

Important Legislation on the Tapis

The first week of the new year saw many chemists journeying to Washington. Three important matters of particular interest to the chemical industries have come up for active consideration on the part of Congress. The chemical schedule of the new tariff bill will be considered at the first of the series of hearings to be held by the Committee on Ways and Means. The Patent Office bill, with its rider authorizing the Federal Trade Commission to administer patents granted to Government employees, comes up for hearings beginning Jan. 5. The third matter is the bill authorizing the creation of the United States Fixed Nitrogen Corporation.

Since so many chemical activities come within the infant industry class, the need for a protective tariff is

felt by a large number of the subdivisions of the industry. As a result these hearings are expected to be of unusual interest.

In view of the apparent determination of some of the members of the conference committee on the Patent Office bill to force it through, rider and all, the hearings before that body seem to be the only hope that the opponents of the rider have to secure the defeat of the legislation.

There is increasing hostility to the Fixed Nitrogen Corporation bill, especially in view of the changed economic situation. The manufacture of fertilizer materials on a large scale at this time by the Government is denounced very strongly in some quarters. Efforts are being made to stir up opposition to the measure in the Senate. A very little opposition aroused now, with the end of the short session in sight and with unprecedented congestion of the legislative program, would be all that is necessary to prevent passage of the bill. Should the effort in the Senate fail, there is a good chance to block it in the House, it is believed, owing to the disinclination to authorize any further appropriations. The present situation in the nitrate market is such that it is not believed to be feasible to finance the corporation from funds which might be obtained from the sale of the War Department's reserve of sodium nitrate.

British Dye Bill

The text of the British dye bill, which passed the House of Commons Dec. 20, is as follows:

With a view to the safeguarding of the dye-making industry, the importation into the United Kingdom of the following goods—that is to say, all synthetic organic dyestuffs, colors and coloring matters, and all organic intermediate products used in the manufacture of any such dyestuffs, colors or coloring matters—shall be prohibited.

Goods prohibited to be imported by virtue of this act shall be deemed to be included among the goods enumerated and described in the table of prohibitions and restrictions inwards contained in section 47 of the customs consolidation act, 1876, and the provisions of that act and any act amending or extending that act shall apply accordingly.

The Board of Trade have power by license to authorize, either generally or in particular case, the importation of any of the goods or any class or description of the goods prohibited to be imported by virtue of this act.

For the purpose of advising them with respect to the granting of licenses the Board of Trade shall constitute a committee consisting of five persons concerned in the trades in which goods of the class prohibited to be imported by this act are used, three persons concerned in the manufacture of such goods, and three other persons not directly concerned as aforesaid. Such one of the last-mentioned three persons as the board shall appoint shall be chairman of the committee.

For the purpose of providing for the expenses incurred by the board in carrying this act into execution, the board may charge in respect of a license a fee not exceeding £5.

Subject to compliance with such conditions as to security for the re-exportation of the goods as the Commissioners of Customs and Excise may impose, this act shall not apply to goods imported for exportation after transit through the United Kingdom or by way of transshipment.

Anything authorized under this act to be done by the Board of Trade may be done by the president or a secretary or assistant secretary of the board or by any person authorized in that behalf by the president of the board.

The provisions of this act shall continue in force for a period of ten years from the commencement thereof and no longer.

This act may be cited as the dyestuffs (import regulation) act, 1920.

Bill for Federal Manufacture of Atmospheric Nitrogen Expected to Pass the Senate

The bill providing for federal manufacture of atmospheric nitrogen is expected to pass the Senate, but strong opposition to the measure has developed in the House, where its course is likely to be more difficult. Senator Underwood of Alabama, the minority leader, has given notice that the minority will employ such methods as are available to insure its passage.

The opposition in the House is based for the most part on the probability that the enterprise will call eventually for large appropriations. The bill provides for the financing of the proposed United States Fixed Nitrogen Corporation by the sale of a portion of the War Department's reserve of nitrate of soda. Now that the price of nitrate has declined materially since the bill was drafted, it is feared that it would not be wise to attempt to raise the \$12,500,000, for which the bill calls, from the sale of the nitrate reserve, since at present prices it would deplete that reserve unduly.

Book Reviews

PLANTATION RUBBER AND THE TESTING OF RUBBER. By G. Stafford Whitby. 555 pages. New York: Longmans, Green & Co., 1920. Price \$9.50 net.

Although there have been extremely few contributions to the technology of rubber goods manufacture, the literature on crude rubber is rather abundant. This is due in a great measure to the fact that both the Dutch and the British went into the systematic planting of rubber trees before the beginning of this century.

The author of this work has divided his book into two almost equal parts. The first part treats of such topics as methods for obtaining the milk from the rubber trees, collection of this latex, coagulation of the latex, conversion of the coagulated milk into sheets, and the process of "smoking" sheet rubber. In Part II of his book the author has presented many data on rubber from the viewpoint of the physical chemist. He has discussed such subjects as Young's modulus, Hooke's law, the stress-strain curve for rubber, and tensile tests. In his discussion of tensile strength and elongation the author passes over the Henry Scott testing machine with a two-line note, which is disappointing for American readers. The literature references are for the most part English and Dutch, although one finds casual references to the work of Kratz, Flower, Tuttle and Cranor in the United States.

Although the rubber industry was born the day Good-year discovered vulcanization in 1839, it was not until about 1910 that serious scientific work was done in the field of rubber chemistry. Even the theory of vulcanization was not proposed before Carl Otto Weber in 1902 published his now historic book. The rubber industry was in fact a "house of mystery" until the demands made by consumers of rubber goods compelled the manufacturers to invite chemists into their plants. And so it comes that we find in the present text books such phrases as "co-efficient of vulcanization," "accelerated aging tests," "optimum cure" and "state of cure."

Forty-four pages have been devoted to a bibliography in which the author has discovered 350 names of writers on rubber topics in book and periodical literature. Unfortunately he has omitted all mention of the valuable papers which have appeared in *CHEMICAL & METALLURGICAL ENGINEERING* during the past five years. All reference to synthetic rubber has been carefully deleted from the book, as well as from the bibliography, but a considerable number of unimportant publications have been noted. In spite of this the author has rendered a service of unusual value to

rubber investigators who desire to find references on plantation rubber and rubber testing.

In general the short-sentence style has been used, but sentences of 120 words (page 261) should be modified in later editions. Aside from this the text is readable, the subject matter true, the proof carefully corrected, and a great deal of material on the physics and physical chemistry of rubber has been published in book form for the first time. In this country the book will probably be of greater value to university men than to manufacturers of rubber goods.

FREDERIC DANNERTH.

Obituary

Dr. HENRY A. BUMSTEAD, professor of physics at Yale University, who had been on leave of absence serving as chairman of the National Research Council, died on a train en route from Chicago to Washington on Dec. 31. He had just taken a very active part in the Christmas week meetings of the various scientific societies. The death of Dr. Bumstead comes as a shock to the scientists of the country and particularly to the National Research Council, where he was in the midst of a constructive program for the work of that institution. The services rendered by Dr. Bumstead during the war were particularly notable. As an attaché of the American Embassy at London he was in immediate charge of the exchange of confidential scientific data with the Allies. Due to his twenty-seven years of service as an instructor at Yale, Dr. Bumstead has influenced the thought of many thousands of students. As a result of his particularly attractive personality, these students have clung to him with unusual affection. The laboratory at Yale which was under his direction is regarded as one of the finest in the world. Dr. Charles Walcott, the vice-chairman of the National Research Council, will succeed Dr. Bumstead at least temporarily as the active chairman of the Council. Dr. Bumstead was fifty years old and was graduated from Johns Hopkins University in 1891, later receiving his doctor's degree from Yale.

Personal

RICHARD H. CATLETT has resigned his position as production manager of the Taylor Chemical Co., Penn Yan, N. Y., and is now chemical engineer with the Lewis Recovery Corp., Boston, Mass.

CHARLES A. EDWARDS, for many years manager of the Portland, Ore., office of A. O. Anderson & Co., has severed that connection to become head of the Portland Vegetable Oil Milling Co., Portland.

Dr. SAMUEL EYDE, joint inventor of the Birkeland-Eyde arc process for nitrogen fixation, arrived in New York on Dec. 30. He plans to make an extensive visit in the Canadian nickel territory.

Dr. CARL HERING of Philadelphia, Pa., has moved his office from 210 South 13th St. to 1317 Spruce St.

Dr. J. A. MONTGOMERY, formerly chief chemist for the Structural Materials Research Laboratory, has resigned to become chief chemist for the Borromite Company of America, 105 West Monroe St., Chicago, Ill.

H. L. MOYLER resigned his position Nov. 1 as assistant superintendent of acid plants, Naval Proving Grounds, Indian Head, Md., to become general supervisor of acid production, Monsanto Chemical Works, Plant B, East St. Louis, Ill.

Dr. M. C. TEAGUE, formerly gas chemist at the Pittsburgh station of the Bureau of Mines, is now research chemist with the United States Rubber Co., 561 West 58th St., New York City.

Current Market Reports

The Chemical and Allied Industrial Markets

New York, Jan. 3, 1921.

Reflections of the holiday week were apparent in the chemical market and trading in most quarters was reported quiet. However, the tone of the general market is steady. The trade is looking forward to the new year with confidence, although it is generally conceded that business will probably be slow during the next few weeks. Opinions of the dealers and manufacturers show a feeling more hopeful for a resumption of activity. Those close to the inside workings of the market stated that sellers are plucking up more nerve and that buyers have been turned down on several occasions because they refused to meet an advance in lately prevailing prices.

The extent of business has not improved much on the surface of the market and it is not expected to improve materially until the holiday excitement and inventory periods are out of the way. There is no denying that buyers have shown more interest in the market than for several weeks and sales have been freer although of small individual volume.

Solid caustic soda displayed a firmer tendency in the open market and offerings of standard material were not much in evidence. Buying was considered good in several quarters and rumors were current of large interests operating. Spot prices ranged from \$3.75 to \$3.85 per 100 lb. for carlots. Occasional odd lots moved at a shade under this figure through brokers. Makers were still holding contract prices at 3½c. per lb., basis 60 per cent, f.o.b. works, over next year.

Producers reported quiet trading in *yellow prussiate of soda*. Large manufacturers were willing to book contracts at 18c. per lb., but stated that consumers were not taking much interest in futures. Second hands are doing business in small lots at prices ranging from 17c. to 17½c. per lb. Makers of *silicate of soda* quote \$2.90@3 per 100 lb. for the 60 deg. Bé. in large lots and up to 3½c. per lb. for small lots. Business was reported quiet, with sales mostly moderate for home and abroad. The 40 deg. test is offered at \$1.15@1.25 per 100 lb. in carload lots and up to \$1.50@1.75 in small quantities. Single bags of *soda ash* were held at \$1.90@2 per 100 lb. at the works for prompt shipment. Offerings continued limited and the market showed a steady tendency. Resale lots for export were quoted at \$1.85@1.90 with scattered transactions reported. Barrels ranged about 5c. per 100 lb. advance. Contracts continued to be quoted by producers for 1921 shipment at \$1.82½@1.90, basis 48 per cent, f.o.b. works.

Manufacturers of *sodium sulphide* are trying to keep the price of the 60-62 per cent at 7c. per lb. for drums in carload lots. Resale material was evident on the market at lower prices and sales were made down to 6c. per lb. Resale *bleaching powder* in large drums was on the market at 2½c. per lb. and it seemed possible that some interests would shade this figure on firm business. The supply could not be called heavy, but the demand gave the market an easy appearance. Producers of *glaubers salt* reported prices at 1½c. per lb. in bags. Barrels were held at \$2.05 per 100 lb. for carlots and \$2.35 in smaller quantities. Some foreign *oxalic acid* was offered on the market as low as 17½c. per lb., but most dealers gave 18½c. as the prevailing price for prime American material and prices extend all the way up to 20c. per lb. depending entirely upon brand, quantity and seller. Trading has remained quiet in this commodity, as prices are somewhat above the views of buyers.

Resale *formaldehyde* is commanding 18½c. per lb. in barrels on the spot market and business was known to have been placed at this level. Round lots are very scarce and in some quarters 19c. is the best offering for goods ex warehouse. The undertone was reported very steady. *White granular sal ammoniac* was offered on the open market at 10½@11c. per lb., with little trading reported at these low

figures. Odd lots of the gray material were available at 9½@10c.

SODIUM PRODUCTION

According to a recent report by the United States Geological Survey, the production of sodium compounds in the United States was slightly less during 1919 than it was in 1918, the total for 1919 being 9,393,749 short tons, as compared with 10,199,493 for the preceding year. The total value of these products declined from about \$143,000,000 in 1918 to slightly more than \$121,000,000 in 1919. This total includes the production of common salt, which accounts for practically 7,000,000 short tons of the total for both years. About 500,000 tons of sodium chloride was imported in 1919.

During 1919, exports of many of the sodium compounds were heavier than in 1918. The use of sodium products instead of potassium is being continued and has been materially increased because of sodium compounds being cheaper.

The following is a table of various important sodium compounds produced during 1918-1919:

	1918, Tons	1919, Tons
Acetate soda.....	2,622	2,426
Bicarbonate soda.....	118,535	134,962
Bichromate soda.....	26,526	28,334
Soda ash.....	981,054	1,390,628
Yellow prussiate soda.....	3,437	4,525
Caustic soda.....	355,466	513,363

COAL-TAR PRODUCTS

Despite the holiday recessions, offerings and inquiries were more in evidence. This showed a renewal of interest was taking the place of a long period of dullness. There were no inquiries of large enough volume to mention. Operations in some markets are beginning to show a little life and sharp-sighted merchants see that the curtailment of production and low prices have gone pretty near the limit. They also believe that stocks of many kinds have reached a level where buying now is a safer proposition.

The crude market was also a dull affair with little trading in any quarter. *Naphthalene* flakes and balls showed a firmer tendency, although trading was of a light nature. Only very small lots of *orthotoluidine* were in demand and supplies were easy, with prices ranging from 30c. to 35c. per lb. Recent trading in *paranitrophenol* has been limited to small lots on a basis of 75@80c. per lb. Producers of *beta naphthol* reported a fair volume of supplies available at 40@45c. per lb. Second hands are still offering goods and 38c. seems possible on distressed lots. *Diethylaniline* was offered in very small quantities among second hands and producers reported conditions quiet. Supplies were fairly easy at \$1.35@1.45 per lb.

VEGETABLE OILS

The market on vegetable oils remained quiet and uninteresting during the holiday week. Prices in most cases were nominal, with no large business consummated. Crushers of *linseed oil* reported that the inquiry was almost at a standstill so far as round lots were concerned. Operators were reluctant to name 78c. per gal. without any real bids to work upon. Consumers were offered raw linseed at less than 78c. for January-April shipment. Producers of No. 1 U.S.P. *castor oil* quoted the market at 12c. per lb. in barrels. The technical grade has been revised to 11½c. per lb. The outside market has sold the No. 3 type as low as 9½c. *Crude corn oil* was unsettled due to the drop in cottonseed oil, and the market closed nominal at 6½c. per lb., sellers' tanks, for immediate shipment from Chicago. No business was reported in *coconut oil* in carlots during the week. Prices held on an even basis, both here and on the Coast. Domestic Ceylon type oil held at 9c. per lb. sellers' tanks, f.o.b. Coast, with the Manila at 9½c. for January-March shipment.

The market on *palm oil* was unsettled, with lower prices in evidence in some directions for future. Lagos for shipment closed nominally at 7½c. per lb. Niger closed at 7½c. for prompt shipment from abroad. Offerings for *soya bean oil* appeared more plentiful and slightly easier prices for prompt shipment oil were noted. Inquiry was dull. Soya bean oil for December shipment from the Coast was offered at 5½c. per lb., sellers' tanks, while there were sellers of January-March at 5½c.

Chemical Market for 1920

During the latter half of 1920 the chemical industry underwent the most radical change in its history. Liquidation and all that goes with it exerted full force on the chemical market and prices yielded in almost every important item. Tight collections, efforts to ship goods prior to the advanced freight rates that became effective Aug. 26, 1920, and the influx of surplus stocks held by large consuming plants have been factors all working against the maintenance of a steady market. Reports from New England noted a state of acute quietness among most of the dye and bleaching plants. This condition was also reflected all through the textile industry. Finished textile products were not in demand and factories had to close their doors to thousands of employees. Several of these plants offered bichromate, prussiate and caustic soda for resale in the open market through various dealers. Arrivals were often considerably under the market to facilitate a quick sale.

The American export trade during the first six months of 1920, helped by Europe and Japan, established the United States as the leading chemical center of the world. Prices were reflected by the persistent demand and for several months speculators who had contracted long before were reaping the benefit of a soaring market. Spot stocks were partly wiped out and with the shortage of fuel, railroad entanglements and general existing abnormal conditions large producers were forced to shut down their plants. Germany's future after the war was another situation that kept foreign buyers on edge. When it was clearly evident that the German industry was not in a position to supply the rest of the civilized world, those who had been holding off flooded the American market with voluminous orders for miscellaneous chemicals and dyestuffs. This delicate situation brought speculation to its highest point and commodities were known to have advanced 10 to 15c. per lb. within twenty-four hours. Japanese buyers in their over-enthusiasm joined in the procession and played the speculative game harder than any of their neighbors. It was Japan that helped prices reach their highest peak and also their lowest level. Japan went into the market as a blind buyer and within a short period realized that she had bought enough for her requirements for the next three years. The surplus purchasing had a mortifying effect on Japanese financiers.

COMPARATIVE PRICES OF GENERAL CHEMICALS, JANUARY TO DECEMBER, 1920

	Jan.	June	Oct.	Nov.	Dec.
Acetic acid, 28%, lb.	\$0.02½	\$0.03½	\$0.03½	\$0.03	\$0.03
Acetic acid, glacial, lb.	.12	.16	.11½	.11½	.10½
Muriatic acid, 20 deg., 100 lb.	1.75	3.50	2.00	1.85	1.85
Nitric acid, 40 deg., lb.	.06½	.07½	.07½	.07½	.07
Oxalic acid, lb.	.33½	.58	.40	.25	.18½
Sulphuric acid, 66 deg., ton.	21.00	23.00	21.00	21.00	21.00
Acetate of lead, lb.	.12½	.13½	.14½	.14½	.13½
Ammonia alum, lump, lb.	.04	.04½	.04½	.04½	.04½
Potassium alum, lump.	.07½	.07½	.05½	.05½	.05½
Aluminum sulphate, iron free, lb.	.02½	.03	.05	.04	.03½
Aluminum sulphate, commer., lb.	.01½	.02	.04½	.03	.02½
Aqua ammonia, 26 deg., lb.	.07	.09	.09½	.07½	.06½
Sal ammoniac, white, lb.	.14½	.17½	.14	.12½	.10½
Arsenic, white, lb.	.10½	.14½	.14	.13	.11½
Barium chloride, ton.	80.00	150.00	120.00	100.00	75.00
Bleaching powder, lb.	.02½	.06½	.07½	.06	.03½
Carbon tetrachloride, lb.	.11	.11	.13½	.13	.12
Cobalt oxide, lb.	1.50	2.00	4.00	4.00	3.90
Copper sulphate, lb.	.08½	.08	.08	.07½	.06½
Cream of tartar, lb.	.55	.56	.52	.45	.38
Epsom salt, U. S. P., lb.	.02½	.04½	.04	.03½	.03
Formaldehyde, lb.	.40	.51	.40	.23	.18½
Glauber salt, lb.	.01½	.02	.02½	.02	.01½
Lead arsenate, paste, lb.	.16	.16	.16	.15	.13
Bichromate potash, lb.	.30	.42	.30	.22	.17½
Carbonate potash, 80-85%, lb.	.23	.21	.19	.15	.12
Caustic potash, 88-92%, lb.	.30	.28	.25	.17	.14
Muriate potash, ton.	150.00	115.00	105.00	100.00	100.00
Nitrate potash, lb.	.13½	.13½	.14	.11½	.11½
Permanganate potash, U. S. P., lb.	.60	.85	.70	.65	.60
Prussiate potash, yellow, lb.	.37	.36	.38	.36	.33
Acetate soda, lb.	.06½	.12	.11	.08	.06½
Soda ash, light, 100 lb.	2.00	3.25	2.50	2.00	1.85
Bichromate soda, lb.	.19	.32	.16	.11	.09½
Caustic soda, solid, 100 lb.	4.35	6.50	4.00	4.00	3.75
Chlorate soda, lb.	.12	.12	.12	.11	.10
Cyanide soda, lb.	.28	.35	.34	.26	.23
Fluoride soda, lb.	.14	.19	.21	.20	.17
Nitrate soda, lb.	.03	.03½	.03	.02½	.02½
Prussiate soda, lb.	.25	.26	.24	.19	.17½
Salsoda, 100 lb.	1.25	1.25	2.00	2.00	2.00
Sulphide soda, 60%, lb.	.05	.10½	.09	.07½	.06½
Tin oxide, lb.	.60	.65	.52	.50	.50

Credits were immediately stopped and Japan shifted from the position of leading buyer to the selling end in a vain attempt to cover her great losses. Failures among large business interests and banks followed on the heels of this change, and it was not long after that the rest of the world followed suit. Cancellations on old contracts bought by domestic dealers and foreign orders were noted. Steamers docked with cargoes of returned surplus material. All this was dumped on the American market for resale. It is in this condition that the chemical market finds itself at the turn of the year.

Perhaps the outstanding feature of the chemical market during the past year was the unique position of the dealer with his resale material and prices. During the latter part of 1919, jobbers foreshadowed a rising market and contracted heavily with manufacturers at low figures. These chemicals were later turned over at huge profits when the scarcity arose. Since June, however, prices have continually been on the decline and in some commodities the resale market has been consistently below the cost of manufacturing. Leading interests are of the opinion that the downward trend has run its course on most of the important items and that the first quarter of 1921 will be the impetus for another strong market that will once more bring out the American chemical industry as the guiding light for the rest of the world.

The Iron and Steel Market

Pittsburgh, Dec. 31, 1920.

In the past week the steel market as a whole has been even quieter than formerly, if such a thing is possible. There has been no open demand to speak of, and prices have not been tested. The view formerly held still obtains, and even more strongly, that the turn of the year will witness a mild resumption of buying. No general movement is expected for January, or even for several months to come, but it is held that complete stagnation cannot in the nature of things prevail for any length of time. The common attitude of buyers has been that they have no quarrel with the market, but simply have no interest in it. They are busy with year-end adjustments, unusually difficult this time, and will wait a more convenient season for developing a definite policy as to making fresh commitments.

OPERATIONS

The general closing of independent steel mills that was predicted in some quarters has not occurred. It is true the rate of operation of the independents as a whole has become very low, averaging perhaps under 25 per cent, but there is not a universal closing. Perhaps half the mills are closed, with those operating running at rates from 25 to 60 per cent.

The United States Steel Corporation is understood to be operating at 92 per cent, or a trifle more, measured by ingots. A very few finishing departments are closed for repairs, but on the other hand some have been working up accumulations of semi-finished material.

WAGES

Wage reductions began to appear some time ago, and it looked as though these were forerunners of a general reduction among the iron and steel producers, or at least among the independents. That impression is now seen to be erroneous. Many steel producers openly express the opinion that the wage reductions made were ill-timed and the example is not being generally followed. It is not a case of producers holding that wages should not be reduced, but that the time is not ripe. It is maintained that the various wage advances more than kept pace with the increase in the cost of living, up to the latter's peak, and that with the decrease in the living cost that has already occurred, with more to follow, the iron and steel producing industry is eventually to be on a materially lower wage basis.

COKE

Additional Connellsville furnace coke contracts for the first half of the new year on the general basis of a 5 to 1 ratio against basic pig iron at valley furnaces have been reported beyond the business noted in last review, and the total is now in the neighborhood of 75,000 tons a month.

Some contracts made a couple of months ago, equivalent to a ratio of about $4\frac{1}{2}$ to 1, are still in existence, but will probably be modified when the furnaces involved have occasion to run. Basic pig iron is quotable nominally at \$33 valley, but the trade is under the impression that at the beginning of January a \$30 price will be recognized by some producers. That would make the coke on a 5 to 1 contract cost \$6, this being regarded as a moderately fair cost in the circumstances, the coke operator having little control over his coal mining cost, which is dictated by the general coal scale even though the Connellsville region is technically non-union. Spot furnace coke can be had without difficulty at \$5.50.

PIG IRON

The pig iron market remains dormant, with merchant furnaces continuing to go out of blast. In western Pennsylvania and Ohio fully half the merchant furnaces are out, and others are to go out shortly. The furnaces accumulate no stocks before blowing out, and as consumers have been reducing their stocks the market situation is very sound in that respect, even though quoted prices almost entirely lack buying support. Quotations are practically nominal at \$35 for foundry and bessemer and \$33 for basic, f.o.b. valley furnaces. It seems safe to predict that next week furnace offerings will establish prices of about \$32 for bessemer and \$30 for basic, while foundry iron may merely sag somewhat.

SEMI-FINISHED STEEL

No interest whatever is manifested in billets and there can hardly be said to be even a nominal market price. In sheet bars all producers are holding firmly to \$47, which is the Industrial Board price of \$42 plus a \$5 advance made last September by the Steel Corporation. It is the contention of some sheet mills that the real market basis is \$42 and that the \$47 price is only temporary. Some customers of the Steel Corporation, however, state that they have received no intimation of an intention to supply sheet bars in 1921 at any other price than \$47. At any rate, some sheet mills are said to be "holding out" for a \$42 price with the independents from whom they usually draw supplies, but a case is yet to be heard of a consumer making a firm bid for a tonnage at \$42.

FINISHED PRODUCTS

In the past few weeks, as already reported, the important finished steel products have declined in the independent market to the Steel Corporation level. Pipe was, and remains, the exception, the independents having a list from \$7 to \$10 a ton above the corporation list. There is a rumor that some of the independents will issue a new and reduced list under date of Jan. 3. Pipe is exceptional among steel products in having shown to date an excellent demand against contracts, with pipe departments generally running full. As the mills should normally carry stocks, there is an opportunity for independents to run on stocks and a reduction in price is not considered absolutely necessary at this time.

RAILS

Contrary to expectations entertained in many quarters, the independent rail mills one by one have reduced their asking prices to the Steel Corporation or Industrial Board level, \$45 per gross ton for bessemer and \$47 for open-hearth. The distribution of rail orders for 1921 replacements will be somewhat heavier in consequence. The Pennsylvania system, which for many years has had almost precisely one-eighth the total ton-mileage of freight movement, has distributed orders for 200,000 tons. The New York Central is taking 175,000 tons or more. It seems safe to predict that the total orders for replacement on the steam roads will be between 1,500,000 and 2,000,000 tons, probably nearer the latter figure. With rails for electric line, industrial use and export, the total output in 1921 is likely to be somewhat over rather than under 3,000,000 tons. This would compare favorably with the average in recent years, but would leave the 4,000,000-ton record of 1906 untouched.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.			\$0.55 - \$0.60	
Acetone.....lb.	\$0.13 - \$0.13 $\frac{1}{2}$		.13 $\frac{1}{2}$ - .14	
Acid, acetic, 28 per cent.....100 lbs.	3.00 - 3.25		3.50 - 3.75	
Acetic, 56 per cent.....100 lbs.	6.00 - 6.25		6.50 - 6.75	
Acetic, glacial, 99 $\frac{1}{2}$ per cent, carboys, 100 lbs.	10.50 - 11.00		11.25 - 11.50	
Boric, crystals.....lb.	.14 $\frac{1}{2}$ - .15		.15 $\frac{1}{2}$ - .16	
Boric, powder.....lb.	.15 $\frac{1}{2}$ - .16 $\frac{1}{2}$		.17 - .18	
Citric.....lb.			.52 - .54	
Hydrochloric.....100 lb.	1.85 - 2.25		2.75 - 3.00	
Hydrofluoric, 52 per cent.....lb.	.15 - .16		.16 $\frac{1}{2}$ - .18	
Lactic, 44 per cent tech.....lb.	.10 - .11		.11 $\frac{1}{2}$ - .12	
Lactic, 22 per cent tech.....lb.	.04 $\frac{1}{2}$ - .05 $\frac{1}{2}$		.06 - .07	
Molybdic, C. P.....lb.	4.00 - 4.50		4.50 - 5.00	
Muriatic, 20 deg. (see hydrochloric).....lb.	.07 - .07 $\frac{1}{2}$		.08 - .08 $\frac{1}{2}$	
Nitric, 40 deg.....lb.	.07 $\frac{1}{2}$ - .08		.08 $\frac{1}{2}$ - .09 $\frac{1}{2}$	
Nitric, 42 deg.....lb.	.18 - .18 $\frac{1}{2}$		.19 - .20	
Oxalic, crystals.....lb.	.18 - .18 $\frac{1}{2}$		.18 $\frac{1}{2}$ - .19	
Phosphoric, Ortho, 50 per cent solution.....lb.	.28 - .35		.40 - .50	
Picric.....lb.			2.30 - 2.40	
Pyrogallol, resublimed.....lb.				
Sulphuric, 60 deg., tank cars.....ton			14.00 - 15.00	
Sulphuric, 60 deg., drum s.....ton	18.00 - 19.00			
Sulphuric, 66 deg., tank cars.....ton	21.00 - 22.00		22.50 - 23.00	
Sulphuric, 66 deg., drum s.....ton				
Sulphuric, 66 deg., carbo s.....ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 - 24.00			
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 - 26.00		26.50 - 27.00	
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 - 35.00		40.00 -	
Tannic, U. S. P.....lb.			1.30 - 1.35	
Tannic (tech.).....lb.	.50 - .55		.56 - .60	
Tartaric, crystals.....lb.			.33 - .35	
Tungstic, per lb. of WO.....lb.			1.20 - 1.40	
Alcohol, Ethyl (nominal).....gal.			5.50 - 6.00	
Alcohol, Methyl (see methanol).....gal.				
Alcohol, denatured, 188 proof.....gal.			.82 - .84	
Alcohol, denatured, 190 proof.....gal.			.88 - .90	
Alum, ammonia lump.....lb.	.04 $\frac{1}{2}$ - .04 $\frac{1}{2}$		.05 - .05 $\frac{1}{2}$	
Alum, potash lump.....lb.	.05 $\frac{1}{2}$ - .06		.06 $\frac{1}{2}$ - .07	
Alum, chrome lump.....lb.	.13 - .13 $\frac{1}{2}$		.14 - .14 $\frac{1}{2}$	
Aluminum sulphate, commercial.....lb.	.02 $\frac{1}{2}$ - .03		.03 $\frac{1}{2}$ - .03 $\frac{1}{2}$	
Aluminum sulphate, iron free.....lb.	.03 $\frac{1}{2}$ - .03 $\frac{1}{2}$		.04 - .04	
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.06 $\frac{1}{2}$ - .07		.07 $\frac{1}{2}$ - .08 $\frac{1}{2}$	
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.33 - .35		.36 - .38	
Ammonium carbonate, powder.....lb.	.14 - .14 $\frac{1}{2}$		.14 $\frac{1}{2}$ - .15	
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	.10 $\frac{1}{2}$ - .11		.11 $\frac{1}{2}$ - .11 $\frac{1}{2}$	
Ammonium chloride, granular (gray salamoniac).....lb.	.1 - .10 $\frac{1}{2}$		.10 $\frac{1}{2}$ - .11	
Ammonium nitrate.....lb.	.09 - .09 $\frac{1}{2}$		.10 - .10 $\frac{1}{2}$	
Ammonium sulphate.....lb.	.03 $\frac{1}{2}$ - .04		.04 - .04 $\frac{1}{2}$	
Amylacetate.....gal.			4.50 - 5.00	
Amylacetate tech.....gal.			3.75 - 4.00	
Arsenic oxide, lumps (white arsenic).....lb.	.10 $\frac{1}{2}$ - .11		.11 $\frac{1}{2}$ - .11 $\frac{1}{2}$	
Arsenic, sulphide, powdered (acid arsenic).....lb.	.15 - .15 $\frac{1}{2}$		.15 - .16	
Barium chloride.....ton	75.00 - 80.00		85.00 - 90.00	
Barium dioxide (peroxide).....lb.	.24 - .25		.26 - .27	
Barium nitrate.....lb.	.10 - .10 $\frac{1}{2}$		.10 $\frac{1}{2}$ - .11	
Barium sulphate (precip.) (blanc fixe).....lb.	.04 $\frac{1}{2}$ - .05		.05 $\frac{1}{2}$ - .06	
Bleaching powder (see calc. hypochlorite).....lb.				
Blue vitriol (see copper sulphate).....lb.				
Borax (see sodium borate).....lb.				
Brimstone (see sulphur, roll).....lb.				
Bromine.....lb.	.50 - .52		.54 - .56	
Calcium acetate.....100 lbs.	2.00 - 2.25			
Calcium carbide.....lb.	.04 - .04 $\frac{1}{2}$		.04 - .05	
Calcium chloride, fused, lump.....ton	30.00 - 32.00		33.00 - 35.00	
Calcium chloride, granulated.....lb.	.02 - .02 $\frac{1}{2}$		.02 $\frac{1}{2}$ - .03	
Calcium hypochlorite (bleaching powder).....lb.	.02 $\frac{1}{2}$ - .03		.03 $\frac{1}{2}$ - .03 $\frac{1}{2}$	
Calcium peroxide.....lb.			1.25 - 1.30	
Calcium phosphate, monobasic.....lb.			.18 - .20	
Calcium sulphate, pure.....lb.			.07 - .08	
Camphor.....lb.			.90 - .95	
Carbon disulphide.....lb.	.08 - .08 $\frac{1}{2}$		.09 - .09 $\frac{1}{2}$	
Carbon tetrachloride, drums.....lb.	.11 - .11 $\frac{1}{2}$		.11 $\frac{1}{2}$ - .12	
Carbonyl chloride (phosgene).....lb.			.60 - .75	
Caustic potash (see potassium hydroxide).....lb.				
Caustic soda (see sodium hydroxide).....lb.				
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.09 - .09 $\frac{1}{2}$		.10 - .10 $\frac{1}{2}$	
Chloroform.....lb.			.43 - .50	
Cobalt oxide.....lb.			3.90 - 4.00	
Copperas (see iron sulphate).....lb.				
Copper carbonate, green precipitate.....lb.	.22 - .22 $\frac{1}{2}$		.24 - .25	
Copper cyanide.....lb.			.50 - .60	
Copper sulphate, crystals.....lb.	.06 $\frac{1}{2}$ - .06 $\frac{1}{2}$		.07 - .07 $\frac{1}{2}$	
Cream of tartar (see potassium bitartrate).....lb.				
Epsom salt (see magnesium sulphate).....lb.				
Ethyl Acetate Com. 85%.....gal.			1.05 - 1.10	
Ethyl Acetate pure (acetic ether 98% to 100%).....gal.				
Formaldehyde, 40 per cent.....lb.	.18 $\frac{1}{2}$ - .18 $\frac{1}{2}$		.19 - .19 $\frac{1}{2}$	
Fusel oil, ref.....gal.			3.50 - 3.60	
Fusel oil, crude.....gal.			2.75 - 3.00	
Glauber's salt (see sodium sulphate).....lb.				
Glycerine, C. P. drums extra.....lb.			.20 - .21	
Iodine, resublimed.....lb.			3.85 - 4.00	
Iron oxide, red.....lb.			.10 - .20	
Iron sulphate (copperas).....100 lb.	1.50 - 1.75		2.00 - 2.25	
Lead acetate, normal.....lb.			.13 $\frac{1}{2}$ - .16	
Lead arsenate (paste).....lb.	.13 - .14		.14 $\frac{1}{2}$ - .15	
Lead nitrate, crystals.....lb.			.90 - 1.00	
Litharge.....lb.	.10 - .10 $\frac{1}{2}$		.10 $\frac{1}{2}$ - .11 $\frac{1}{2}$	
Lithium carbonate.....lb.			1.50 -	
Magnesium carbonate, technical.....lb.	.10 $\frac{1}{2}$ - .11		.11 $\frac{1}{2}$ - .12	
Magnesium sulphate, U. S. P.....100 lb.	3.00 - 3.25			
Magnesium sulphate, commercial.....100 lb.			1.50 - 1.75	
Methanol, 95%.....gal.			1.75 - 1.80	
Methanol, pure.....gal.			2.10 - 2.15	
Nickel salt, double.....lb.			.12 - .12 $\frac{1}{2}$	
Nickel salt, single.....lb.			.13 - .13 $\frac{1}{2}$	
Phosgene (see carbonyl chloride).....lb.				
Phosphorus, red.....lb.	.35 - .37		.38 - .40	
Phosphorus, yellow.....lb.			.35 - .37	
Potassium bichromate.....lb.	.17 $\frac{1}{2}$ - .17 $\frac{1}{2}$		.18 - .18 $\frac{1}{2}$	

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar).... lb.	\$.. - \$....	\$0 38-\$0.40
Potassium bromide, granular..... lb.	.. - ..	.35 - .40
Potassium carbonate, U. S. P..... lb.	.35 - .40	.45 - .50
Potassium carbonate, crude..... lb.	.11 - .11½	.11½ - .12
Potassium chlorate, crystals..... lb.	.12 - .13	.13½ - .18
Potassium cyanide..... lb.	.. - ..	.65 - .70
Potassium hydroxide (caustic p. tash).... lb.	.14 - .14½	.15 - .16
Potassium muriate..... ton	75.00 - 80.00	.. - ..
Potassium iodide..... lb.	.. - ..	3 00 - 3.20
Potassium nitrate..... lb.	.11 - .12	.12½ - .13
Potassium permanganate..... lb.	.60 - .63	.65 - .70
Potassium prussiate, red..... lb.	.55 - .57	.58 - .60
Potassium prussiate, yellow..... lb.	.32 - .32½	.33 - .33½
Potassium sulphate (powdered)..... ton	\$225.00 - 230.00	.. - ..
Rochelle salts (see sodium potas. tartrate)	.. - ..	.. - ..
Salammoniac (see ammonium chloride).....	.. - ..	.. - ..
Sal soda (see sodium carbonate).....	.. - ..	.. - ..
Salt cake..... ton	.. - ..	45.00 - 50.00
Silver cyanide..... oz.	.. - ..	1.25 - ..
Silver nitrate..... oz.	.. - ..	.43 - .45
Soda ash, light..... 100 lb.	1.90 - 2.00	2.10 - 2.30
Soda ash, dense..... 100 lb.	2.30 - 2.50	2.75 - 3.00
Sodium acetate..... lb.	.05½ - .05½	.06 - .06½
Sodium bicarbonate..... 100 lb.	2.45 - 2.60	2.65 - 3.00
Sodium bichromate..... lb.	.09½ - .09½	.09½ - .10
Sodium bisulphate (nitre cake)..... ton	7.00 - 7.50	8.00 - 11.00
Sodium bisulphate powdered, U.S.P..... lb.	.06½ - .07	.07½ - .08
Sodium borate (borax)..... lb.	.07½ - .08	.08½ - .08½
Sodium carbonate (sal soda)..... 100 lb.	2.00 - 2.25	2.50 - 2.75
Sodium chl. rate..... lb.	.10 - .10½	.10½ - .11
Sodium cyanide, 96-98 per cent..... lb.	.22 - .24	.26 - .29
Sodium fluoride..... lb.	.17 - .17½	.17½ - .18½
Sodium hydroxide (caustic soda)..... 100 lb.	3.75 - 4.00	4.25 - 4.35
Sodium hyposulphite..... lb.	.. - ..	.03 - .04
Sodium nitrate..... 100 lb.	2.85 - ..	3.00 - ..
Sodium nitrite..... lb.	.06 - .06½	.06½ - .07
Sodium peroxide, powdered..... lb.	.30 - .31	.32 - .34
Sodium phosphate, dibasic..... lb.	.03½ - .04½	.04½ - .05
Sodium potassium tartrate (Rochelle salts) lb.	.. - ..	.33 - .35
Sodium prussiate, yellow..... lb.	.17½ - .17	.18 - .18½
Sodium silicate, solution (40 deg.)..... lb.	.01½ - .01½	.02 - .02½
Sodium silicate, solution (60 deg.)..... lb.	.03 - .03½	.03½ - .04
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.75 - 2.00	2.25 - 2.50
Sodium sulphide, crystal, 60-62 per cent (conc.) lb.	.06 - .06½	.07 - .07½
Sodium sulphite, crystals..... lb.	.04 - .04½	.04½ - .05
Strontium nitrate, powdered..... lb.	.20 - .20½	.21 - .22
Sulphur chl. ride, red..... lb.	.08 - .09	.10 - .10½
Sulphur, crude..... ton	16.00 - 20.00	.. - ..
Sulphur dioxide, liquid, cylinders..... lb.	.09 - ..	.10 - .12
Sulphur (sublimed), flour..... 100 lb.	.. - ..	3.70 - 4.35
Sulphur, roll (brimstone)..... 100 lb.	.. - ..	3.40 - 3.90
Tin bichloride, 50 per cent..... lb.	.18 - .19	.. - ..
Tin oxide..... lb.	.. - ..	.50 - .51
Zinc carbonate, precipitate..... lb.	.16 - .18	.19 - .20
Zinc chloride, gran..... lb.	.12 - .13	.13½ - .14
Zinc cyanide..... lb.	.45 - .49	.50 - .60
Zinc dust..... lb.	.12 - .13	.13½ - .14
Zinc oxide, XX..... lb.	.10 - .10½	.11 - .11½
Zinc sulphate..... lb.	.03½ - .03½	.04 - .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 - \$1.15
Alpha-naphthol, refined..... lb.	1.45 - 1.50
Alpha-naphthylamine..... lb.	.40 - .44
Aniline oil, drums extra..... lb.	.22 - .26
Aniline salts..... lb.	.27 - .30
Anthracene, 80% in drums (100 lb.)..... lb.	.90 - 1.00
Benzaldehyde (f.f.c.)..... lb.	2.00 - 2.10
Benzidine, base..... lb.	1.00 - 1.10
Benzidine sulphate..... lb.	.85 - .90
Benzoic acid, U.S.P..... lb.	.70 - .75
Benzoate of soda, U.S.P..... lb.	.75 - .85
Benzene, pure, water-white, in drums (100 gal.) gal.	.32 - .35
Benzene, 90% in drums (100 gal.)..... gal.	.30 - .32
Benzyl chloride, 95-97%, refined..... lb.	.35 - .40
Benzyl chloride, tech..... lb.	.25 - .35
Beta-naphthol benzoate..... lb.	3.50 - 4.00
Beta-naphthol, sublimed..... lb.	.75 - .80
Beta-naphthol, tech (nominal)..... lb.	.40 - .45
Beta-naphthylamine, sublimed..... lb.	2.25 - 2.40
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 - .18
Ortho-cresol, in drums (100 lb.)..... lb.	.23 - .25
Cresylic acid, 97-99%, straw color, in drums..... gal.	.95 - 1.00
Cresylic acid, 95-97%, dark, in drums..... gal.	.90 - .95
Cresylic acid, 50%, first quality, drums..... gal.	.65 - .75
Dichlorobenzene..... lb.	.07 - .15
Diethylaniline..... lb.	1.35 - 1.40
Dimethylaniline..... lb.	.65 - .90
Dinitrobenzene..... lb.	.30 - .37
Dinitrochlorobenzene..... lb.	.25 - .30
Dinitronaphthalene..... lb.	.40 - .45
Dinitrophenol..... lb.	.40 - .45
Dinitrotoluene..... lb.	.30 - .32
Dip oil, 25%, tar acids, car lots, in drums..... gal.	.38 - .40
Diphenylamine..... lb.	.70 - .75
H-acid..... lb.	1.40 - 1.55
Meta-phenylenediamine..... lb.	1.25 - 1.30
Monochlorobenzene..... lb.	.15 - .16
Monoethylaniline..... lb.	1.75 - 2.25
Naphthalene crushed, in bbls. (250 lb.)..... lb.	.08 - .08½
Naphthalene, flake..... lb.	.08 - .08½
Naphthalene, balls..... lb.	.09 - .09½
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.40 - .50
Nitro-toluene..... lb.	.18 - .25
Ortho-amidophenol..... lb.	3.20 - 3.75
Ortho-dichlor-benzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.75 - .80
Ortho-nitro-toluene..... lb.	.23 - .30
Para-amidophenol, base..... lb.	.25 - .30
Para-amidophenol, HCl..... lb.	2.20 - 2.25
Para-amidophenol, HCl..... lb.	2.10 - 2.15

Para-dichlorobenzene..... lb.	.10 - .15
Paranitroaniline..... lb.	.93 - 1.00
Para-nitrotoluene..... lb.	1.25 - 1.40
Para-phenylenediamine..... lb.	2.20 - 2.35
Para-toluidine..... lb.	1.70 - 1.80
Phthalic anhydride..... lb.	.60 - .70
Phenol, U. S. P., drums (dest.), (240 lb.)..... lb.	.09 - .10
Pyridine..... gal.	2.00 - 3.50
Resorcinol, technical..... lb.	2.75 - 2.80
Resorcinol, pure..... lb.	3.60 - 3.80
Salicylic acid, tech., in bbls. (110 lb.)..... lb.	.32 - .33
Salicylic acid, U. S. P..... lb.	.35 - .37
Salol..... lb.	.85 - .95
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.30 - .35
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.19 - .22
Sulphanilic acid, crude..... lb.	.32 - .35
Tolidine..... lb.	1.35 - 1.40
Toluidine, mixed..... lb.	.45 - .55
Toluene, in tank cars..... gal.	.30 - .32
Toluene, in drums..... gal.	.33 - .35
Xylidines, drums, 100 gal..... lb.	.45 - .50
Xylene, pure, in drums..... gal.	.42 - .45
Xylene, pure, in tank cars..... gal.	.45 - .48
Xylene, commercial, in drums, 100 gal..... gal.	.37 - .38
Xylene, commercial, in tank cars..... gal.	.30 - ..

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.26 - \$0.27
Beeswax, refined, light..... lb.	.28 - .30
Beeswax, white pure..... lb.	.35 - .40
Carnauba, No. 1..... lb.	.85 - .90
Carnauba, No. 2, North Country..... lb.	.45 - .50
Carnauba, No. 3, North Country..... lb.	.20 - .25
Japan..... lb.	.19 - .20
Montan, crude..... lb.	.07 - .08
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.06½ - .06½
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.06½ - .06½
Paraffine waxes, refined, 118-120 m.p..... lb.	.07 - .07
Paraffine waxes, refined, 125 m.p..... lb.	.07½ - .08
Paraffine waxes, refined, 128-130 m.p..... lb.	.08½ - .09
Paraffine waxes, refined, 133-135 m.p..... lb.	.10 - .11
Paraffine waxes, refined, 135-137 m.p..... lb.	.11½ - .12
Stearic acid, single pressed..... lb.	.14½ - .15
Stearic acid, double pressed..... lb.	.15½ - .15½
Stearic acid, triple pressed..... lb.	.16 - .16½

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr., 0.930-0.940..... gal.	\$1.90
Pine oil, pure, dest. dist..... gal.	1.50
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75
Pine tar, ref., thin, sp.gr., 1.080-1.960..... gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970..... gal.	1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.35
Pinewood creosote, ref..... gal.	.52

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B- , bbl..... 280 lb.	\$8.75 - ..
Rosin E-I..... 280 lb.	8.75 - ..
Rosin K-N..... 280 lb.	8.75 - ..
Rosin W. G.-W. W..... 280 lb.	9.00 - ..
Wood rosin, bbl..... 280 lb.	9.00 - ..
Spirits of turpentine..... gal.	.76 - ..
Wood turpentine steam dist..... gal.	.74 - ..
Wood turpentine, dest. dist..... gal.	.74 - ..
Pine tar pitch, bbl..... 200 lb.	.. - 8.50
Tar, kiln burned, bbl. (500 lb.)..... bbl.	.. - 15.00
Retort tar, bbl..... 500 lb.	15.00 - 15.50
Rosin oil, first run..... gal.	.60 - ..
Rosin oil, second run..... gal.	.62 - ..
Rosin oil, third run..... gal.	.75 - ..

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41
70-72 deg., steel bbls. (85 lb.)..... gal.	.39
68-70 deg., steel bbls. (85 lb.)..... gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30

Crude Rubber

Para-Upriver fine..... lb.	\$0.18½ - \$0.19
Upriver coarse..... lb.	.14 - .14½
Upriver caucho ball..... lb.	.14½ - .14½
Plantation—First latex crepe..... lb.	.17 - ..
Ribbed smoked sheets..... lb.	.16½ - ..
Brown crepe, thin, clean..... lb.	.16 - ..
Amber crepe No. 1..... lb.	.17 - ..

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.10 - \$0.11½
Castor oil, AA, in bbls..... lb.	.12 - .13
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.09 - .09½
Cocanut oil, Ceylon grade, in bbls..... lb.	.13 - .13½
Cocanut oil, Cochín grade, in bbls..... lb.	.13½ - .14
Cori oil, crude, in bbls..... lb.	.09 - .09½
Cottonseed oil, crude (f. o. b. mill)..... lb.	.06 - .07
Cottonseed oil, summer yellow..... lb.	.08½ - .08½
Cottonseed oil, winter yellow..... lb.	.09 - .09½
Linseed oil, raw, car lots (domestic)..... gal.	.77 - .79
Linseed oil, raw, tank cars (domestic)..... gal.	.73 - .74
Linseed oil, boiled, car lots (domestic)..... gal.	.78 - .80

Olive oil, commercial.....	gal.	2.60	—	2.70
Palm, Lagos.....	lb.	.07 $\frac{1}{2}$	—	.08
Palm, Niger.....	lb.	.07 $\frac{3}{4}$	—	.08 $\frac{1}{2}$
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.07	—	.07 $\frac{1}{2}$
Peanut oil, refined, in bbls.....	lb.	.13	—	.13 $\frac{1}{2}$
Rapeseed oil, refined in bbls.....	gal.	1.10	—	1.15
Rapeseed oil, blown, in bbls.....	gal.	1.20	—	1.25
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.08 $\frac{1}{2}$	—	.09
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.06	—	.07

FISH

Light pressed Menhaden.....	gal.	\$0.53	—	\$0.55
Yellow bleached Menhaden.....	gal.	.55	—	.58
White bleached Menhaden.....	gal.	.57	—	.60
Blown Menhaden.....	gal.	1.00	—	....

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	\$24.00	—	\$30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek...	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	....
Blanc fixe, dry.....	lb.	.05	—	.05 $\frac{1}{2}$
Blanc fixe, pulp.....	net ton	60.00	—	65.00
Caseine.....	lb.	.14	—	.18
Chalk, domestic, extra light.....	lb.	.05	—	.06
Chalk, domestic, light.....	lb.	.04 $\frac{1}{2}$	—	.05 $\frac{1}{2}$
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04 $\frac{1}{2}$	—	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	8.00	—	10.00
China clay (Kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (Kaolin) powdered, f.o.b. Georgia...	net ton	18.00	—	22.00
China clay (Kaolin) crude f.o.b. Virginia points.	net ton	8.00	—	12.00
China clay (Kaolin) ground, f.o.b. Virginia points.	net ton	15.00	—	40.00
China clay (Kaolin), imported, lump.....	net ton	25.00	—	35.00
China clay (Kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fuller's Earth, f.o.b. New York.....	net ton	16.00	—	17.00
Fuller's earth, granular, f.o.b. Fla.....	net ton	25.00	—	....
Fuller's earth, powdered, f.o.b. Fla.....	net ton	18.00	—	....
Fuller's earth, imported, powdered.....	net ton	35.00	—	40.00
Graphite, crucible, 90% carbon, Ashland, Ala...	lb.	....	—	.09
Graphite, crucible, 85% carbon, Ashland, Ala...	lb.	.07	—	.09
Graphite, higher lubricating grades.....	lb.	.11	—	.40
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic, lump.....	lb.	.06	—	....
Pumice stone, ground.....	lb.	.04	—	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	....	—	10.00
Quartz (acid tower) 1 $\frac{1}{2}$ @ 2 in., f.o.b. Baltimore...	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	1.00	—	1.05
Shellac, orange superfine.....	lb.	1.05	—	1.10
Shellac, A. C. garnet.....	lb.	.90	—	.95
Shellac, T. N.....	lb.	.85	—	.95
Soapstone.....	ton	15.00	—	25.00
Sodium Chloride.....	long ton	....	—	17.50
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	60.00	—	70.00
Talc, California Talcum Powder grade.....	ton	20.00	—	45.00

Refractories

Bauxite brick, 56% Al., f.o.b. Pittsburgh.....	1,000	160	—	....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	100-110	—	....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	55-60	—	....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	60-65	—	....
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	—	....
Fire clay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	—	....
Magnesite brick, 9-in. straight.....	net ton	110	—	....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	121	—	....
Magnesite brick, soaps and splits.....	net ton	134	—	....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65-70	—	....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56-61	—	....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	55-60	—	....

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium; 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.16	—	.17
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.17	—	.18
Ferro-manganese, 76-80% Mn, domestic.....	gross ton	120.00	—	125.00
Ferro-manganese, 76-80% Mn, English.....	gross ton	130.00	—	135.00
Spiegeleisen, 18-22% Mn.....	gross ton	60.00	—	65.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo..	lb.	2.00	—	2.50
Ferro-silicon, 10-15%.....	gross ton	55.00	—	60.00
Ferro-silicon, 50%.....	gross ton	78.00	—	80.00
Ferro-silicon, 75%.....	gross ton	....	—	150.00
Ferro-tungsten, 70-80%, per lb. of contained W...	lb.	.55	—	.60
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00	—	....
Ferro-vanadium, 30-40% per lb. of contained V....	lb.	6.50	—	7.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe ₂ O ₃ , up to 20% silica, not more than H ₂ O 4% moisture..	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min....	unit	.60	—	.65
Chrome ore, 50%, Cr ₂ O ₃ , f.o.b. Atlantic Seaboard.....	unit	.55	—	.60
Coke, foundry, f.o.b. ovens.....	net ton	....	—	7.00
Coke, furnace, f.o.b. ovens.....	net ton	....	—	6.00
Coke, petroleum, refinery, Atlantic Seaboard...	net ton	21.00	—	22.00
Fluor spar, lump, f.o.b. Tonuco, New Mexico...	net ton	17.50	—	....
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	—	25.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 $\frac{1}{2}$	—	.01 $\frac{1}{2}$
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	.40	—	.45
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport	unit	35.00	—	....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport...	unit	.12	—	....
Pyrites, Spanish, furnace size, c.i.f., Atlantic seaport.....	unit	.17	—	....
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	....
Tungsten, Scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.75	—	4.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	4.00	—	4.25
Uranium Ore (Carnotite) per lb. of U ₃ O ₈	lb.	2.75	—	3.00
Uranium oxide, 96% per lb. contained U ₃ O ₈ ...	lb.	2.75	—	3.00
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium Ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	....
Zircon, washed, iron free.....	lb.	.05	—	....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	15 00
Aluminum, 98 to 99 per cent.....	27 50
Antimony, wholesale lots, Chinese and Japanese	5.25 @ 5.37 $\frac{1}{2}$
Nickel, ordinary (ingot).....	43.00
Nickel, electrolytic.....	45.00
Tin, 5-ton lots.....	34.02 $\frac{1}{2}$
Lead, New York, spot.....	5.37 $\frac{1}{2}$
Lead, E. St. Louis, spot.....	6.25
Zinc, spot, New York.....	7.00
Zinc, spot, E. St. Louis.....	6.75

OTHER METALS

Silver (commercial).....	oz.	\$0.65 $\frac{1}{2}$
Cadmium.....	lb.	1.40 @ 1.50
Bismuth (500 lb. lots).....	lb.	2.40
Cobalt.....	lb.	6.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.35
Platinum.....	oz.	75.00
Iridium.....	oz.	350.00 @ 400.00
Palladium.....	oz.	75.00
Mercury.....	75 lb.	50.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per Lb.

Copper sheets, hot rolled.....	22 50
Copper bottoms.....	34.00
Copper rods.....	29.00
High brass wire and sheets.....	20.25
High brass rods.....	18.25
Low brass wire and sheets.....	30.50
Low brass rods.....	19.50
Brazed brass tubing.....	36.25
Brazed bronze tubing.....	41.50
Seamless copper tubing.....	26.00
Seamless high brass tubing.....	25.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	12.00	17.00	10.00	11.50
Copper, heavy and wire.....	11.50	16.00	9.50	11.00
Copper, light and bottoms.....	10.00	14.00	9.00	9.50
Lead, heavy.....	4.00	4.75	4.00	4.50
Lead, tea.....	3.00	3.75	3.00	3.50
Brass, heavy.....	7.00	10.50	7.00	10.50
Brass, light.....	5.50	7.50	5.00	5.50
No. 1 yellow brass turnings.....	6.50	10.00	5.50	5.50
Zinc.....	4.50	5.00	3.00	4.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by $\frac{1}{2}$ in. and larger, and plates $\frac{1}{2}$ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes...	\$3.80	\$4.15	\$3.47	\$3.58	\$3.37	\$3.58	\$3.47
Soft steel bars.....	3.70	4.15	3.37	3.34	3.27	3.48	3.37
Soft steel bar shapes	3.70	4.15	3.37	3.48	3.27	3.48	3.37
Soft steel bands.....	4.65	5.50	4.07	6.25	....	....	....
Plat.s, $\frac{1}{2}$ to 1 in. thick	4.00	4.15	3.67	3.78	3.57	3.78	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

EL CENTRO—The City Council plans an election in January to vote on \$125,000 to purchase and enlarge the present privately owned gas plant. W. F. Holt, principal owner.

LOS ANGELES—The Consolidated Vanadium Co., 1225 Washington Bldg., has awarded the contract for the construction of a 1-story, 50x50-ft. factory for the manufacture of vanadium products, to the Union Iron Works, 5125 Santa Fe Ave., Estimated cost, \$4,000.

Massachusetts

WAKEFIELD—The town plans to install equipment in the gas plant of the municipal light plant. Estimated cost, \$250,000.

Colorado

LA JUNTA—The town plans an election Jan. 20 to vote on \$200,000 bonds to construct a high school. A chemical laboratory will be installed in same.

Georgia

CREST—The Taylor Graphite Co. plans to install mining and concentrating equipment. Estimated cost, \$23,000. J. E. Taylor, pres.

Iowa

CHARLES CITY—The city is having plans prepared for the construction of a sewage disposal plant. Estimated cost, \$25,000. W. E. Buell, 228 Davidson Bldg., Sioux City, engr.

DECORAH—The Bd. Educ. plans an election Jan. 10 to vote on \$150,000 bonds to construct a 2- or 3-story high school. A chemical laboratory will be installed in same. C. F. Barefoot, secy.

KEOKUK—The city plans an election soon to vote on \$500,000 bonds to build a 3-story high school. A chemical laboratory will be installed in same. F. C. Smith, secy.

Maryland

BALTIMORE—The School Bd. of Awards has awarded the contract for the construction of a 3-story, 76x271-ft. high school on Latrobe Park and Fort Ave., to the Standard Constr. Co., 1713 Sansom St., Philadelphia, Pa. A chemical laboratory will be installed in same.

Minnesota

NEW PRAGUE—J. E. Bruzek, city clk., will soon receive bids for the construction of a sewage disposal plant. Estimated cost, \$50,000. J. W. Shaffer & Co., 917 New York Life Bldg., Minneapolis, engr.

NORTHFIELD—St. Olaf's College plans to build a 3-story, 73x186-ft. science hall. A chemical laboratory will be installed in same. Estimated cost, \$500,000. N. E. Mohn, 596 Endicott Bldg., St. Paul, archt.

RENVILLE—A. R. Holmberg, clk. of the Bd. Educ. will receive bids until Jan. 18 for the construction of a 2-story, 146x273-ft. grade and high school. Estimated cost, \$280,000. Croft & Boerner, 1006 Marquette Ave., Minneapolis, archts.

Montana

MILES CITY—The Bd. Educ., c/o Olive Lovett, Supt. of Schools, has had plans prepared for the construction of a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, \$400,000.

New Jersey

NEWARK—The Butterworth-Judson Corp., Doremus Ave., has had plans prepared for the reconstruction of a 3-story paranitraniline unit of its plant which was recently destroyed by fire. Estimated cost, \$180,000.

North Dakota

BISMARCK—The city will soon award the contract for the construction of a waterworks system to include reservoirs, filtration plant, pumping station, distributing system, etc. Estimated cost, \$1,300,000. L. R. Wolff, 1000 Guardian Life Bldg., St. Paul, Minn., engr. Noted June 30.

Ohio

HOLGATE—The town will receive bids until Jan. 8 for altering and building a 2-story, 66x155-ft. addition to the high school. Chemical equipment will be installed in same. Estimated cost, \$90,000. O. L. C. Zachsich, clk. S. P. Stewart & Son, Bowling Green, archts.

Oklahoma

VINITA—The city has had plans prepared for the construction of a purification plant to include liquid chlorine treatment and sand filters, etc. Estimated cost, \$460,000. H. G. Olmsted & Co., 417 Oil Exch., Oklahoma City, engr. Noted Nov. 24.

South Dakota

MCINTOSH—The Bd. Educ. will receive bids until Jan. 24 for the construction of a 2-story grade and high school. A chemical laboratory will be installed in same. Estimated cost, \$150,000. E. J. Geers, clk. G. Issenhuth, Huron, archt.

Virginia

NORFOLK—The Western Junior High School plans to build a 4-story, 150x310-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$700,000.

Wisconsin

DURAND—The Bd. Educ., c/o H. A. Miles, secy., is having plans prepared for the construction of a 2-story, 80x124-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$100,000. Oppenhamer & Obel, Wausau, archts. Noted Aug. 25.

FOND DU LAC—The Bd. Educ., c/o A. M. Hunter, secy., has had plans prepared for the construction of a 3-story, 110x115-ft. senior high school on Linden St. A chemical laboratory will be installed in same. Estimated cost, \$275,000. Childs & Smith, 64 East Van Buren St., Chicago, archts.

HARTFORD—The city retained J. Donohue, engr., 720 New York Ave., Sheboygan, to prepare plans for altering the sewerage system, building septic tank, etc. Estimated cost, \$50,000. W. Radke, city clk.

KIMBERLY—The city engaged F. A. C. Smith, engr., Colby-Abbott Bldg., Milwaukee, to prepare plans for the construction of a sewerage system and sewage disposal plant. Estimated cost, \$100,000.

MILWAUKEE—T. Rogers, chemist, c/o Dept. of Pub. Wks., plans to install \$15,000 worth of special equipment in the garbage plant for the purpose of determining the practicability of making alcohol from garbage.

OCONTO FALLS—The Bd. Educ., c/o G. Krohn, secy., is having plans prepared for the construction of a 1-story, 76x100-ft. high and grade school on Main St. A chemical laboratory will be installed in same. Estimated cost, \$100,000. Juul & Smith, Imig Bldg., Sheboygan, archts.

WEST ALLIS—The City Council plans to build an addition to the septic tank. Estimated cost, between \$15,000 and \$25,000. A. Schneider, City Hall, engr.

Ontario

SMITHS FALLS—The town plans to construct a filtration plant. Estimated cost, \$15,000. J. A. Lewis, clk.

Quebec

MONTREAL—The Can Welding Co., Amherst St. near Ontario St., plans to construct a plant, including equipment. Estimated cost, \$60,000.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its annual meeting Feb. 21 to 24, 1921, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29, 1921.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting Feb. 14 to 17 in New York City.

COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA will hold its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.

COMPRESSED GAS MANUFACTURERS' ASSOCIATION will hold its eighth annual meeting, Monday, Jan. 17, 1921, at 2 p.m., at the Hotel Astor, New York, and its eighth annual dinner at the same place that evening.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetter's Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY holds its Perkin Medal Award Meeting at Rumford Hall, Chemists' Club, New York, on Jan. 14, 1921.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Jan. 7, American Chemical Society; Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

Industrial Notes

THE JAPANESE TISSUE MILLS, INC., of Holyoke, Mass., which is a combination of the former Mt. Holyoke Tissue and Japanese Tissue Mills, has changed its name to the American Tissue Mills. Important changes are being made in the company.

THE AMHERST WAXED PAPER CO., Amherst, Mass., is preparing to locate in Holyoke, Mass., in a building constructed some time ago by J. L. Perkins, who purchased the company some years back. The new mill is being fitted up with waxed paper machinery and will employ 100 hands when operating to full capacity. The present mill is located at Amherst and will be retained for some time to come.

THE CIVIC AND COMMERCIAL ASSOCIATION of Denver, Col., is making a research study for the porcelain industry for the benefit of the city; Homer B. Vanderblu, of the industrial research department, is spending three weeks in the ceramic industries, particularly at Liverpool, O. He will make arrangements for the testing of Colorado clays by the experts of the Ohio region and investigation as to the various possible uses in the manufacture of porcelain. Technical investigations will later be made in cooperation with the Colorado Society of Engineers, which has offered to participate in the work.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO., East Pittsburgh, Pa., has initiated a part-time employment plan, in order that engineering students of the University of Pittsburgh and the Carnegie Institute of Technology may be able to gain practical knowledge regarding the production and testing of electrical apparatus, and at the same time earn extra money. Students are allowed the regular hourly rate for work on Saturday afternoons, Sunday and holidays. For the most part the employment consists of store-keeping, which allows the students to become familiar with the size and character of the different kinds of electrical apparatus.

THE STAR BRASS WORKS, 3114-28 Carroll Ave., Chicago, announces that on and after Jan. 1, 1921, the company name will be changed to Binks Spray Equipment Co. Such change of name has been made to conform more nearly with the nature of the products manufactured. Simultaneously announcement is also made of the completion of a new plant and office extension on the west wing of the old plant in which provisions are made for new salesroom, testing laboratories, and greatly increased manufacturing facilities on the first floor, with new offices and drafting rooms on the second floor. This company also announces the establishment of a Pacific Coast office in charge of L. M. Page, Rialto Bldg., San Francisco.

THE MAX-LEW CHEMICAL CO., of 20 Clinton St., Newark, N. J., with David E. Bernstein as agent, has been chartered in the office of the Secretary of State to operate in New Jersey in the manufacture and sale of chemicals, alkalis, etc., as some of its principal objects. The concern has a capitalization of \$100,000, which is divided into 1,000 shares at \$100 each, while the amount that will be devoted to the starting of business is \$3,000. The incorporators and the number of shares held by each are Max Lewitt, of 68 Howard St., Newark, N. J., 10; George Lewitt, of 68 Howard St., Newark, N. J., 10, and Abraham Lewitt, of 68 Howard St., Newark, N. J., 10.

THE METAL & THERMIT CORP., New York, announces that O. E. Falls, who has had many years of experience in charge of foundry and thermit welding work at the Norfolk Navy Yard, Portsmouth, Va., has accepted a position with it. Announcement is also made of the opening of a branch office at 141 Milk St., Boston, in charge of Robert L. Browne.

THE ELECTRIC FURNACE CO., Alliance, O., has just shipped two 165-kw. Baily units to Norway, where they will be used to melt zinc at the Jossingfyord plant in Stavanger, and to melt aluminum at the Norsk Aluminium Works at Christiania. Complete rolling mill brass-melting furnaces, designed for pouring the metal directly into the molds, have recently been shipped by this company to the Amsinck Corp. of Mexico, Mitsui & Co. of Japan, and Allen Everett, Ltd., of England. In addition to these units Baily electric furnaces have recently been installed at three Canadian plants: The Dominion Steel Products Co. of Brantford, Ont., the Monarch Metals Co. of Hamilton, Ont., and the Union Screen Plate Co. of Lennoxville, Que.

New Publications

NEW BUREAU OF STANDARDS PUBLICATIONS: Sci. Paper 392, A Photographic Method of Detecting Changes in a Complicated Group of Objects, by M. H. Stillman; Sci. Paper 394, Air Forces on Circular Cylinders, Axes Normal to the Wind, With Special Reference to Dynamical Similarity, by Hugh L. Dryden; Sci. Paper 395, Relation of the High-Temperature Treatment of High-Speed Steel to Secondary Hardening and Red-Hardness, by Howard Scott; Sci. Paper 397, A Study of the Relation Between the Brinell Hardness and the Grain Size of Annealed Carbon Steels, by Henry S. Rawdon and Emilio Jimeno-Gill; Sci. Paper 400, Ionization and Resonance Potentials of Some Non-Metallic Elements, by F. L. Mohler and Paul D. Foote; Tech. Paper 167, An Examination of the Munsell Color System, by Irwin G. Priest, K. S. Gibson and H. J. McNicholas; Tech. Paper 172, Cast Iron for Locomotive-Cylinder Parts, by C. H. Strand; Tech. Paper 174, Effects of Cal as an Accelerator of the Hardening of Portland Cement Mixtures, by Roy N. Young; Tech. Paper 175, Pouring and Pressure Tests of Concrete, by W. A. Slater and A. T. Goldbeck; Tech. Paper 176, Slushing Oils, by Percy H. Walker and Lawrence L. Steele; Tech. Paper 176, Sulphur in Petroleum Oils, by C. E. Waters.

NEW BUREAU OF FOREIGN AND DOMESTIC COMMERCE PUBLICATIONS: Schedule Governing the Statistical Classification of Imports Into the United States, with rates of duty and regulations governing the preparation of monthly and quarterly statements of imports; Statistical Classification of Domestic Commodities Exported From the U. S.

NEW U. S. GEOLOGICAL SURVEY PUBLICATIONS: Natural-Gas Gasoline in 1918, by E. G. Sievers (Mineral Resources of the U. S., 1918, Part II), published Sept. 22, 1920; I: 2, Platinum and Allied Metals in 1919, by James M. Hill (Mineral Resources of the U. S., 1919, Part I), published July 30, 1920; I: 3, Arsenic, Bismuth, Selenium and Tellurium in 1919, by James M. Hill (Mineral Resources of the U. S., 1919,

Part I), published Sept. 16, 1920; I: 5, Bauxite and Aluminum in 1919, by James M. Hill (Mineral Resources of the U. S., 1919, Part I), published Aug. 30, 1920; I: 6, Gold, Silver, Copper, Lead and Zinc in the Eastern States in 1919, by J. P. Dunlop (Mineral Resources of the United States, 1919, Part I), published Nov. 8, 1920; I: 24, Gold and Silver in 1919 (General Report), by J. P. Dunlop (Mineral Resources of the United States, 1918, Part I), published July 15, 1920; I: 25, Nickel in 1918, by Frank L. Hess (Mineral Resources of the U. S., 1918, Part I), published June 29, 1920; II: 4, Peat in 1919, by K. W. Cottrell (Mineral Resources of the U. S., 1919, Part II), published Oct. 14, 1920; I: 26, Cobalt Molybdenum, Tantalum, Titanium, Radium, Uranium and Vanadium in 1918, by Frank L. Hess (Mineral Resources of the U. S., 1918, Part I), published June 29, 1920; I: 28, Copper in 1918, by B. S. Butler (Mineral Resources of the U. S., 1918, Part I), published Sept. 28, 1920; I: 29, Cobalt, Molybdenum, Nickel, Titanium, Tungsten, Radium, Uranium and Vanadium in 1917, by Frank L. Hess (Mineral Resources of the U. S., 1917, Part I), published Aug. 31, 1920; II: 1, Thorium, Zirconium and Rare-Earth Minerals in 1919, by Waldemar T. Schaller (Mineral Resources of the U. S., 1919, Part II), published Sept. 1, 1920; II: 2, Fuel Briquetting in 1919, by F. G. Tyron (Mineral Resources of the U. S., 1919, Part II), published Aug. 13, 1920; II: 28, Lime in 1918, by G. F. Loughlin and Herbert Insley (Mineral Resources of the U. S., 1918, Part II), published June 7, 1920; II: 29, Clay-Working Industries, Silica Brick and Building Operations in the Larger Cities in 1918, by Jefferson Middleton (Mineral Resources of the U. S., 1918, Part II), published July 14, 1920; II: 33, Abrasive Materials in 1918, by Frank J. Katz (Mineral Resources of the U. S., 1918, Part II), published Aug. 27, 1920; II: 34, Stone in 1918, by G. F. Loughlin and A. T. Coons (Mineral Resources of the U. S., 1918, Part II), published Oct. 11, 1920.

Manufacturers' Catalogs

AMERICAN TERRA COTTA CO., Chicago, Ill., is now publishing a house organ entitled *Common Clay*, which deserves special mention as to reading matter and illustrations. W. D. Gates, president of the company and dean of Chicago ceramists, writes a department called "Button-hole Talks." These talks are bits of philosophy well worth reading. The American Terra Cotta Co. manufactures art and ornamental terra cotta and the publication is a successful exposition of the company's artistic developments.

CLARENCE W. MARSH, 101 Park Ave., New York City, has published an instructive folder on the Marsh electrolytic cell for chlorine and caustic soda.

W. S. ROCKWELL CO., New York, calls attention to Bull. 222. In this bulletin the purpose is not to talk about furnaces of the company's manufacture, but to place before the furnace-using public the principles drawn from the company's experience, prints of actual installations being used to illustrate the points raised. Such points include: The applicability of car-type and car-and-ball type furnaces to the heat-treatment of material that cannot be advantageously handled in other types of furnaces; factors governing selection of the type (car or car-and-ball) best suited to individual manufacturing requirements; the difference in design of each type; influence of unequal cooling on the quality of finished product; typical heat-treatment installations involving the use of car-type and car-and-ball type furnaces.

THE METAL & THERMIT CORP., New York, has just issued and will distribute on request the third edition of the Thermit Welding pamphlet No. 17 for mill and foundry repairs. The new edition has been revised and brought up to date both as regards new practices recommended and illustrations showing recent interesting repairs on certain types of equipment since the publication of the former edition. The pamphlet begins with a general discussion of the proper applications and fields for oxy-acetylene, electric and thermit welding, respectively. It then describes in detail the methods to be followed and apparatus used in welding iron and steel sections in general. Later it outlines thoroughly special applications of thermit welding, such as for crankshaft, pinion and roll repairs and also for cast-iron welding. Not previously included in former editions of this pamphlet is a description of a new method of welding teeth in pinions. The pamphlet

concludes by explaining the various applications of thermit in foundry practice, such as for increasing the temperature of iron and steel, facilitating the introduction of other metals which it is desired to alloy for special purposes, making semi-steel in the ladle, keeping metal and risers liquid for a considerable period and making small steel castings. This company also announces a revised Thermit Rail Welding pamphlet, No. 39, which describes the various ways in which thermit welding can be advantageously used for rail welding, and pamphlet No. 20 on thermit carbon-free metals and alloys. The pamphlet, in addition to containing a detailed description of the properties and characteristics of the various carbon-free metals and alloys manufactured by this company, includes an explanation of the advantages of using Tungstabs, or tablets of pure tungsten metal, in the production of high-speed steel and other alloys containing tungsten instead of using tungsten powder and ferrotungsten. Metallurgical losses caused by oxidation in melting and by the absorption of tungsten by the crucible and electric-furnace lining, particularly in the initial heats, are reduced because by using Tungstabs the melting time is decreased and there is a higher recovery of the tungsten owing to the fact that the Tungstabs melt down with the charge.

THE JOSEPH T. RYERSON & SONS CO., Chicago, has issued a leaflet entitled "Do You Know How to Make a Chisel?" which contains a complete description of working, grinding, hardening and tempering the ordinary hand chisel, and will be found of interest to anyone who has to do with the use of chisels generally.

THE BOOTH ELECTRIC FURNACE CO., Chicago, has issued a handsomely illustrated catalog describing the Booth rotating furnaces, giving a list of plants where these are installed. Tables of dimensions of the several sizes appended to blueprints give an accurate idea of the details of construction.

THE MANUFACTURERS' EQUIPMENT CO., Dayton, O., has issued a new bulletin entitled "The Underwood Producer Gas System," which contains descriptions of apparatus and application for burning all kinds of clay products, for glass house furnaces, steel furnaces, the making of carbon products, the heating of enameling furnaces, and the heating of furnaces in chemical and acid plants. The pamphlet contains technical data interesting to those engaged in the above industries.

THE CLEVELAND BREATHING MACHINE CO., Cleveland, O., has issued a 4-page folder on "The Lyon Breathing Machine."

THE CUTLER-HAMMER MFG. CO., Milwaukee, Wis., announces that in order to include information under one cover on C-H products for mine applications a new 48-page illustrated booklet has been prepared, which is entitled "For the Mine." Attention is also called to Publication 867, entitled "Dictionary of Uses" of C-H Electric Space Heaters.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING CO., East Pittsburgh, Pa., has just received from the Press Bull. 7-A-C-1 on "Mine Locomotive Headlights."

OXWELD ACETYLENE CO., Chicago, Ill., is issuing its new "Ever-ready" instruction book, which is a treatise on every-day oxy-acetylene welding and cutting. This volume, which is 5x8 in., contains fifty-five printed pages, inclusive of illustrations and drawings.

PLANT ENGINEERING & EQUIPMENT CO., New York City, calls attention to a new catalog on Peeco Equipment, which gives illustrations and descriptions of its steam trap gages, valve steam traps, turbo-blowers for steam boilers, Mason condensation meter, etc.

DODGE SALES & ENGINEERING CO., Mishawaka, Ind., has issued Catalog D-20-C on Standardized Elevators and Conveyors, continuous mechanical handling, which is very complete and gives illustrations as well as descriptions.

THE BROWN HOISTING MACHINERY CO., Cleveland, O., has published Catalog K 1921, on Locomotive Cranes. This attractive 88-page catalog illustrates and describes the many types of cranes and equipment.

BLAKE PUMP & CONDENSER CO., Fitchburg, Mass., desires to announce Catalog H-40, on "High-Efficiency Pumping Machinery." The predominating feature of the pumping apparatus shown in this catalog is the application of the Blake-Fitchburg high-efficiency four-bearing type power end to certain types of fluid ends which have been developed to a high efficiency for the particular service to which they are applicable. Many interesting illustrations are given of the different types.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

L. W. CHAPMAN
Western Editor
CHESTER H. JONES
CHARLES A. BLATCHLEY
Industrial Editors
J. S. NEGRO
Managing Editor

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New York, January 12, 1921

Number 2

New Hearings on The Patent Office Bill

WHILE no new arguments against section 9 of the Patent Office bill were offered at the hearings before the joint conference committee of the House and Senate, reported elsewhere in this issue, industrial chemical concerns took advantage of their first opportunity to apprise Congress of their views. They appeared in large numbers, representing the leading manufacturers whose interests are considered jeopardized by the proposal to patent the inventions of Government employees and administer these patents through license by the Federal Trade Commission. In our issue for Oct. 27, 1920, we devoted a great deal of space to the subject, and but little can be added here to the pros and cons there given.

Viewing the matter after this lapse of time and in the light of the representations before the committee at Washington, it is still quite evident that there are some features of the proposal which are rightly objectionable to industry. Even though the measure should fail to function—a probability frankly advanced by unbiased as well as partisan witnesses—its administration involves principles which are repugnant to business men. Will the Federal Trade Commission grant exclusive or non-exclusive licenses? If the latter, none are likely to be taken; if the former, there must inevitably be protest against favoritism. Projecting ourselves into the future operation of the measure, it would seem as though exclusive licenses will be essential to its operation. Non-exclusive licenses will gain nothing more than is now obtained by dedication to the public. Again, what is the proper disposition of useful knowledge gained by Government employees occupied in official duties at public expense? Shall it be parceled out discriminately? And if so, who shall be the fortunate recipient of the product of a public servant's toil? The practical consequence must be confusion, crimonations and re-criminations.

Further, what is the legitimate field of research for the Government? Should it be in those lines of industry which will yield patentable inventions that will require some special method of administration in the public industry? Shall industry be further encouraged to conduct its own research, using such media as consulting scientists and industrial laboratories, or shall it be discouraged from this course and led to look to the Government for its progress? Admitting that there are now some industries so poorly developed or existing in large numbers of small units, so that they need a correlating agency to assist them, is not the whole idea of industrial research so well developed that in most instances the Government could rely on established private agencies to do the necessary work, and even refer industries to such agencies?

While it is problematical what the joint conference

committee will do as a result of the opposition to section 9, we may hazard a guess that it will retain the measure in the bill in spite of the unanimous opposition of industry. The opposition will be discounted on the ground that it represents the selfish interest of large and greedy corporations that wish to stifle Government investigation in the interest of the people. The rôle of the corporations is unpopular, in spite of the fact that they have done and are doing much to advance industrial research which ultimately benefits the consuming public. Nor will the conference committee consent to separate section 9 from the bill for relief of the Patent Office, because thus separated it will have no chance of passage at this session of Congress. Full advantage will be taken of the opportunity of putting the section through as a rider to a measure which has the indorsement of all the people.

When Will Activity In General Business Return?

THE question asked in the caption to these remarks is one that is being heard on all hands, and a wide variety of answers is being given, most of them distinctly evasive. As a rule there is a close connection between the character of answer and the individuality of the one suggesting the answer. The man who has been worrying for a year or two about the high wages the country has been paying answers that activity in business will be restored when wages come down. The man whose hobby is crops and the Western farmers says the farmer owes a great deal of money to the banks and cannot buy until he has paid off his notes, so that it will be a long time before we have business activity. The man who has always considered the railroads the chief source of prosperity in the country holds that activity will return when the railroads begin to buy, but has doubts whether they will do so soon, and so on and so on.

As a test of the prophet's trustworthiness it would be very useful to find out what the man thought six months ago. Probably in nine cases out of ten it would be found that the man who now sets the longest time for the return of activity is the man who six months ago was most strongly convinced that the business conditions of that time were marked for indefinite continuance.

There are men who can be got to admit that in the past few weeks as they have seen prices drop more than they expected and more factories close than they had looked for, they have increased their estimate of the time that will elapse before the wheels of industry are turning freely again. They admit that we are engaged in a process of readjusting. When they see readjustment proceeding rapidly and thereupon lengthen the time estimated for completion of the process they tacitly admit that they had no idea of the extent of the

readjustment requisite, for if the readjustment had a fixed distance to go, the quicker it moved the sooner it would reach the objective.

It seems fairly clear that the readjustment through which we are passing is one of mental attitudes, and such a process does not require a long period of time. Men must become willing to do a bigger day's work and receive only reasonable wages for the day's work. Retailers, wholesalers and manufacturers must become content with moderate profits. An idle workman does not require a long period of idleness for a change of mind. The retailer, particularly if his customers have no jobs, can change his philosophy quite suddenly. There are manufacturers who have closed their plants with the thought that they have accumulated safe reserves and will not resume operations until offered their former profits, but it is not in human nature to enjoy the spectacle of an idle plant for any length of time. The mental reactions can occur in rather a short time. Then there are the buyers, who have gone on strike. They know what they went on strike for—lower prices—but they do not know how much lower. Idleness will become irksome to them also and they will be willing to compromise.

The idea that the readjustment is one of mental attitudes rather than of physical conditions is reinforced by contemplation at long range of mental attitudes during and since the war. Toward the close of the war the majority of people thought that commodity prices would decline immediately after the war, but there were not a few who expected prices to advance very sharply. As a matter of fact, prices did decline after the armistice, and then afterward they advanced a great deal. Evidently there was a very unstable mental condition.

A very common prediction during the war had been that there would be a "transitionary period" while things were getting changed from a war-time to a peace-time basis, and then a prolonged era of great prosperity. We have not had that era of prosperity and there is no proof that we cannot have it. The transition was made difficult by men not taking hold in the right way. First there was fear and then there was inordinate greed, both mental attitudes and both very objectionable. Now we are booked to get into a new mental attitude, and the process does not necessarily require a long period of time.

Beware the

Ides of March!

THE present Chief of Staff, General PEYTON C. MARCH, apparently still continues his opposition to proper development of Chemical Warfare Service. In this he is seemingly well supported by the present Secretary of War. However, with the change of Administration we may expect a change in this, as in many other governmental conditions. Indeed, about Washington one hears the very pointed sentence, "March fourth, forth goes MARCH."

One may even believe that it is not committing *lèse majesté* to hope that there will promptly be a selection of a new Chief of Staff who really appreciates and will support (as required by law) the Chemical Warfare Service. The recent report of the special commission headed by General PERSHING to select eligibles for the General Staff affords ample good material for this purpose.

Timeo Danaos

Et Dona Ferentes

HAVE you heard of the "Friends of Science, interested in its development"? If not you may yet entertain angels unawares. And if you have not seen the salmon-colored sheet of propaganda for German scientific porcelain, glassware and apparatus, issued by the aforesaid Friends, you have missed an amateurish effort at camouflage that is not very convincing. Anyhow our anonymous Friends are solicitous for the welfare of American colleges and universities, and bemoan the proposed surrender of the privilege which those institutions have enjoyed of importing scientific apparatus and instruments duty free. The Friends would have the privilege retained because it means a continuance of business which German manufacturers have enjoyed for a long time.

The activity of the Friends is timed to a nicety because Congress is now considering emergency tariff legislation, and the Ways and Means Committee of the House is holding hearings on the various schedules of the tariff as a basis for formulating a new law. It is unnecessary for us to go into details of the matter at this time, for we have previously reported and supported the efforts of the chemical and allied industries to protect themselves from ruinous post-war competition and hold the strategic positions gained during the war. It is not Germany alone, but Japan and others, which loom as competitors against which the American industries cannot hold their own in free and unrestricted markets. Wherever these industries bear a vital relation to national welfare, we favor their reasonable protection.

A feature of the Bacharach bill, which passed the House at the last session of Congress and which was favorably reported by the Senate, is a repeal of the duty-free clause of the present tariff law which has long been a concession to our educational institutions. And rightly too, under past conditions. But sympathetic as we are with the financial needs of our schools, we cannot help feeling that they ought to stand on their own feet and pay the bill in order that vital American industries shall live. Most of the consumption by educational institutions is for student purposes, and the cost can be passed on to individuals. Hitherto we have published arguments urging that students should more nearly defray the actual cost of their education, and we support that plea in this instance.

Nor are we unmindful of the excellent arguments on the other side of the question, for of course there are two sides. Elsewhere we publish a communication from Prof. J. W. RICHARDS opposing our own view and supporting the retention of the duty-free privilege. It is but fair to say that Prof. RICHARDS is not alone in his stand, nor do we wish to connect him with the insidious and anonymous propaganda of the "Friends of Science, interested in its development." On the other hand he does not represent all of the colleges, for in the hearings before the Senate it was brought out through a questionnaire that the heads of chemical departments in seventeen out of twenty institutions favored the surrender of the duty-free privilege, even if about one-half of the scientific apparatus and instruments imported come in under the duty-free clause for educational institutions.

There is always room for an honest difference of opinion on questions of policy, and we welcome the frank expression of opinion from those who do not

attempt to conceal their identity. But propaganda is abroad in the land. Naturally it is camouflaged. It poses. It purports to be what it is not. It takes refuge in anonymity, which is the resort of those who have neither the courage of conviction nor pride of opinion. It pretends friendship and unselfish devotion while secretly advancing its own cause. It is rightly an object of suspicion and merits contempt. If the "Friends of Science, interested in its development," had come out into the open, they would at least have been credited with business acumen and integrity.

"I am afraid of the Greeks, even when they come bearing gifts."

Corporation Dividends, Education and Research

ON AUGUST 5 last at the general meeting in England of the corporation of Brunner, Mond & Co. a resolution was passed "that the directors be and they hereby are authorized to distribute to such universities or other scientific institutions in the United Kingdom as they may select for the furtherance of scientific education and research, the sum of £100,000 out of the investment surplus reserve account."

A stockholder named EVANS brought suit to restrain the directors from carrying out the resolution, on the ground that Brunner, Mond & Co. as a chemical manufacturer had no business with general science; that the resolution was *ultra vires*, and not within the objects of the company. Mr. Justice EVES in the Chancery Division of the High Court dismissed the complaint. For the purpose of this decision the distinguished magistrate did not discriminate between the powers of the company and its objects, on the ground that its charter permitted it to do all things incidental or conducive to its business as a chemical manufacturer. The evidence showed that it would benefit the community and also the corporation. The objection of the plaintiff that this was too vague was overruled. The directors and others on behalf of the corporation testified that the gift would tend to cause universities and institutions to train students and others whose services would be of benefit to the company. The company acknowledged itself in great difficulty to find the right class of men necessary for the conduct of its business as a chemical manufacturer, and his Lordship concluded that the advantage the corporation would gain by the better provision of properly trained men as a result of the aid thus rendered outweighed the objection raised by the plaintiff that some of the men trained by means of this gift might go to competitors.

A very pretty little scrap, we should say, with an unspoken touch of humor in it. We have plenty of just such persons here, who cannot see what chemistry has to do with selling soda ash. Of course dividends are dividends, and when they are earned and set aside for the purpose it would seem that the stockholders have rights in them. We note here a point in bookkeeping—that there may be a hazard in the expression "surplus available for dividends," and that the term "investment surplus reserve account" has greater merit. Research has become a function of industry, research in pure science, at all events, is a legitimate function of university procedure, and that industry needs pure science is shown by the fact that industry needs engineering, and engineering is the application of pure science.

From the record it may occur to some that it contains

a hint to the effect that in consideration of the gift, the several universities will train men especially for the alkali industry. We think it more likely, however, that this was allowed to be inferred from the testimony as an argument to win the case than as a statement of conditions. The establishment of Brunner, Mond & Co. is a great and progressive one, and as such its problems are doubtless very like those of great and progressive American organizations. And these are almost unanimous in calling, not for specially trained caustic men or soap boilers or pulp cooks or specialists of any sort, so much as for men whose training in science is broad and general and thorough; it wants men of scholarship in science rather than technicians. Courses in technology are of great value to develop the engineering sense of chemical engineers, but those institutions that give the best courses in this respect would be the last to offer them as a substitute for physics, for instance.

A point that cannot be evasized or made clear to the evans type of mind, or even demonstrated in court, or explained at a stockholders' meeting, is that it is better for a corporation if a competitor makes an advance in applied science than if neither of them makes an advance. In the former case the backward corporation is usually induced to shake a leg, as the saying is, and make an effort to keep up with the procession. The only way to do this is by means of research, even though it takes "surplus available for dividends" to pay for it. In the latter case—that is, if neither the corporation nor its competitor makes an advance—it is bad for the industry as a national institution. For a reason that those who are most to blame are inclined to call "psychological," the industry usually moves away to some other state or country.

Surveys of Chemical Industry

CHEMICAL industry and the Tariff Commission, as well as the Ways and Means Committee of the House of Representatives, are to be congratulated on the completion and publication of technical tariff information with respect to the chemical industry in a way that surpasses all previous effort. This information is presented in the form of reports known as "Tariff Information Surveys," dealing with all phases of tariff policy and tariff legislation now before Congress. They represent an unbiased summary of extended studies by the chemical staff of the Tariff Commission covering a description of each commodity, its uses, methods and processes of manufacture, differences in American and foreign practice, nature and source of raw materials used, data concerning production, import, export, prices and cost of production, and other pertinent facts. In other words, the series is a compendium of industrial chemical information of tremendous value, particularly in tariff revision but also as a general guide to each industry which has been surveyed.

Elsewhere in this issue are given details regarding the nineteen separate pamphlets in which are discussed all of the commodities covered by Schedule A of the tariff of 1913, which schedule relates to chemicals, oils and paints. Whether one is interested in citric acid, wood products, aluminum, chloroform or any other of more than two hundred commodities on which there is duty, or which are specifically mentioned in the "free list," he cannot afford to neglect this important source of reliable and comprehensive information.

Readers' Views and Comments

Duty-Free Apparatus for Colleges

To the Editor of Chemical & Metallurgical Engineering

SIR:—May I ask your indulgence for the presentation of a matter which I realize should appear in the *Journal of Industrial and Engineering Chemistry* but which I am prevented from publishing in that medium through the rather arbitrary action of its editor, Dr. Herty. I refer to a communication which I inserted in the November bulletin of the American Electrochemical Society in favor of duty-free importation of chemicals and laboratory apparatus for colleges and universities, and which was subsequently the subject of an editorial attack on me as secretary of the American Electrochemical Society in the December issue of the *Journal of Industrial and Engineering Chemistry*. When I attempted to reply publicly to the criticism the privilege was denied me on the technical ground that the editor had attacked me as secretary of an organization whereas I responded as an individual. I feel that there are two sides to the question and, with your permission, would like to present the point of view held by some in the colleges.

The Bacharach bill now before the Senate places an increased duty on chemical supplies and apparatus, and incidentally repeals the duty-free importation privilege now possessed by educational institutions. Many college professors, most of them members of the American Chemical Society, believe that such repeal will not only hurt the educational institutions by diminishing the purchasing power of their available funds, but will seriously hamper the efficiency of technical training and thus be detrimental to the progress of the country as a whole.

The argument for the repeal is based principally on the assertion that the enterprises manufacturing these articles are *key industries*, that it is of paramount importance that our country make what it needs in this line, and that in order to assist such industries it is necessary and advisable that the duty-free privilege be withdrawn from educational institutions. It is also stated that the use of foreign supplies and apparatus by our students is detrimental to their patriotism, giving them the idea that the U.S.A. is unable to compete in these things with foreign makers, and thus depressing their ideas of the resources and efficiency of their country.

It can be shown, however, that such repeal is neither advisable nor necessary, and for the following reasons:

1. Educating technical men is also to be classed among the *key industries*, in fact, it is *the master key*. Just as surely as "men are more than kings," just so surely is the efficiency of their technical training of greater importance than the extension of some of our other key industries. If any nation had ulterior designs upon our progress as a nation, which would hurt us most: to hinder our manufactures or to hamper the training and education of our technical men?

2. Duty-free importation was granted by our Government to increase the efficiency of education by increasing the purchasing power of available educational funds. It is certain that withdrawal of this privilege will decrease that purchasing power and therefore reduce the efficiency of the education given.

3. The great increase in industrial control laboratories and private and industrial research laboratories has certainly created a large demand for chemical and physical apparatus and supplies altogether apart from the educational institutions. Since the former cannot import duty free, they may be taxed by duties sufficient to keep our domestic industries going; the same tax on educational institutions would hamper their efficiency simply to make *more* business.

4. Many apparatus and supplies made abroad cannot be obtained in this country at all, being made only abroad. Why make the educational institutions pay a high duty on what is not to be had in this country? If the high duty falls only on the private laboratories, they will certainly look for a domestic source of supply, and thus those who are best able to bear the expense will assist in the establishment of new domestic industries.

5. The proposed repeal hits our allies as well as our former enemies. We get apparatus and supplies from England and France, and it seems unfortunate, to say the least, that we treat friend and foe alike.

6. Concerning the effect on the students' patriotism, I wish to take exactly the opposite stand from that expressed by those favoring repeal of the duty-free privilege. College and university should teach students the truth, and if foreign apparatus and supplies are better or cheaper (duty-free) than the domestic, the students should know it; the last thing to teach them is a blind pseudo-patriotism which thinks that anything American is necessarily the best to be had or is "good enough." Moreover the student who has any red blood in him (and most of them have) will feel a generous ambition to outdo the foreigner when he learns the facts. My experience in teaching university students for over thirty years leads me to state without hesitation that knowledge of the facts stimulates the men by putting a goal of achievement before them, and engenders in them the praiseworthy ambition to try to beat the foreigner.

7. Finally, for purely pedagogic and efficiency reasons, teaching equipment should be the very best obtainable, irrespective of its source. If I wish to show a student of qualitative analysis the reaction of potassium, it is of first importance that I use the purest potassium salt I can get (and am able to buy) irrespective of its source. If I want to show my students the spectra of the elements, I should have the best spectroscopic my funds will procure, irrespective of who makes it, in order to raise my teaching to its highest efficiency.

When it comes to education and training of our technical men, we can very well afford to use foreign materials from any source when by so doing we can thereby increase the efficiency of the education given, and thereby eventually acquire the ability to beat the foreigner at his own business. Any other principle will result in hampering technical education, and thereby defeating the very ends that we wish to accomplish. I plead for a broader vision and for a further look ahead.

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Hearings on Patent Office Bill

Conference Committee Reopens Hearings on Bill for Relief of the Patent Office in Order to Give Opponents of Section 9 Opportunity to Register Their Objections

AS ANNOUNCED in our issue for Dec. 29, 1920, the joint conference committee of the House and Senate on the Patent Office bill reopened hearings on that measure and listened to a large number of witnesses on Jan. 5 and 6. In convening the session Senator Norris, presiding, called attention to the extraordinary nature of the proceedings—holding hearings on a measure which had passed both houses of Congress and which had been referred to conferees for adjustment of differences. He explained that the committee could listen to arguments bearing on only those matters on which the House and Senate were in disagreement. These were particularly the matter of salaries and clerical force in the Patent Office, and section 9, relating to the patenting by the Government of the inventions of its employees and assignment of such patents to the Federal Trade Commission for administration through license.

SALARY REDUCTIONS INSERTED BY SENATE

H. R. 11984, as passed by the House for the relief of the Patent Office by increasing the salaries of employees and increasing their number, was amended by the Senate reducing the salary recommendations of the House and reducing the force of employees. As brought out in the testimony, the effect of the bill would be to reduce the force 15 per cent at a time when the work of the office has increased 30 per cent. It was also shown without difficulty that salaries in this important bureau of the Government were woefully inadequate, being very much lower than those paid in private industry for similar service, as well as being incommensurate with the education and technical ability required of Patent Office employees. Testimony was introduced by former Patent Commissioner Ewing to show that the Patent Office had been steadily disintegrating for the past thirty years, due to failure to provide salaries that would hold competent men. He explained that the patent system of the United States requires examiners who are not only skilled in patent law but whose familiarity with conditions in the Patent Office is essential to the expedition of business. Deterioration of the force, through loss of examiners by resignation, not only retards prompt attention to applications but makes it impossible to give to applicants the careful consideration necessary to avoid the issuance of invalid patents. Mr. Ewing stated emphatically that unless prompt relief were granted the Patent Office would be congested with a volume of work that could not be transacted, and industry would suffer.

NECESSITY FOR INCREASING SALARIES URGED

Among others who testified regarding the inadequacy of the present salaries, or even those contemplated by the Senate amendments, was E. J. Prindle, who stated that resignations in the Patent Office were continuing in spite of the fact that the present bill promised some relief. He cited these resignations as evidence that the prospect of receiving the lower salaries recommended

by the Senate was not sufficiently attractive to hold men in their positions, and he urged the restoration of the salaries recommended by the House. Mr. Prindle offered resolutions passed by the National Research Council, Engineering Council, American Chemical Society and National Association of Manufacturers supporting the necessity for relief in the Patent Office. He also introduced some results of a questionnaire of the American Patent Law Association, showing that former examiners in the Patent Office are now receiving from private industry salaries several times as great as they received in the Government service. Practically all of the witnesses before the committee, including those who appeared for other reasons, indorsed heartily the necessity for increasing salaries in the Patent Office and providing a force adequate to cope with the business of that bureau.

HOUSE PROVISION LIKELY TO BE REINSTATED

In explanation of the Senate's amendment reducing salaries it should be stated that the Senate is not unalterably committed to that program, nor does it necessarily believe that the House provisions were too high. It was felt that the subject of salaries should receive the attention of the Senate conferees, and the best way to do that was to introduce amendments. Senator Norris stated in the hearings that the two committees were not in material disagreement on this point, from which it may be inferred that the contentions of the witnesses will prevail and that the House provisions will be reinstated after they have been reviewed.

OPPOSITION TO SECTION 9

Opponents of section 9, which the Senate attached as a rider to H. R. 11984, appeared before the committee in large number, representing chemical manufacturers and industrial companies. The arguments were mainly a repetition of those published in *CHEMICAL & METALLURGICAL ENGINEERING* of Oct. 27, 1920, following a meeting of several scientific societies in New York before which Dr. Cottrell and Dr. Alsberg spoke in behalf of the measure. Practically all of the witnesses opposing this section of the bill not only objected to it in principle but felt that it should not be attached to the bill for relief in the Patent Office. They advocated its elimination and separate consideration.

The gist of the opposition to section 9, as expressed before the committee, is that it will bring the Government into competition with private industry; that the Federal Trade Commission as the administrative agency has not the confidence of the country; that the granting of licenses involves the question of discrimination among competitors in an industry; that the Federal Trade Commission would be under the necessity of defending title to its patents for the benefit of its licensees; that dedication of a patent to the public meets satisfactorily the condition which section 9 proposes to relieve; that if Government research is con-

ducted in the proper sphere of fundamental science or in those industries for which there is no established research agency no need will exist for section 9; that if Government research is not so conducted it will extend into development work that will involve large expenditures; that more extensive industrial research by the Government will discourage private industry from extending its research activities and rely more and more on the Government for the solution of its problems; and that no special machinery is required to meet the situation as stated by proponents of the measure.

ADMINISTRATION UNDER PROPOSED SYSTEM QUESTIONED

The possibility of administering satisfactorily patents assigned to the Federal Trade Commission was the subject of much of the testimony and of colloquies between members of the committee and witnesses. It was contended by the latter that the licensing of patents would be the cause of much dissatisfaction to the inventor and the industry and the public. Frederick P. Fish stated emphatically that the Federal Trade Commission would find itself confronted with the necessity of choosing between exclusive and non-exclusive licenses; that if the former were adopted there would be dissatisfaction among unsuccessful applicants and the Commission would find itself open to the charge of favoritism. When Senator Norris said that he doubted if much hue and cry would be raised by the granting of an exclusive license Senator Brandegee retorted, "Let the Commission grant an exclusive license to the Standard Oil Co. and see what will be said." In Mr. Fish's opinion this feature would open the way for a vast amount of dissatisfaction if not scandal. If the Commission should grant non-exclusive licenses it would seem unlikely that any would be taken, in which event nothing more would be accomplished by the bill than by original dedication to the public.

LIMITATION OF GOVERNMENT ACTIVITY URGED

On the contention that dedication to the public is now satisfactorily meeting the situation R. P. Perry, of The Barrett Co., introduced some evidence based on the premise that "industry, inventors and the large majority of the American public believes that governmental activities should be limited to those fields where private industry cannot function as well and that private enterprise should be encouraged in all fields where it can function as well as or better than the Government."

Continuing, Mr. Perry said: "Now what does this mean in the present case? It means simply this, that the proper and legitimate sphere for Government technical research is, in the opinion of industry, limited to such work as formulating standards of quality in fields of general public interest (drugs, foods, etc.), developing testing methods and determining accurate fundamental data, such as the true physical constants of materials and making investigations in fields of agriculture and animal industry not reached by private enterprise. It means that Government technical research is out of bounds when it goes into the development of new products or processes in chemical or other applied industry. The legitimate need to be met is therefore, in my opinion, a limited need and if the Government keeps within its proper sphere it will only very occasionally and incidentally develop any patentable inventions relating to applied industry and consequently will very seldom have occasion to take out patents. I cannot conceive of it other than as a very limited need

unless Government technical research unconsciously or consciously is to invade the fields of private enterprise in competition with industry. . . . I believe such invasion will sooner or later be the inevitable result of the plan proposed by section 9. At the present moment the point is that unless there is to be such expansion of effort into the field of private industry the needs to be met are limited and the present arrangement has met these needs."

By way of proof that under present conditions Government inventions are exploited by the public when open to public use Mr. Perry cited the instances of calcium arsenate, which was developed by the Bureau of Chemistry as an insecticide; oil- and water-proofing in concrete, developed in the Office of Public Roads; hog cholera serum, a product of the Bureau of Chemistry; and phthalic anhydride, developed in the Color Laboratory.

ANOTHER OBJECTION TO SECTION 9

An objection raised by Mr. Perry and others to the present innovation embodied in section 9 is that it will be an entering wedge that will not stop with the patenting of inventions made by Government employees in the course of their official duties, but that since an undeveloped invention is worth little or nothing there will be a great temptation to develop patents so that they will be of some value to the inventor and the Federal Trade Commission. Indeed, it was the contention of witnesses that undeveloped patents would find little or no sale, and that development would be essential if the plan of section 9 were to amount to anything and meet the expectations of its sponsors.

The prospective expense to the taxpayers entailed by this experiment in patent administration was the subject of attack by witnesses. Mr. Randall, secretary of the Air Reduction Co., foresaw the necessity for the Federal Trade Commission building up within itself an organization for the expert administration of patents, defending infringement suits, etc. Senator Norris asked why it would be necessary for the Federal Trade Commission to defend patent suits. He was informed that prospective licensees would not accept a license, especially if non-exclusive, if there was a prospect that they would have to prosecute infringers or stand suit for infringement in case their patent should prove invalid. The situation would be little better in the case of exclusive licenses, and in any event it would be incumbent on the Federal Trade Commission to maintain an elaborate legal department.

An interesting witness was former Commissioner of Patents Ewing. Speaking from some years of experience he expressed opinions on various points brought out by other witnesses. In his judgment it would be necessary to issue exclusive licenses if the scheme were to have any chance of success, and yet he felt that there was so much objection to that kind of discrimination that it would kill what little chance of success there might be for section 9 to function as its sponsors hope. In Mr. Ewing's opinion the whole matter would not amount to anything, because it would not work practically. He was certain that the Government would have to protect its licensees by defending patent suits.

A. I. C. E. OPPOSES SECTION 9

David Wesson presented the attitude of the American Institute of Chemical Engineers as follows:

The Institute has an able committee on patent legis-

lation which reports at the regular semi-annual meetings progress of all patent legislation.

The Nolan bill, as originally passed in the House, was discussed by the Institute in open meeting and approved.

When section 9 was added to the bill the Institute, in conjunction with the New York sections of the American Chemical Society, the Electrochemical Society and the Society of Chemical Industry, held a special meeting in October last in New York at which Dr. Cottrell and Dr. Alsberg fully explained the intent and meaning of section 9.

The meeting, representative of the industrial, scientific thought of the country, discussed the proposition, which was disapproved by all who spoke on the subject.

The patent committee of the Institute reported the bill at the annual meeting held in New Orleans Dec. 6, 1920. The following resolution was drawn up and unanimously adopted:

Be It Hereby Resolved, That Congress be petitioned to pass Bill H.R. 11,984, otherwise known as the Nolan bill, in its original form, without the addition of section 9, that the Patent Office may obtain the needed relief to maintain its efficiency; and be it further

Resolved, That we consider the passage of section 9 would lead to the interference by the Government bureaus with business enterprises with which they were originally designed to co-operate in supplying service and benefit to all.

RUST MEMORANDUM ON SECTION 9

Mr. Randall asked the committee to divorce section 9 from the bill in anticipation of the substitution therefor of an act to be drawn by co-operative effort of all the parties at interest. He summarized the hearing with the following wire from H. B. Rust, president of the Koppers Co.:

The principal purpose of our patent system is to encourage private enterprise and invention. This section will do exactly the opposite.

1. It will place a body of Government-owned and administered patents, worked out by Government inventors at public expense, in competition with another body of patents developed and owned by private industry. Such an effect is bound to be discouraging and harmful to all industry.

2. It will make it possible for executive orders to direct that all patents taken out in any Government bureau be turned over to the Federal Trade Commission for administration.

3. It will make the Federal Trade Commission a holding agency for a great group of patents affecting practically every branch of private industry.

4. It will make it possible for the Federal Trade Commission to discriminate in the issuance of licenses, allowing them to certain parties and refusing them to others.

5. It will even make it necessary for the Federal Trade Commission to so discriminate, "for unless licenses are restricted in number there is no gain over dedication of the patent to the public in the first instance."¹

6. It will make it possible for a taxpayer of the United States to be refused the right to use an invention that he has contributed funds to develop.

7. It will involve private industry in continual litigation with the Government on questions of patent validity, infringement, etc., litigation that will become a burden not only to the parties, but to the public.

8. It will discourage the co-operation between Government bureaus and private concerns that is now benefiting both. Private industry will certainly not be willing to give Government employees information that may later be developed into patents and turned against it.

9. It will place any Government bureau developing patents in an unfair position with respect to related

industries in competition. The Government bureau has means, not possessed by any private individual, of acquiring information from competitors. Such information can and will be used in the development of patents and to the detriment of competing industries.

10. It will give undue personal benefit to the Government employee working with the advantage of Government funds and Government information.

11. It will give undue personal benefit to a favored group of Government employees who happen to be so placed that they can work on inventions, as compared with the many other employees who are not so placed.

12. It will place an irresistible temptation before Government employees, especially of the technical and scientific groups, to devote their time to work on patentable inventions that will lead to personal benefit to themselves.

13. It will create dissatisfaction among those employees who are not permitted to work on inventions.

14. It will seriously curtail the fundamental technical and scientific activities of various Government agencies that have few patentable possibilities, but are, nevertheless, of the utmost value to industry.

15. Under the patent law of the United States, inventions, made by an employee at his employer's expense, belong to the employer. The employer of every Government employee is the public. Inventions of Government employees are made at the expense of the public and should belong to the public without any qualification such as this section 9 introduces.

The conference committee of the House and Senate is respectfully urged to reject this section.

DR. COTTRELL SPEAKS FOR THE SECTION

Dr. Frederick G. Cottrell, late Director of the Bureau of Mines and new chairman of the Division of Chemistry and Chemical Technology of the National Research Council, appeared in behalf of section 9. Dr. Cottrell is generally recognized as principal sponsor of the bill. He explained to the committee that this is an experiment in administration of patents in the interest of the public; that in the course of official duties Government employees produce as a byproduct certain patentable discoveries which, unless patented and administered, will be lost to public use; that dedication to the public does not, in his opinion, meet the situation; and that the bill has been drafted as a permissive measure to try the experiment of assignment to a public body and administration by it. In the course of his testimony Dr. Cottrell was questioned by a representative of the Standard Oil Co., who asked, in effect, "Would the industrial concerns with which the various Government bureaus now have co-operative agreements allow Government employees to enter their works and laboratories if they suspected that later they might be asked to pay a royalty on some invention made as a result of knowledge and information picked up in the course of co-operative relations?" Dr. Cottrell was of the opinion that the operation of section 9 would not affect the cordial relations now existing between Government bureaus and various industrial concerns. He spoke from some years of experience in administration of Government technical work, and said that in his judgment there was great need of some such medium as section 9 in order to salvage and make available for public use many discoveries now lost. At the present time there are a number of such patented discoveries awaiting the establishment of a suitable agency through which the patents can be assigned and licensed. In reply to the criticism that the Federal Trade Commission would experience a great deal of difficulty in licensing patents Dr. Cottrell cited the fact that during the war that body administered a number of enemy-owned patents, licensing their use without difficulty.

¹Quotation from CHEM. & MET., Oct. 27, 1920.

Bacteria as Chemical Reagents

Activities of Micro-Organisms—Factors Determining the Extent of Chemical Transformations
by Bacteria—Food for Bacteria and Its Influence on Their Activities—
Bacterial Standards of Purity—Chemical Equation of Life

By ARTHUR I. KENDALL

AT THE very foot of the ladder of life, the simplest in structure and the smallest in size, there is a group of micro-organisms known as bacteria. The sinister impressions which arise at the mere mention of germs, indeed all the notoriety which attaches to the term "bacteria," arise from the malignant potency of a small but formidable group of these micro-organisms—the pathogenic microbes—whose activities are in opposition or partial opposition to those of plants, animals or man.

In reality the prime function of bacteria in nature is one of beneficence. Without their participation in the rotation of certain elements between the living and the dead all life would inevitably cease upon this planet. Bacteria maintain a balance between the organized and unorganized kingdoms in nature. They restore those essential elements, of which the available supply is limited, to the soil in fully oxidized form, suitable for resynthesis by plants through the agency of sunlight acting upon chlorophyll. Otherwise much nitrogen and other elements essential to the perpetuation of life would be locked up in complex, useless combinations in the dead bodies of plants and animals and their waste products, while vestiges of the slowly weathering corpses of prehistoric monsters and prehistoric vegetation would still encumber the earth.

ACTIVITIES OF MICRO-ORGANISMS

The purification of water and sewage by bacterial action is illustrative of their analytical activation. The soluble organic substances of sewage and contaminated water are broken into simpler hydrolytic products through the action of soluble digestive enzymes which the bacteria secrete, and in turn these relatively simple compounds are absorbed, digested and excreted by microbes as fully oxidized derivatives of nitrogen, carbon, etc. Such compounds are available for plant synthesis. The biological purification of water and sewage, therefore, is essentially a process of bacterial digestion. The rapidity with which the biological purification of water and sewage takes place in specially constructed filters is illustrative of the advantage of creating favorable conditions which thus hasten the natural process. It also indicates the great measure of chemical transformation which these very small microbes bring about.

In addition to the great analytical processes of the nitrogen cycle, which are caused by bacteria, the artificial and natural souring of milk, of ensilage and many other preservative processes are the work of microbes. The fermentation industries for the production of organic acids, alcohols and many patented reactions, and a multitude of others, all indicate uses to which the intelligently controlled activities of micro-organisms can be applied.

Micro-organisms play an important part in the human

economy. The ravages of tuberculosis, typhoid, cholera, dysentery, diphtheria and other infections are well known, but the normal bacteria of the alimentary canal also exercise a protective function against invasion by them. The extent to which this protection shields the host against contagion is not yet known, but unquestioned evidence exists in favor of it. Modern research is leading to the formation of dietary measures which will increase this protection, or re-establish it, if it has been diminished or lost.

Bacteria are minute, unicellular organisms, devoid of sex, and their reproduction is a simple and rapid process. They are also devoid of any catalytic pigment, as chlorophyll, so that it would appear to be impossible for bacteria to become synthetic agents, as are the green plants. Bacteria require preformed food in their dietary; hence their activities are essentially analytical rather than synthetic. The perpetuation of bacteria requires an expenditure of energy, and the source of this energy, as will be shown, is of leading importance.

FACTORS DETERMINING THE EXTENT OF CHEMICAL TRANSFORMATIONS BY BACTERIA

The simplicity of structure of bacteria and absence of any photochemical agent, such as chlorophyll, within them automatically reduce their activities to two closely related but very distinct processes. These are, first, an anabolic, or structural, process or phase, and, secondly, a vegetative energy, or katabolic phase. The former perpetuates the integrity of the species, the latter determines the function of the organism.

Now it is just because the individual bacteria are so small that their activities are so great. The physical basis for this resides in the large ratio of surface of the organism to its volume or weight, and also to the rapidity with which successive generations of bacteria appear when conditions are favorable to their growth.

The cholera vibrio, for example, measures about 2 microns in length and 1 micron in diameter. The volume, therefore, of a single cholera germ is about 0.000000002 cu.mm., while its surface measures nearly 0.00001 sq.mm. For purposes of comparison it may be stated that a man weighing 100 kg., 200 cm. in height, has a surface area of approximately 2.4 sq.m.

Since the energy requirement of living things varies with the surface area rather than the volume or weight, it is evident that the relatively large surface area of bacteria in proportion to their volume or weight creates a condition requiring proportionately a great deal of energy to maintain them. It should be borne in mind, however, that the energy requirement of bacteria, measured in terms of chemical transformation, depends somewhat on the type. Thus, bacteria which play a prominent part in natural processes appear to effect chemical transformations of even greater magnitude than those of

similar size which are pathogenic for man. The second factor which plays an important part in determining the extent of chemical transformation by bacteria is the amazing rate of reproduction. Under favorable conditions successive generations of cholera vibrios may appear at intervals as frequent as every fifteen minutes, each individual dividing into two individuals in this short time. The theoretical descendants of a single vibrio, therefore, in four hours would number about 32,000. The weight of the progeny would be approximately 0.00064 mg., while the combined surface of the descendants of a single organism at this time would be nearly 0.32 sq.mm. The energy requirement of a four-hour culture, therefore, would have increased 32,000 times, but the actual amount of material necessary to build up the bodies of the microbes at this time would be only 0.00066 mg. in weight. Fortunately such a rate of reproduction cannot long be maintained. Nature provides barriers and restraints, and these always keep proliferation within endurable limits. Were this not so man and animals would long ago have perished.

ESSENTIAL FOOD FOR BACTERIA

Bacteria, in common with all known living entities, contain nitrogen as an essential element in their structure. Now nitrogen is notoriously an inert element, and this inertia is perhaps a feature of stability in the changing manifestations of protoplasm. Nitrogen is therefore necessary for the structure of all bacteria, and reproduction and growth are impossible in environments which do not contain it in utilizable form.

The nature of the nutritional compounds containing nitrogen required by bacteria is varied. Some types appear to use simple combinations of nitrogen with hydrogen, carbon and oxygen. The great majority of micro-organisms can derive their nitrogen requirement from amino acids or relatively simple polypeptids. Some—as the fastidious *gonococcus*—require practically unaltered protein from human sources for their cultivation.

Nitrogen, although essential for the structural requirements of bacteria, is without apparent value as a source of energy. This is true for animals and man as well. Indeed, when appropriate nitrogenous compounds, as protein or protein derivatives, are the sole source of dietary energy for bacteria, animals or man the carbon of the protein or its derivative is oxidized for this purpose only after the nitrogen is removed from the molecule by a process of deamination. The ammonia resulting therefrom is left unchanged, or transformed to urea and excreted in this form.

Dietary energy for bacteria and for animals arises from the intracellular oxidization of carbon, so far as we can judge from available evidence. It is also generally true that the partly oxidized carbon existing in carbohydrates is more readily utilized than the reduced carbon of the amino acids, for the same purpose.

The waste products arising from the utilization for energy of such nitrogenous substances as amino acids, polypeptids or proteins, furthermore, are, as we have indicated above, strikingly different from those derived from the intracellular combustion of carbohydrates. A few examples will illustrate the immense importance of this difference.

INFLUENCE OF THE CULTURE MEDIUM ON THE ACTIVITY OF THE BACTERIA

One of the leading culture mediums for bacterial cultivation is called "plain" or sugar-free broth. It con-

sists essentially of a sterile aqueous solution of 1 per cent of peptone and 0.3 per cent meat extracts, all neutral in reaction. This medium offers amino acids and polypeptids as the sole sources of nitrogen, carbon and other elements essential for bacterial growth. In such a medium, therefore, both the structural and energy requirements of bacteria must be obtained from amino acids, or combinations of amino acids, which are not coagulated by heat.

An entirely similar medium, both in composition and reaction, but containing about 1 per cent of glucose, is designated "glucose broth." Both plain and glucose broth offer to bacteria amino acid complexes for structure. But in plain broth these same amino acids are also the sole sources of carbon for the energy requirement of the bacteria, whereas in glucose broth a choice is available between the nitrogen-containing carbon complexes—i.e., amino acids and their derivatives—and the non-nitrogenous carbohydrates for the energy requirements of the microbes.

The diphtheria bacillus is an organism whose formidableness to man is measured by the potency of the water-soluble, extracellular toxin it produces. Under certain conditions 0.025 c.c. of a seven-day *plain* broth culture of this organism will kill a guinea pig weighing 250 g. within four days with definite symptoms and lesions.

In other words, in the plain broth, in which carbohydrates are lacking, the energy requirement as well as the structural requirement of the diphtheria bacillus is derived from the utilization of protein derivatives, and under this condition a very powerful specific soluble poison is produced which is the deadly weapon of the diphtheria bacillus. The same diphtheria bacillus, however, grown in the same medium but to which a small amount of glucose is added, produces substances which are not even slightly poisonous; they are, in fact, potentially buttermilk. Instead of producing the virulent poison they secrete essentially lactic and acetic acids.

The diphtheria bacillus, therefore, under the conditions of culture stated above, is a veritable Dr. Jekyll and Mr. Hyde. Grown in a purely protein medium it produces a virulent poison; in a glucose-protein medium it forms potentially buttermilk. The utilization of glucose in place of the nitrogenous amino acid complexes for energy is the only known factor concerned in this remarkable transformation.

The colon bacillus, a common inhabitant of the intestinal tracts of man and of animals, produces considerable amounts of indol from the utilization of tryptophan, an important amino acid, when protein derivatives are the only available sources of energy. When a utilizable sugar—as glucose—is added to the medium the products arising from the growth of the organism fail to include indol. They are, on the contrary, principally lactic and acetic acids. [It would appear from this that glucose might occasionally be used advantageously to avoid the evil odors attendant on putrefaction.—ED.]

The bacteria which incite typhoid fever, bacillary dysentery, cholera and many other diseases react in a precisely similar manner; they produce characteristic nitrogenous products, which appear to be specific for each organism, all nitrogen-containing, when protein or protein derivatives only are available for energy. All of these formidable incitants of human infection, however, produce the chemical equivalent of buttermilk when an available source of energy in the form of carbohydrate is present in mediums where they are growing. Generally speaking, the carbohydrate spares the protein constitu-

ents of the nutritive environment from decomposition for the energy requirements of the organism.

IMPORTANCE OF THE UTILIZATION OF PROTEIN AND CARBOHYDRATE FOR ENERGY

It is obvious, therefore, that in either medium protein must be used for the structural requirement of the organisms, and it is also evident that the products arising either from the utilization of protein or from that of carbohydrate for *energy* should be of great significance in defining the function of the various kinds of bacteria. This is emphasized by the far greater requirement of bacteria for energy than for structure.

This great fundamental principle of the use by bacteria of either carbohydrate or protein for energy is in all probability the most important single principle to note in approaching the unexplored field of the chemistry of medical, agricultural and industrial bacteriology.

An illustration or two will be explanatory.

Many years ago at the Lawrence Experiment Station at Lawrence, Mass., bacterial sewage filters which had nitrified the organic constituents of sewage successfully for a period of years were found to permit the passage of the nitrogenous constituents of sewage but little changed in terms of free and albuminoid ammonia when cane sugar was added to the sewage just before it was introduced to the top of the filter. An explanation was not available when this experiment, repeated several times, was performed. In all probability this is a concrete example of the sparing action of carbohydrates for proteins in fermentation. If it is easier for the bacteria resident in the filter to obtain their energy from cane sugar than from the nitrogenous constituents of the sewage they will do this very thing, and the effluent will show theoretically but little chemical evidence of nitrification.

Several years ago certain eggs, broken and mixed with a considerable amount of cane sugar, were seized and condemned on the ground that they were filthy, rotten and decomposed. There were many thousands of colon bacilli per gram of egg, and it is known that *Bacillus coli* produces relatively large amounts of indol, an exceedingly foul-smelling substance, from the decomposition of protein.

Most careful analysis confirmed the high bacterial content of these eggs, but failed to reveal ammonia, indol or other products indicative or even suggestive of protein decomposition by *Bacillus coli*. The reaction of the eggs, contrary to what might have been expected from protein putrefaction, was distinctly acid, and lactic acid in considerable amounts was found in the mixture. These eggs, furthermore, were used in cakes and other culinary products without the slightest suggestion of disagreeable odor or taste. What appears to have happened is readily explained—the colon bacilli derived their energy requirement from the cane sugar, leaving the protein of the egg practically untouched except for the minimal amounts necessary to fulfill their nitrogen structural requirement. Evidence of protein decomposition would scarcely be expected under the circumstances, and in reality the principal change was at the expense of the cane sugar, rather than the protein.

Nature's method of preserving milk by souring, so extensively practiced in the tropical and subtropical Orient, especially by nomadic peoples, and the recently developed use of bacteria for "starters" in the butter industry are examples of the selective action of bacteria

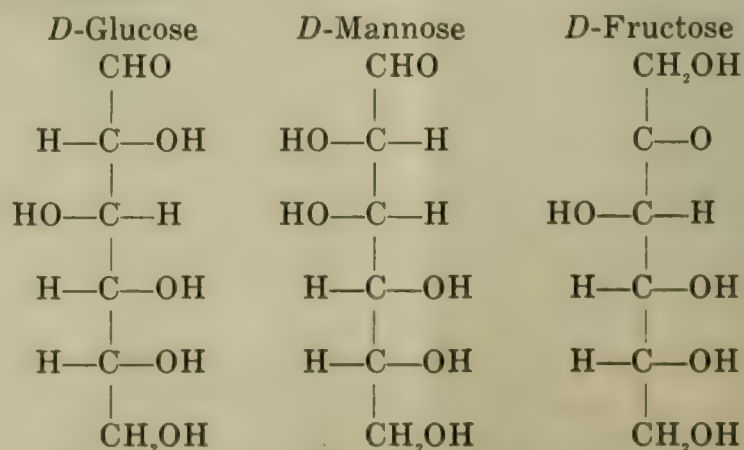
upon sugars in place of the protein constituents. The development of acid tends to retard, or even prevent, the growth of non-lactose-fermenting proteolytic bacteria which otherwise might induce putrefaction in place of souring. Examples might be cited almost without limit upon this phase of the problem, but another phase deserves mention because of the theoretical possibilities associated with it.

SIGNIFICANCE OF "UTILIZABLE CARBOHYDRATE"

For many years, beginning with 1885, bacteriologists have added various sugars, starches and glucosides to plain broth, and have observed that specific bacteria differ in their respective powers to "ferment" or "not ferment" the various carbohydrates. Long-continued observation has led to the selection of a few sugars for general bacterial use, the kinds depending somewhat upon the organisms studied. Thus glucose, lactose, saccharose and the alcohol mannitol have been found by repeated trials to be of great use in separating bacteria derived from the alimentary canal into distinct types or species. Confirmatory tests, using the serums of horses immunized to certain of the respective pathogenic types, have been employed in the final diagnosis of these.

Although the empirical facts relating to the respective availability of such carbohydrates have been thus laboriously established, the underlying principle appears to have been overlooked. This principle is that in the presence of such utilizable carbohydrates they are consumed by the bacteria for their energy requirement, while the protein constituents of the medium are spared. The recognition of the principle of this *sparing action* of utilizable carbohydrate leads at once to a contemplation of the most fundamental consideration of all—what relationship exists between the structure of a utilizable carbohydrate and the ability of the living protoplasm of a specific organism to use such a structure as a source of energy? Some of the relationships between the stereo configuration of very closely related sugars and their respective values as sources of bacterial energy are truly amazing in their specificity. Bacteria are extraordinarily delicate appraisers of optical antipodes; that is, they are themselves sensitive polariscopes.

D-glucose, *d*-mannose and *d*-fructose differ, according to available information, solely in the arrangement of hydrogen and hydroxyl around the carbon atom next to the aldehyde group—except in fructose, which is, of course, a ketone. The brilliant researches of Emil Fischer and others have shown the specific arrangement of the six carbon, twelve hydrogen and six oxygen atoms which collectively determines the identity of each member of this group, which tends to form a dynamic chemical equilibrium of the three through a common *enol* when any one of them is dissolved in an alkaline aqueous solution.



Furthermore it will be seen from the diagram that

d-glucose and *d*-mannose differ from each other solely in the arrangement of the H and OH groups next to the aldehyde group. This difference consists merely of a reversal of the two in mannose as compared with glucose. Neither the number nor the kind of groups of atoms differs; it is merely a transposition of one H and one OH upon one carbon atom out of the six. The remaining carbon atoms and associated groups are precisely the same. Yet certain bacteria, as *Bacillus proteus*, and cholera vibrios can derive energy from the intracellular utilization of glucose, but appear unable to utilize mannose in the slightest degree. On the contrary, bacteria which are apparently much more fastidious in many of their dietary requirements, especially with reference to protein, can ferment mannose as well as glucose. Observations with several hundred bacteria, comprising many of the more important pathogenic types, have revealed similar instances of a most extraordinary relationship between the structural configuration of various carbohydrates and their susceptibility or immunity to specific bacterial decomposition. Apparently definite strains of bacteria never make a mistake in picking out the proper structural formula for transformation into energy. Thus two strains of cholera and proteus, tested at intervals of four years, have consistently used glucose and refused mannose, as stated above. Whether all strains of cholera or of proteus, for example, that are in existence at the present time would be unable to utilize mannose cannot be decided in the light of available information. Conversely, if strains said to be one or the other of these types are found which ferment mannose, an extremely fundamental question of their respective identities would at once be raised.

Observations upon one hundred different strains of dysentery bacilli have revealed one small group of three which do not ferment galactose. They do ferment (as do all the remaining types which could utilize galactose) glucose, mannose and fructose, as well as other sugars.

So far as available evidence goes, the alcohol *d*-arabitol is fermented only by members of the *Mucosus capsulatus* group. If a large series of authentic strains of this group exhibit in common this peculiarity, a means of rapid diagnosis for one group will have been demonstrated. The application of this principle along the line of specific bacterial diagnosis is perfectly obvious.

BACTERIAL STANDARDS OF PURITY

The unerring, uncanny positiveness with which the two cholera and two proteus organisms distinguish between glucose and mannose suggests at once a means of detection of traces of the former sugar as an impurity in the latter. The extension of this principle to possible bacterial standards of purity for all sugars and indeed for many other substances through a careful selection of particular bacterial strains for specific purposes needs no further elucidation.

As an example of the possible delicacy of such a reaction mention may be made of the common use by bacteriologists of milk containing litmus as an indicator. Milk as ordinarily purchased and used in bacteriology contains about 3 per cent of protein, 3 per cent of fat, and 5 or more per cent of carbohydrate in addition to inorganic salts and water. Clearly, bacteria have a theoretical choice of protein or carbohydrate for energy. Fats are omitted for the sake of simplicity

from this discussion. The carbohydrate content of milk consists of somewhat less than 0.1 per cent of glucose, the remainder being lactose.

Dysentery bacilli and many others can ferment glucose but not lactose. Bearing in mind what has been said, it is obvious that the theory outlined demands a primary bacterial attack upon the glucose for energy. If this is used up without the formation of products inimical to the further growth of the bacteria they must subsequently derive their energy from the protein constituents of the milk, because experience has shown that dysentery bacilli cannot attack the lactose.

The products of the fermentation of glucose by dysentery bacilli are acid; those arising from the putrefaction of the milk proteins are alkaline. The litmus indicator shows this sequence very clearly. It responds to the acidity generated from less than 0.1 per cent of glucose by turning distinctly violet, then it gradually becomes blue as the alkaline products of protein decomposition for energy accumulate and neutralize the fermentation acid.

This is a crude illustration of the ability of specific bacteria to distinguish very small amounts of a specific carbohydrate in the presence of another. Even with the relatively gross conditions of this experiment the results are unmistakable. How delicate such a reaction can be made is yet undetermined. The application of this principle to the identification of minute amounts of specific sugars and to the products of hydrolysis of bioses and polysaccharides is perfectly clear.

Attempts to produce bacterial evidence of enolization and subsequent equilibrium of hexoses (as of the glucose-fructose-mannose group) in alkaline media have so far been unsuccessful, although the prevailing idea regarding this phenomenon should be susceptible of demonstration.

CHEMICAL EQUATION OF LIFE

However interesting, instructive or important the relationships between structure of carbohydrates and their adaptability for energy may be as abstract phenomena, there is underlying all these manifestations the problem of the chemical equation of life. The remarkable precision with which bacteria of certain types distinguish between such closely related hexoses as glucose and mannose has its exact counterpart in the equally astonishing phenomena of specific immunity and susceptibility of animals and man to bacterial infection.

Man is relatively free from many of the epizootic diseases of animals, and animals do not naturally become infected with many human infections, as typhoid fever. Much more specific examples of immunity and susceptibility to infection are known, however. Algerian sheep are said to be immune to anthrax, that bacterial pestilence which has decimated herds of ordinary sheep both in Europe and America. House mice are extremely resistant to infection with glanders, while field mice are unusually susceptible. Goats are not readily infected with tubercle bacilli, but cattle and swine are extremely prone to the disease.

Science is wholly uninformed with respect to the origin and mode of the action of immune processes. Much empirical knowledge has been laboriously collected concerning the methods of testing such immunological phenomena, but an adequate, satisfying explanation of them is wholly and entirely lacking.

At first sight the enormous complexity of proteins to which immunological processes are ordinarily ascribed

would appear to be an insurmountable barrier to further advances. Seventeen amino acids which comprise the building blocks of the proteins may be arranged in hundreds of thousands of combinations within a molecule as large as that of a native protein. Realizing what a mere transposition of H and OH in glucose does in creating bacterial immunity, the enormous complexity of the extension of this process to protein and protoplasmic sources is very obvious.

Nevertheless, bacteria may throw some light even here. *Bacillus coli* and *Bacillus proteus* and some others are tryptophanophilic; in the absence of non-nitrogenous sources of energy they appear to pick out tryptophan from the protein molecules and utilize the alanin portion, leaving indol as a useless residuum. Other bacteria select other amino acids. Without prolonging this suggestion and without mentioning some other features of bacteria decomposition of protein which are pertinent, it may be stated that untouched possibilities remain which the bacteriological chemist of the future will study and from which he will glean information leading directly to the heart of that mystery of mysteries, the chemical equation of life.

Use of Bituminous Coal as Water-Gas Generator Fuel*

BY W. W. ODELL†

IT HAS long been recognized that coke is a more desirable fuel than bituminous coal in water-gas apparatus of present design, but still considerable headway has been made in the use of the latter fuel as a substitute for coke. This is particularly true in the Central States, where the supply of high-grade coke has been very limited and uncertain during the past few years and where coking coals of low sulphur content were available in quantities. In fact, with the present difference in price of coal and coke, it is possible to realize a marked saving when using a coking bituminous coal as generator fuel.

Difficulties have been encountered in the use of such fuel, but they have been overcome to a large extent. One of the chief obstacles in the use of the more general utilization of bituminous coal for water-gas manufacture is the fact that with normal operation the capacity per unit of time is reduced. This of course is a serious problem for plants operating at capacity with coke fuel. However, this difficulty can be remedied to a large extent by a changed method of operating, and can be remedied entirely by a combination of the latter with a change in the design (or proportions) of a water-gas set. The preceding statement, it will be understood, refers more particularly to a carburetted water-gas set.

PRESENT PRACTICE IN THE MANUFACTURE OF WATER GAS FROM COKE

In the manufacture of water gas from coke present practice requires that for continuous 24-hr. service the heat of combustion of all the carbon monoxide (CO) generated during the air blow be utilized in addition to the sensible heat of the gas coming from the generator.

This is doubly true when making carburetted water gas from bituminous coking coal. The reasons why

this is so are apparent when the following factors are considered.

The average value of the blue gas from coke fuel is 300 B.t.u. per cu.ft., whereas that from the coal is 335 B.t.u. Also the volume and quality of the blast gas are appreciably greater when the latter fuel is used. In other words, when making carburetted gas from bituminous coal the quality of the blue gas is so much richer than the same gas from coke that less oil is required to carburet it to a given standard. Therefore less heat is required for heating the checker chambers. This condition is aggravated by the fact that more and richer blast gas is available than ever, and must be wasted at the stack in large quantities when making gas to a standard lower than 565 B.t.u. The lower this standard the greater the quantity of blast gas wasted. Therefore, with the present tendency toward lower standards for city gas, the benefits to be realized by the utilization of a waste heat boiler are at once apparent.

The general practice in the past in the use of waste heat boilers has been to utilize only the sensible heat of the gas, no consideration being given to the heat of combustion of the excess combustible blast gas. This is perhaps due to the fact that when making carburetted gas to a 600 B.t.u. standard or better, using coke fuel, there is but little combustible gas wasted, since more oil is used per 1,000 cu.ft. of gas and the percentage of blue gas in the finished gas is lower. The changes brought about by the use of bituminous coal as generator fuel and by the lower gas standard materially alter this condition and make it particularly desirable to supply a combustion chamber in conjunction with a waste heat boiler for utilizing the heat of combustion of the waste blast gas.

ADVANTAGES OF USING BITUMINOUS COAL AS WATER-GAS GENERATOR FUEL

In drawing attention to the use of bituminous coal as generator fuel it is not my purpose to claim that it is better fuel than coke but to point out that:

1. Carburetted gas can be made from it cheaper than with coke, due to the fact that although slightly more generator fuel is used per 1,000 cu.ft. of gas produced, the difference in the prices of coal and coke is great enough to offset this difference. Also, the oil consumption per 1,000 cu.ft. is less, due to the higher heating value of the blue gas from coal fuel.

2. A still greater economy can be realized from the use of such fuel (bituminous coking coal) when a properly designed waste heat boiler with a suitable combustion chamber is provided.

The Bureau of Mines in its investigations of the use of central bituminous coals as water-gas generator fuel, conducted at its mining experiment station at Urbana, Ill., has made a special study of the design of types of water-gas sets using coal. A report on the results of the study of this problem, entitled "Water-Gas Apparatus Designed for Use With Bituminous Coal as Generator Fuel," by William W. Odell, has just been completed, and will appear as a Bureau of Mines publication. Another paper to be published by the bureau of interest to those concerned in the manufacture of carburetted water gas is a report of experiments made during July and August, 1920, in the use of mixed fuels, coal and coke, on a commercial scale, making over 1,000,000 cu.ft. of gas a day.

*From Reports of Investigations, U. S., Bureau of Mines.

†Gas engineer, Bureau of Mines.

Density of Aluminum From 20 to 1,000 Deg. C.

Experimental Methods for Measuring With Precision the Density of Liquid Metals, and Figures for the Results When Applied to Pure Aluminum — Derived Data of Importance Are Solid Shrinkage, or Pattern Allowance, and Solidification Shrinkage

By JUNIUS DAVID EDWARDS* AND T. A. MOORMANN†

ONE of the most interesting properties of aluminum from the standpoint of usefulness is its low density, and innumerable determinations of its density have been made. This work has nearly all been confined, however, to the observation of the density at "room" temperatures. In the technology of aluminum, the density of the liquid metal is a significant factor and there are no accurate data on the density of liquid aluminum in the literature. Furthermore, there has not always been a satisfactory correlation of the density of the material with its chemical composition and physical structure. It has been necessary, therefore, in some of our work to determine certain of these constants of aluminum and its alloys. This work has not only made available an exact knowledge of the density under varying conditions but has led to some very interesting observations and conclusions regarding the process of solidification of aluminum and its alloys. These results are of particular interest in connection with the casting of aluminum alloys. This paper is one of a series which will describe the work and the conclusions reached.

The term density, as used in these articles, may be defined as the mass of the metal in grams per milliliter. The density multiplied by the factor 0.0361 gives the mass in pounds per cubic inch. These values refer to weighings *in vacuo*; weighings made in air with brass weights and an equal arm balance will be about 0.03 per cent less. The specific volume is the reciprocal of the density or the volume in milliliters per gram of mass.

EXPERIMENTAL METHODS

The density of metal at room temperature has been determined in the usual manner by determining the apparent loss in weight when immersed in water. A platinum wire 0.10 mm. in diameter was used for supporting the specimen. No correction has been made for the effect of surface tension on the wire, because in nearly every case the correction is much less than one part per thousand. All weighings are corrected to *in vacuo*.

The determination of the density of the liquid metal presented greater difficulties. An attempt was made to determine the density by determining the apparent loss in weight of a sinker immersed in the metal. Fused quartz appeared to be the material best adapted for the construction of the sinker because of its low coefficient of expansion and it was hoped that it would not be seriously attacked by the aluminum. Because the density of fused quartz is insufficient to insure its sinking in liquid aluminum, a hollow quartz sinker was constructed with a cylinder of nickel or iron inside to increase its weight. A short, slender, quartz rod 1 mm.

in diameter was attached to the top of the sinker, and this was suspended by a platinum wire. The sinker is illustrated in Fig. 1. A number of results were obtained with this design of sinker, and they are in fair agreement with the results obtained by the densimeter method to be described later. The quartz sinkers are, however, quite rapidly attacked by the metal, particularly at temperatures above 700 or 800 deg. C., and the behavior of the sinker becomes erratic and the results unreliable. This method was accordingly abandoned in favor of another method. However, such a sinker would give very satisfactory results in contact with a metal or liquid which did not attack it and they can be readily constructed with a little practice.

Densimeter of Frary and Edwards. It has been found possible to determine the density of liquid metals with good precision by means of a densimeter devised by Dr. F. C. Frary and one of the authors. Fig. 2 shows a graphite densimeter of this type which was used with liquid aluminum and its alloys. The small inner crucible is completely filled with metal at a temperature somewhat below that at which its density is to be determined, and the cover is screwed down tight by means of two steel screws. The space between the inner and outer crucibles is filled with aluminum until the surface of the metal is about 0.5 in. from the top of the inner crucible; this bath of metal aids greatly in securing a uniform and constant temperature in the inner crucible.

The temperature of the furnace is then slowly increased until the bath of metal shows the desired temperature as measured by a platinum-platinum rhodium thermocouple, and then is carefully held at this temperature for from five to ten minutes. Great care is exercised to reach this temperature slowly, and not to exceed it at any time. As the temperature rises, the aluminum in the inner crucible expands and completely fills the crucible. The excess runs out through a very small channel formed by a groove in the top face of the crucible and the tightly fitting cover. Any beads of metal adhering to these openings are detached, the crucible is removed from the furnace, the metal in the surrounding bath is poured out, and the crucible is allowed to cool. When cold, the ingot is removed and weighed. The volume of the inner crucible has previously been determined by weighing the volume of mercury just required to fill it. The volume of the crucible at the temperature of measurement is calculated by means of the expansion coefficient of Acheson graphite, as determined by Day and Sosman.¹ This correction is



FIG. 1.
SINKER

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†Chemist, Aluminum Company of America.

¹Day and Sosman, *J. Ind. Eng. Chem.*, vol. 4, p. 490 (1912).

small—only 0.65 per cent at 1,000 deg. C. The density is readily calculated from the weight of the metal and the volume it occupied at the temperature of the determination. This method was considerably more precise than the sinker method but required a longer time to carry out a series of determinations.

DENSITY OF SOLID ALUMINUM

The density of a metal is subject to variation from changes in both composition and structure. As a result, the data on the density of aluminum as well as the density of other metals are frequently both conflicting and confusing. When metals are cast there are certain voids left in the metal as cracks, pores, etc. The application of pressure to the metal as in rolling or cold working tends to eliminate these voids, with a resultant increase in density. It has been observed, however, by a number of investigators that continued working of many metals eventually results in a decrease of density, and that annealing of these hard-worked specimens results in an increase of density. The explanation of this interesting phenomenon as proposed by Beilby² lies in his "amorphous phase" theory. According to this theory the deformation of the metal results in the transformation of small amounts of the crystalline metal into an amorphous modification possessing properties similar to those of a super-cooled liquid. This amorphous metal should have theoretically a lower density than the crystalline modification, and so its production lowers the average density of the metal. Upon annealing, the amorphous metal crystallizes and the density increases. These changes are not large in magnitude, but are apparently well authenticated. A good review of the evidence has been given by Johnston and Adams.³ More recently Hull⁴ has shown that mechanical working tends to change the crystal structure of aluminum from a face centered cubic lattice to a hexagonal arrangement. The changes in density under discussion might possibly be accounted for by some such change in crystal structure without recourse to the amorphous phase theory. In the case of aluminum, Kahlbaum⁵ found the density of a sample of hard-drawn aluminum wire to increase from 2.6995 to 2.7031 upon annealing. Brislee⁶ in an extensive series of experiments found variations of the same magnitude between hard-drawn and annealed aluminum wire, and

somewhat smaller differences in the case of metal which had not suffered as great deformation.

A number of tests were made by the authors to confirm these observations; a summary of these tests is given in Table I.

The sample of very pure metal (99.75 per cent) taken from the pig was increased in density from 2.686 to 2.703 by rolling; annealing produced no further change, however. Two samples of hard-rolled sheet (99.23 per cent) decreased slightly in density upon annealing. A cast sample of low-grade metal decreased in density with compression, and later increased upon annealing. According to the theory, the increase of density upon annealing should be greatest in the specimens which had suffered the greatest deformation. To test this point, samples of conductor wire were twisted almost to the breaking point. In the two tests made, there was an increase in density upon annealing, and the increase was greatest in the case of the wire most severely deformed. The decrease in density caused by annealing of the hard-rolled sheet referred to may have been caused by expansion of pores and fissures during annealing with its consequent crystal growth. The last-mentioned specimens had not received severe mechanical treatment.

It may be of interest to calculate the percentage of metal which must be present in the amorphous form to account for the observed changes in density. Take, for example, the sample of No. 10 wire which increased in density from 2.703 to 2.706 upon annealing. If it is assumed that the density curve of the solid amorphous metal is continuous with that of the liquid, then by extrapolation of the graph of Fig. 3, the density of amorphous aluminum at 20 deg. C. would be approximately 2.55. A simple calculation from the corresponding specific volumes shows that the presence of 1.8

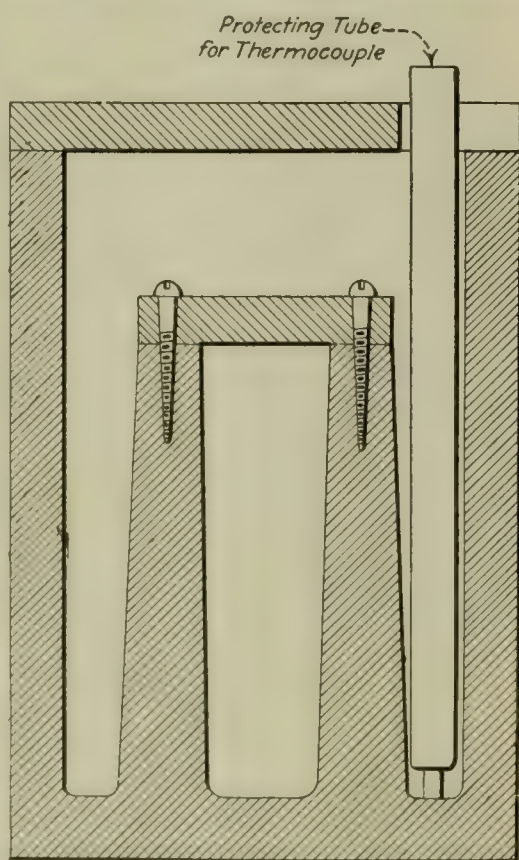


FIG. 2. DENSIMETER OF FRARY AND EDWARDS FOR LIQUID METALS

TABLE I. EFFECT OF PHYSICAL TREATMENT UPON DENSITY OF ALUMINUM

Purity of Sample, (per Cent Al)	Condition and Treatment of Sample	Density, (20 Deg. C.)
99.75	Sample sawed from pig.....	2.6827
	Sample sawed from pig.....	2.6861
	Same, cold rolled from $\frac{1}{8}$ to $\frac{1}{16}$ in.....	2.7031
	Preceding sample, annealed 15 min. at 850° F.....	2.7030
	Same, annealed 2 hr. longer.....	2.7030
99.23	Hot rolled to $\frac{1}{8}$ in.; finished to 0.22 in.; not annealed....	2.7078
	Same, after annealing.....	2.7069
	Hot rolled to $\frac{1}{8}$ in.; finished to 0.27 in.....	2.7077
	Same after annealing.....	2.7057
98.25	Small ingot cast in graphite.....	2.7279
	Same, compressed under load of 50,000 lb.....	2.7258
	Same, after annealing at 850° F.....	2.7266
99.49	Wire from aluminum cable.....	2.7064
	Another sample of same after twisting severely.....	2.7046
	Preceding sample annealed.....	2.7055
	Another sample after twisting very severely.....	2.7052
	Same, after annealing.....	2.7091
99.5	Hard drawn aluminum wire, No. 10 gage.....	2.7029
	Same, after annealing.....	2.7063
	Hard drawn aluminum wire, No. 6 gage.....	2.7019
	Same, after annealing.....	2.7048

per cent of amorphous metal of the assumed density would account for the change in density from 2.703 to 2.706.

Although we have contributed very little to the evidence on this phase of the investigation, the following conclusions seem warranted:

The working of cast aluminum increases its density by the elimination of voids. A point may be reached, however, at which further deformation of the metal results in a decrease in density, and the annealing of such metal again produces an increase in density. This

²Beilby, *J. Inst. Metals*, vol. 6, p. 5 (1911).

³Johnston and Adams, *J. Am. Chem. Soc.*, vol. 34, p. 563 (1912).

⁴Hull, *Proc. Am. Inst. Elec. Eng.*, vol. 38, p. 1,171 (1919).

⁵Kahlbaum and Sturm, *Z. anorg. Chem.*, vol. 46, p. 217 (1905).

⁶Brislee, *Trans. Faraday Soc.*, vol. 9, p. 162 (1913).

latter effect is best explained by the production of amorphous metal during working, which modification has a lower density than crystalline aluminum.

Examination of the available data indicates, in the authors' opinion, that the density of pure annealed

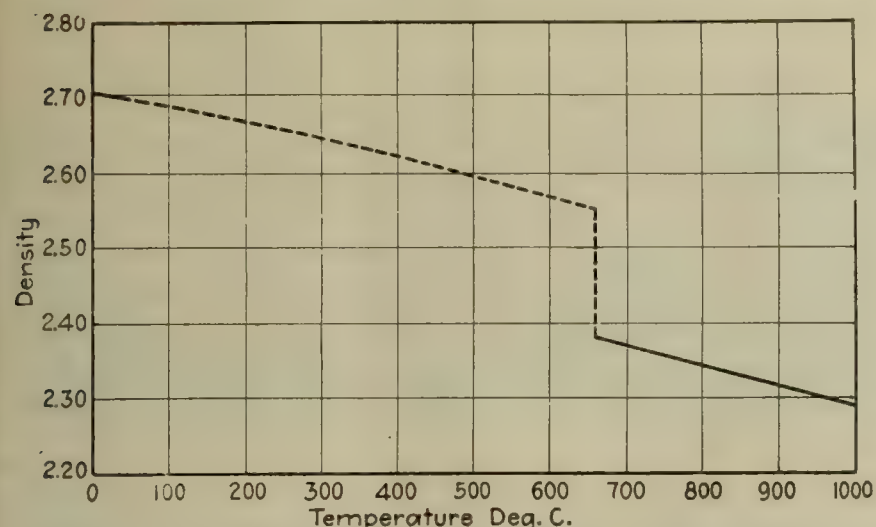


FIG. 3. DENSITY OF ALUMINUM, 99.75 PER CENT Al (DOTTED PORTION OF GRAPH WAS CALCULATED)

aluminum (100 per cent aluminum) is very close to 2.700. Samples of hard drawn wire of high purity may have densities only slightly lower than this value (for example, 2.699 or 2.698), caused by the mechanical working. Much lower values than these indicate the presence of voids. Small increases in the amounts of the usual impurities present cause an increase in density as indicated in Table IV.

THERMAL EXPANSIVITY OF ALUMINUM

A knowledge of the thermal expansivity of aluminum can be used to calculate the density of aluminum at higher and lower temperatures than "room" temperature. A summary of the available measurements is given in Table II.

TABLE II. THERMAL EXPANSIVITY OF ALUMINUM

Observer	Thermal Expansivity $\Delta l/l_0$	Temperature Range, Deg. C.	Purity of Metal Tested
Bureau of Standards ⁷	$(22.31t + 0.01115t^2) 10^{-6}$	15 to 295	Si = 0.45% Fe = 0.35%
Dittenberger ⁸	$(22.536t + 0.017071t^2) 10^{-6}$	0 to 610	"Pure"
Jaeger and Scheel ⁹	$(22.9t + 0.009t^2) 10^{-6}$	-78 to 500	Al = 99.6%

These results show some little variation, and we are adopting for the present the value obtained by the Bureau of Standards. The Bureau of Standards is also determining the expansivity of a sample of 99.75 per cent purity, but the results are not yet available.

⁷Bureau of Standards, Circular 76 (1919).

⁸Dittenberger, *Z. Ver. deutsch. Ing.*, vol. 46, p. 1,532 (1902).

⁹Jaeger and Scheel, *Elektrotech. Zeit.*, p. 150 (1919).

The density of the metal might be determined directly at the higher temperatures by the method of hydrostatic weighing if a suitable medium could be found. Oil might be used up to 300 deg. C., but beyond that temperature we have been unable to find any mixture of fused salts which would remain sufficiently constant in density to give satisfactory results.

DENSITY OF LIQUID ALUMINUM

Using the densimeter method outlined in a previous section, the density of aluminum has been determined from the melting point to slightly above 1,000 deg. C. The expansion is apparently linear over this range. The results of these tests are given in Table III. In a later section will be found a table of densities more convenient for use, and which have been taken from the "smoothed curve" fitted to the following data. For the sake of

TABLE IV. DENSITY OF ALUMINUM
Centigrade Temperature Scale

Temp.	Condition of Metal	99.75 per Cent Aluminum	Density 99.4 per Cent Aluminum	98.25 per Cent Aluminum
20	Solid	2.703	2.706	2.727
100	Solid	(2.69)	.....	.....
200	Solid	(2.67)	.....	.....
400	Solid	(2.62)	.....	.....
658.7	Solid	(2.55)	.....	.....
658.7	Liquid	2.382	2.384	2.405
700	Liquid	2.371	2.373	2.394
800	Liquid	2.343	2.345	2.366
900	Liquid	2.316	2.318	2.339
1,000	Liquid	2.289	2.291	2.311
1,100	Liquid	2.262	2.264	2.285

Fahrenheit Temperature Scale

Temp.	Condition of Metal	99.75 per Cent Aluminum	Density 99.4 per Cent Aluminum	98.25 per Cent Aluminum
68	Solid	2.703	2.706	2.727
1,217.7	Solid	(2.55)	.....	.....
1,217.7	Liquid	2.382	2.384	2.405
1,300	Liquid	2.369	2.371	2.393
1,400	Liquid	2.354	2.356	2.377
1,500	Liquid	2.339	2.341	2.362
1,600	Liquid	2.324	2.326	2.347
1,700	Liquid	2.309	2.311	2.332
1,800	Liquid	2.294	2.296	2.316
1,900	Liquid	2.278	2.280	2.301
2,000	Liquid	2.263	2.265	2.286

NOTE.—Values inclosed in parentheses are calculated from expansion formula.

comparison the deviation of each point from the smoothed curve is given in the table. This curve is based entirely on the measurements with the densimeter; the observations taken with the sinker are obviously of somewhat lower precision.

The density of the liquid (99.75 per cent aluminum) may be expressed by the following equation, in which D_t is the density at the specified temperature of t deg. C.

$$D_t = 2.382 - 0.000272(t - 658 \text{ deg.})$$

The only other data available on the density of liquid aluminum are those of Pascal and Jouniaux¹⁰ and Richards.¹¹ The sinker method was used by Pascal and

¹⁰Pascal and Jouniaux, *Rev. Metallurgie*, vol. 11, p. 1,069 (1914).

¹¹Richards, *J. Frank. Inst.*, vol. 138, p. 51 (1894).

TABLE III. RESULTS OF DENSITY DETERMINATIONS OF LIQUID ALUMINUM

Sample No.	Composition of Metal					Temperature, Deg. C.	Density Method	Density, g./ml.	Deviation From Best Curve, per Cent
	Si per Cent	Fe per Cent	Cu per Cent	Mn per Cent	Al per Cent				
7	0.25	0.26	0.08	None	99.38	665	Sinker No. 1.....	2.391	+ 0.38
7	0.25	0.26	0.08	None	99.38	718	Sinker No. 1.....	2.376	+ 0.34
7	0.25	0.26	0.08	None	99.38	754	Sinker No. 1.....	2.364	+ 0.25
7	0.25	0.26	0.08	None	99.38	959	Sinker No. 2.....	2.280	- 0.96
7	0.25	0.26	0.08	None	99.38	1,012	Sinker No. 2.....	2.256	- 1.40
12a	0.19	0.24	0.07	None	99.50	952	Densimeter.....	2.304	0.00
12c	0.17	0.23	0.07	None	99.53	701	Densimeter.....	2.372	0.00
Al	0.11	0.13	0.008	None	99.752	708	Densimeter.....	2.368	0.00
Al	0.11	0.13	0.008	None	99.752	897	Densimeter.....	2.317	0.00
Al	0.11	0.13	0.008	None	99.752	995	Densimeter.....	2.287	- 0.13
Al	0.11	0.13	0.008	None	99.752	996	Densimeter.....	2.282	- 0.35
72	0.38	0.53	0.32	0.52	98.25	706	Densimeter.....	2.391	- 0.04
72	0.38	0.53	0.32	0.52	98.25	822	Densimeter.....	2.362	+ 0.08
72	0.38	0.53	0.32	0.52	98.25	912	Densimeter.....	2.335	- 0.04

NOTE.—Four determinations have been omitted from the table, as having been obtained with a defective crucible; the results of these determinations were so far off as to be obviously incorrect.

Jouniaux with a quartz crystal as the sinker. They report values about 3 per cent higher than ours on metal for which they claim a purity of 99.48 per cent. The density of this metal is given as 2.794 at 20 deg. C., so there is obviously something wrong either with their technique or their analytical results, because metal of the stated purity could not possibly have a density as high as 2.79. Richards determined the weight of aluminum filling an iron mold of known volume and estimated the density of "molten aluminum" (temperature not specified) to be 2.54, which value is also high.

TABLES AND CURVES OF DENSITY, 20 TO 1,000 DEG. C.

In Table IV are shown the values for the density of several grades of metal at various convenient temperatures. The values for the solid metal at high temperatures were calculated by means of the expansion formula referred to in the preceding section. The values of liquid density were taken from graphs plotted from the data of Table III. In Fig. 3 the density of "A" (99.75 per cent aluminum) is shown graphically.

SHRINKAGE OF ALUMINUM

From the preceding data several interesting conclusions may be drawn regarding the shrinkage of aluminum in casting. The "solid shrinkage" of the pattern maker is the linear contraction in cooling from solid metal at 658 deg. C. to room temperature. As calculated from the expansion formula this amounts to 0.22 in. per ft. Tests made on bars cast between two graphite blocks, rigidly held a known distance apart, gave the value 0.21 in. per ft., which is in quite fair agreement with the calculated value.

The foundryman is also interested in what may be called the "solidification shrinkage" and the "liquid shrinkage." The solidification shrinkage may be defined as the percentage change in the volume of the metal in cooling from a liquid at the freezing point to a solid at the melting point of the metal. In the case of a pure metal, the freezing point and the melting point are identical. It is this shrinkage which is responsible for the pipe which is formed when the metal is cast. The

be correspondingly greater. In Table V are given the values for this total shrinkage from various temperatures as calculated from the graph of Fig. 3. There is also included an actual measurement of the shrinkage in a small experimental ingot. The method used was to cast an ingot in a small graphite crucible of known volume (about 240 c.c.) and then to measure accurately the volume of the pipe by weighing the volume of contained mercury. The volume of the pipe, corrected for solid shrinkage, was then expressed as a percentage of the original volume of the metal. The pouring temperature of the ingot was 1,550 deg. F. (843 deg. C.), and it will be noted that if we make the reasonable assumption that the average temperature of the metal was about 100 deg. C. lower at the time the filling and leveling of the crucible of metal was completed, then the calculated shrinkage is in good agreement with the observed value.

SUMMARY

The density of pure, annealed aluminum (100 per cent aluminum) is estimated to be very close to 2.700. The effect upon the density of small changes in composition and changes in structure produced by mechanical working, etc., are discussed in this paper. A graphite densimeter has been developed for determining the density of liquid metals and a series of determinations carried out on liquid aluminum of various grades. The density of liquid aluminum (99.75 per cent aluminum) may be obtained from the following equation:

$$D_t = 2.382 - [0.000272(t - 658 \text{ deg.})]$$

The solidification shrinkage or volume change of aluminum on freezing is shown to be close to 6.6 per cent.

Research Bureau,
Aluminum Co. of America,
New Kensington, Pa.

Rubber in the Manufacture of Dynamite

An interesting note on the important part played by rubber in the manufacture of nitroglycerine and dynamite will be found in *India Rubber World*, Nov. 1, 1920, p. 114.

During the nitration of the glycerine and the subsequent settling, neutralization and washing, the workmen are protected from acid burns and toxic absorptions by rubber gloves and boots. The pure nitroglycerine is conveyed to the storehouses in rubber-lined gutters.

From the storehouse the nitroglycerine is taken to the mixing house in a copper-lined, rubber-tired buggy provided with long rubber tubes for discharging the contents. The absorbents, such as sodium nitrate, ammonium nitrate or wood pulp, are added in the mixing machine, a large wooden bowl in which large hard-rubber-tired wooden wheels revolve. The loose dynamite is removed by wooden shovels to wooden tubs, thence to the packing machine, where it is packed into paraffined paper shells by means of wooden tamps tipped with rubber.

A New Sweet

The *Bulletin* of the Imperial Institute (vol. 18, pp. 123-5, 1920) reports that a sweet of remarkable potency is found in a plant called "caa-che" (*Stevia rebaudiana*), that flourishes in Paraguay. The sweet constituent is a glucoside called estevia, which is accompanied in the plant by another sweet constituent, rebaudin, probably a compound of estevia with sodium or potassium. Estevia and rebaudin are said to be respectively 150 and 180 times as sweet as cane sugar.

TABLE V. SHRINKAGE OF ALUMINUM

Temperature Deg. C.	Total of Solidification and Liquid Shrinkage From t Deg. C. to Solid at 658 Deg. C.—Percentage of Original Volume	Remarks
658	6.6	Calculated from data of Table IV.
700	7.2	Calculated from data of Table IV.
800	8.2	Calculated from data of Table IV.
	7.7	Shrinkage measured on ingot cast at 1,550 deg. F.; temp. estimated at 100 deg. C. lower at completion of filling of crucible.

liquid shrinkage is the contraction of the liquid in cooling to the freezing point and of course varies with the temperature interval through which the metal cools.

Referring to Fig. 3, the solidification shrinkage in metal changing from liquid of density 2.382 at 658.7 deg. C. to solid of density 2.55 at the same temperature is 6.6 per cent. Toepler¹² reports the solidification shrinkage of aluminum to be 5.1 per cent. In the casting of aluminum it must, of course, be poured at a higher temperature than 658 deg. and the total of the solidification shrinkage and the liquid shrinkage will

¹²Toepler, *Wied. Ann.*, vol. 53, p. 343 (1894).



**Present Status of Industry, With Special Reference to Recent Operations in Texas—
Pyrites Versus Sulphur as a Source of SO_2 —Effect of Traces of Petroleum—
Properties and Uses—Sulphur as an Engineering Material**

BY RAYMOND F. BACON* AND HAROLD S. DAVIS†

SULPHUR plays a more basic rôle in chemical industry than any other element. Either as elementary sulphur or combined as a metallic sulphide, it is the source of all sulphuric acid. Hence any changes in the sulphur industry should be of great interest to the chemical engineering profession.

America now dominates the sulphur industry and virtually all the American sulphur is produced by three companies—viz., the Union Sulphur Co., the Freeport Sulphur Co. and the Texas Gulf Sulphur Co. These three companies produce not only virtually all the sulphur used in the United States but also a considerable surplus which is exported. The only other sulphur which normally enters the American market in quantity comes from Japan¹ and its percentage calculated on the consumption of the United States is small and is not likely to increase. Rising costs of living have meant much higher wages in Japan, as well as in other parts of the world; in fact, the percentage increase has probably been greatest in Japan, due not only to world conditions affecting all countries but to the rising standards of living of the Japanese. These facts, together with present higher transportation costs, will make it increasingly difficult for Japanese sulphur to compete on our Pacific Coast with the American product.

EXPANSION OF INDUSTRY DURING WAR

During the World War, and especially after America's entry into it, the demand for sulphur grew enormously. Some time previous to our declaration of war consideration had been given by a certain group of New York capitalists to the opening up of the sulphur deposit (known as the "Big Dome") located near Matagorda, Tex. These plans were hastened to realization by our Government's need and demand during the war for the maximum production from every possible source of sul-

phur. The plans eventuated in the formation of the Texas Gulf Sulphur Co., which, however, did not get its plants into operation until after the armistice. Production has been practically continuous since the company first mined sulphur on March 19, 1919. The plant of this company, which has been described elsewhere,² was designed to have a capacity of 1,000 tons of sulphur per day, but for months at a time during the past year it has produced on an average 2,000 tons per day. The total production for the year 1920 exceeds 800,000 long tons, while in all probability the production for 1921 will be the largest of any sulphur company in the world. The possible daily production with the present plant, under favorable conditions, could be forced to three or four thousand tons per day. The deposit contains upward of ten million tons of sulphur; and a brief description of its character is as follows:

DESCRIPTION OF BIG DOME AT MATAGORDA

The main deposit has a diameter of about 4,000 ft. and is situated 800 to 1,000 ft. below the surface of the ground. The sulphur occurs in an almost flat stratum, whose general shape is like that of a flat-topped umbrella. Above the sulphur stratum is an unconsolidated sediment consisting of bands of shale, gumbo and boulders. Below is a layer of salt and gypsum, and then a layer of salt of undetermined but very considerable thickness. The sulphur content of the deposit runs quite uniform with a slightly higher percentage of sulphur on one side of the dome. The mining operations are carefully checked, and a large-sized model of the deposit enables the engineers constantly to visualize what is taking place underground.

PRODUCTION AND STOCKS EXCEED POST-WAR NORMAL DEMAND

At the time the Texas Gulf Sulphur Co. entered the market the situation was about as follows: The Union Sulphur Co. had on top of the ground, in unsold

¹Read before the American Institute of Chemical Engineers, New Orleans, Dec. 6, 1920.

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²However, no Japanese sulphur is being imported into this country at the present time.

²CHEM. & MET. ENG., vol. 20, No. 4, pp. 186-188. *Eng. Min. J.*, vol. 107 (1919), pp. 555-7.

stock of sulphur, upward of one million tons and the Freeport Sulphur Co. had several hundred thousand tons. The normal consumption of sulphur in the United States had been between four and five hundred thousand tons per annum, which quantity could be readily supplied by the two older companies.³ A new sulphur company entering the market with a large production of sulphur was therefore compelled to pursue one of two policies—either to attempt to obtain a share of the business by cutting prices or to place the sulphur in markets which had not hitherto used sulphur; in other words, to increase the sulphur consumption of the country.

With reference to the first possibility, competition based on cut-throat slashing of prices always has proved disastrous to the whole industry. Moreover,

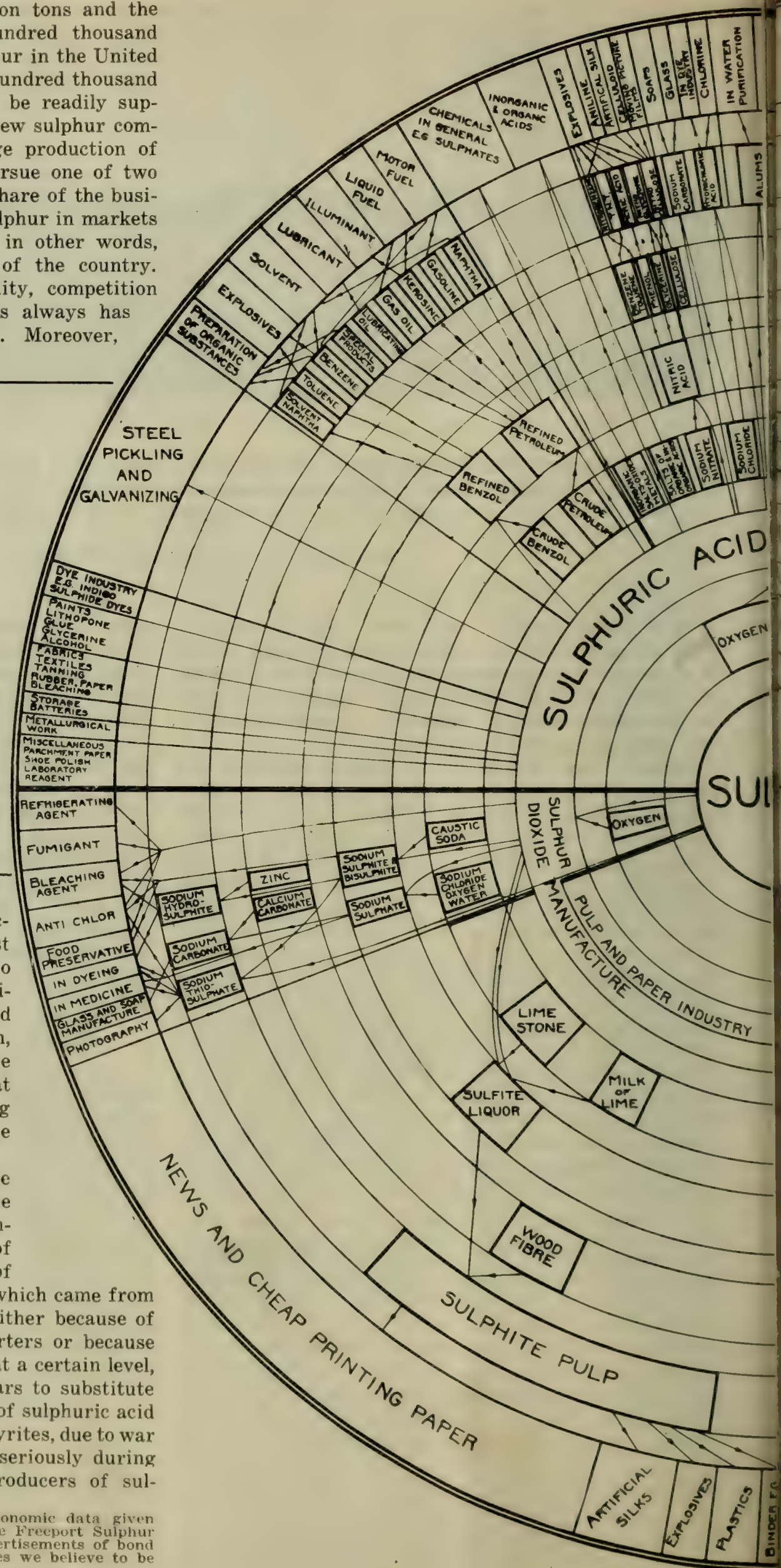
Sulphur Products Chart

Showing Primary Industry Entered, Intermediate and Final Products as Well as Final Use.

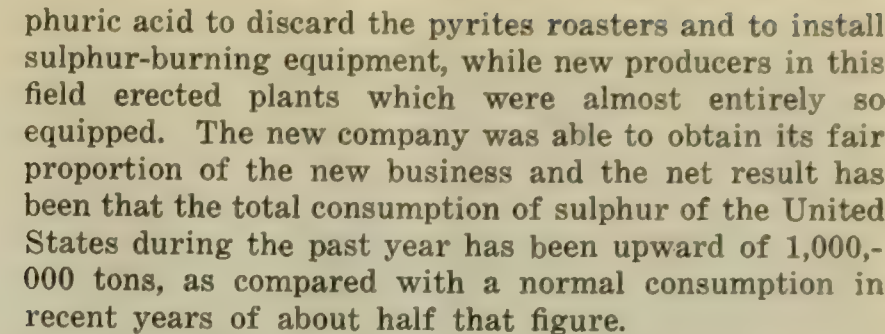
(Prepared by Mary D. Davis)

the mining of sulphur by the Frasch process, to be carried out economically, must be conducted on a very large scale, so that even if a company under the conditions outlined above had obtained a third of a possible 500,000-ton consumption, this would not have insured profitable operation. The company has chosen what is surely the wiser course, in attempting to place its sulphur by increasing the total consumption in the industries.

It was possible to do this owing to the prevailing economic conditions. The United States had in recent years consumed annually, for the manufacture of sulphuric acid, upward of 500,000 tons of sulphur in the form of pyrites, most of which came from Spain. The older sulphur companies, either because of some agreement with the pyrites importers or because of a desire to hold the price of sulphur at a certain level, had not attempted seriously in past years to substitute sulphur for pyrites as the raw material of sulphuric acid manufacture. Importation of Spanish pyrites, due to war transportation conditions, fell off very seriously during the war years. This caused many producers of sul-



³It may be stated, in passing, that any economic data given regarding either the Union Sulphur Co. or the Freeport Sulphur Co. are subject to the usual statement on advertisements of bond sales, that is, "they are gathered from sources we believe to be reliable, but are not guaranteed by us."



PYRITES VERSUS SULPHUR AS A SOURCE OF SO₂

It is interesting, in this connection, to give just a little history, for if the subject is examined it is found that in the early days of sulphuric acid manufacture all the sulphuric acid of Europe, excepting Nord-

hausen acid, was made from brimstone. This includes the period from about 1750 to 1839, when pyrites first was used commercially for the manufacture of sulphuric acid in England. This use of pyrites was due to the fact that the Neapolitan Government in 1838 granted a monopoly for the exportation of sulphur to Taix & Co., of Marseilles, which firm immediately raised the price of sulphur from \$25 to \$70 per ton. By so doing, it killed the goose that laid the golden egg, for pyrites was substituted immediately for sulphur in most European countries and the era of high-priced sulphur was but short lived. The loss of this market

was a permanent setback to Sicilian sulphur.

The subsequent history of the sulphur industry is one of violent ups and downs. If one considers this history up until some time after Frasch made America a factor in the business, it will be noted that it has been characterized at all times by short periods of prosperity, followed by a short-sighted, selfish, destructive competition on the part of certain interests. Following this would come a period of such marked depression as to threaten the life of the entire industry, and it would be necessary for some governmental or other outside agency to exercise pressure to get the producers together on a common-sense basis and thus gradually

put the industry again on its feet.⁴ Since the time when Frasch made possible America's sulphur industry the stability of the whole industry has been much greater. While at the present time there is an extremely lively competition among the companies for business, there is every reason to believe that American common sense, spirit of fair play, and co-operation will prevent this competition going to the extent of threatening the industry itself, as has happened many times in the past. Present indications are that all the sulphur companies are pursuing an enlightened policy, in that all are doing more or less research and development work having as its ultimate object the opening up of broader markets for sulphur, of which sulphuric acid manufacture affords but one.

ADVANTAGES OF SULPHUR OVER PYRITES

For sulphuric acid manufacture sulphur has many very marked advantages over pyrites. Using pyrites means handling into the works a comparatively large quantity of material, its slow combustion in expensive roasters, a certain inevitable dust nuisance and the disposal of a large tonnage of cinder. As against this, sulphur of less than one-half the weight of pyrites for a given tonnage of acid produced is handled into the works, is burned cleanly in inexpensive equipment and leaves no residues to be taken care of. Sulphur is constant in composition, and its freedom from arsenic and other impurities allows the production of a purer acid. It is also claimed that, in practice, the burning of sulphur means a higher rate of production for a given size of lead chamber space.

These acknowledged advantages of the use of sulphur over pyrites for sulphuric-acid manufacture have been demonstrated by the willingness of acid producers to pay a higher price per unit for elementary sulphur than for combined sulphur in the form of pyrites. An example of this is the fact that one of our largest and best organized chemical companies, in making a large contract, chose sulphur over pyrites for sulphuric-acid manufacture, where the differential in offered prices was 8c. per unit of sulphur.

When one considers the present high prices of labor, the uncertainty of the copper market and the fact that sulphur may be purchased in a competing market, from concerns which have large stocks on hand, so that delivery is certain, it would seem to be a wise business policy to use sulphur rather than pyrites for sulphuric-acid manufacture even with a very large differential in price. This is especially true when one considers the other side of the situation—namely, that in buying imported pyrites the consumer is putting himself at the mercy of one large set of interests which, while it may at the present time offer pyrites at low prices and even below actual cost, will almost certainly at some time in the future reap its profit by much higher prices. It is said that imported pyrites has been offered for large contracts in this country at about 10c. per unit of sulphur, ex-vessel, Atlantic seaboard, while at the same time pyrites was selling in England, much nearer the base of supplies, at 20c. to 22c. per unit of sulphur. It reminds one somewhat of the tactics of Standard Oil in the old days before "trust-busting" became fashionable with politicians; and everyone knows that those who bought cheaply when the company was extinguish-

ing a competitor never reaped any permanent advantage, but later more than paid for temporary reductions in price.

Sulphur is today one of the few substances which have not risen in price since pre-war days. In fact, sulphur is cheaper today than at any other time in the history of the industry. The price for large contracts is about \$20 per ton, Atlantic seaboard. This makes sulphur one of the cheapest raw materials available and should, it would seem, greatly extend its usefulness. Sulphur as mined and sold by all three companies is of remarkably high grade. In fact, many so-called C.P. chemicals do not possess the purity of crude sulphur, as sold by these companies. The sulphur is free from arsenic, selenium and tellurium, and often for days at a time wells will yield a product running higher than 99.9 per cent sulphur, as calculated on a moisture-free basis; in fact, sulphur companies selling the crude sulphur on contracts guarantee the purity to be over 99 or 99½ per cent.

EFFECT OF TRACES OF PETROLEUM ON COMBUSTION

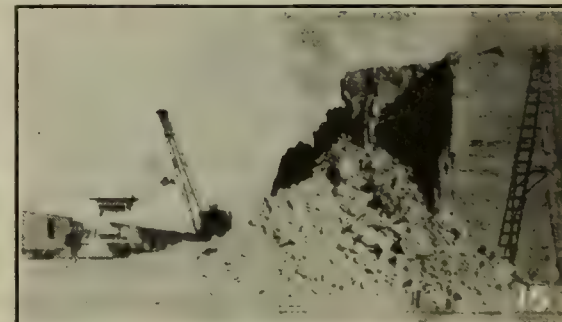
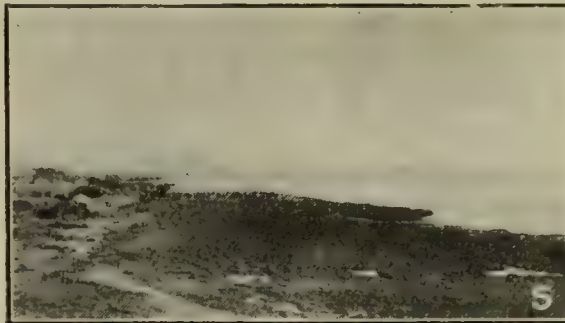
One impurity occurring in traces in the sulphur of all three companies is oil. There is a dearth of information in the technical literature respecting the subject of oil in sulphur. Since the effect of this impurity is very interesting, it is appropriate to discuss it here. The peculiar effect of oil is its influence on the burning qualities and also on the color and odor of sulphur. *A priori*, one would not assume that mere traces of a combustible substance like petroleum oil could affect adversely the combustion of another combustible substance like sulphur, but such is indeed the case.

If one will make a simple experiment by attempting to burn two small lots of sulphur, one being chemically pure and the other containing 0.2 per cent of petroleum oil, he will note the following phenomena: The pure sulphur will burn quietly until it is totally consumed; the sulphur containing the oil will burn for a very short time, when it will be observed that a thin, elastic film is being formed over its surface. Very soon combustion is taking place only in spots, and within an exceedingly short time the flame goes out, although only a small percentage of the sulphur has been consumed. The explanation is quite simple. Sulphur and oil at a moderate temperature react together to form asphalt, and if the reaction is carried to completion the final result is carbon.

In the burning of sulphur containing oil the oil reacts with the sulphur to form an asphaltic material, which quickly spreads as a film over the surface. The result, as combustion proceeds, is a film of carbon over the surface of the sulphur. The ignition temperature of carbon, or of the intermediate asphaltic material, is so much higher than that of sulphur itself or than the temperature developed during the burning of the sulphur that this film is not ignited and consequently the whole flame is extinguished.

The remedy for burning such sulphur is also quite obvious. If the devices for sulphur combustion are such as to agitate the surface of the burning sulphur or in any other way break this film of asphaltic material, no difficulty will be experienced. Acid manufacturers who use mostly modern types of sulphur burners, such as the rotary or cascade type, which allow the sulphur to drop from one level to another, have absolutely no difficulty in burning sulphur containing 0.2 per cent of oil, which figure represents more oil than any of the

⁴In this connection, see Frasch, Perkin Medal Address, MET. & CHEM. ENG., vol. 10, No. 2, pp. 73-82, and J. Ind. Eng. Chem., vol. 4 (1912), p. 139.



General Views Showing Topography, Figs. 1, 2, 5, 8.
Method of Loading for Shipment, Figs. 12, 15, 18, 21.
Houses, Pavilion and Hospital, Figs. 11, 14, 17, 20.

Sulphur Tank Storage System, Figs. 3, 6, 9.
Well Driving Equipment, Figs. 4, 7, 10.
Exterior and Interior Views of Power House, Figs. 13, 16, 19.

commercial sulphurs contain at the present time. On the other hand, many of the small paper-pulp manufacturers still adhere to types of burners in which the burning sulphur is more or less quiescent. With such a type there is no agitation of the burning liquid surface, so that some of these paper-pulp manufacturers have had difficulty in burning sulphur when they happened to obtain a shipment comparatively high in oil.

The sulphur deposits of all three operating companies are located in close proximity to oil fields. When a sulphur deposit is first opened some of the product may be high in oil, running as much as 0.2 per cent, but as production proceeds the oil becomes progressively lower until finally, for days at a time, it may amount to only 0.04 per cent, which is totally negligible, even for burners which provide no agitation of the surface. We have assumed that hot water carried this small quantity of oil from small crevices in the oil-sand formation to the sulphur below when the well was first opened. After a region has become heated up by the hot water, these traces of oil are pretty well washed out; consequently, sulphur mined later in the same area is virtually free from it. Examination of drill cores of native sulphur showed such *in situ* sulphur to be oil-free. We are informed by ex-employees of the Union Sulphur Co. that this corresponds with the experiences of that organization in heating up any new area of sulphur ground. The examination of a very large number of samples of sulphur, representing the production of all three companies, has shown quite positively that none of their sulphur contains enough oil to cause any difficulty in its combustion with rotary burners or other burners which agitate the surface of the burning sulphur during combustion. It is only very exceptionally that one will find a car of sulphur whose oil content is high enough to make difficulties in its combustion in a stationary type of burner.

PROPERTIES AND USES OF SULPHUR

Sulphur is now and is likely to be for some time one of our cheapest raw materials, and accordingly should and undoubtedly will find a much wider range of usefulness. It is by studying the physical and chemical properties of a substance that one first obtains ideas as to possible new uses therefor. The chief physical properties of sulphur are tabulated in Table I. The present tonnage uses of sulphur are presented in the chart. Those properties which suggest certain possible tonnage uses for sulphur are its very poor conductivity of heat and electricity, its resistance to being wetted by water and its inertness toward most acids, all of this combined with a fair degree of physical strength. These properties suggest heat-insulating materials, electrical insulators of various types, water- and acid-proof cements, and acid-proof construction materials.

As against the properties of sulphur which might make it very desirable for certain construction purposes are certain objectionable ones, such as its brittleness and its flammability. The brittleness can be overcome sufficiently for many purposes by making mixtures of sulphur with other materials, such as sand, asbestos, or paper pulp, or by reinforcing with wire screen. In many cases the flammability is not a serious objection.

A survey of the literature, especially the patents, on the subject of sulphur mixtures reveals that almost every conceivable thing has been suggested as a perfective admixture for sulphur to obtain a material which has all the air- and acid-resistant properties one could

desire or to get a completely resistant kind of concrete useful in building. We have tested out most of the recipes which appeared to be promising and find as usual that the claims have been much overstated. However, the ordinary mixture of sand and sulphur which has been repeatedly mentioned in the literature has merits which should make it better known. The mixture which has seemed to us the best for most uses is that of 40 of sulphur and 60 of sand (parts by weight). The tensile strengths of sulphur-sand mixtures as measured in the usual manner for testing cement were as follows:

TENSILE STRENGTHS OF SULPHUR-SAND MIXTURES

Percentage of Sulphur by Weight	Tensile Strength, Lb. per Sq.In.
25	90
35	310
40	400
45	310
50	110
100	250

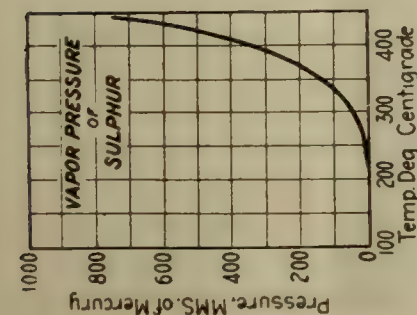
We have also used other fillers which have given tensile strengths of 800 and even 1,100 lb. measured in the same manner and have to a large extent overcome the brittleness of the sulphur in some of these mixtures. Sulphur-sand briquets kept on hand for one year show no deterioration in strength. It is evident that the 40-60 sulphur-sand mixture can be used as an acid-resistant concrete, for making acid-resisting pipe, tanks, gutters, launders, etc. The manipulation of such a mixture is much like that of pouring concrete and is as follows:

Practical Manipulation. It is evident that the sand should contain no constituent which will be attacked by any material which is to come in contact with the finished product; for instance, in the case of acid tanks it should be free from limestone or other acid-soluble constituents. If necessary, it should be washed and dried. The sulphur may be melted in a kettle with constant stirring, and the sand, which has been heated separately, poured into it while the stirring is continued. Unless the sand is heated, it will lump when poured into the sulphur. When the material is thick enough (40 per cent sulphur and 60 per cent sand) it is ladled into the molds.

Considerable flexibility is possible in handling this material. For instance, a small tank was made which was 2 ft. square, 18 in. deep, and 2 in. thick. The mixture was poured into a wooden mold in twelve different lots. Although several of these lots had solidified before the next was poured upon them, nevertheless the resulting joints were strong. Apparently the hot mixture melts sufficient of the solidified part to form a solid joint. There was no contraction of the tank as a whole and no tendency to split in the mold. This mixture can be worked with a trowel, like mortar. It can also be reinforced by wire netting placed in the mold before it is poured. The specific gravity of a sulphur-sand mixture (40:60) was found to be 2.46.

Weight of 1 cu.ft.....	154 lb.
Weight of sulphur required per cu.ft.....	62 lb.
Weight of sulphur required per cu.yd.....	1,670 lb.

Taking the value of sand as \$1 per cu.yd. and of sulphur as \$20 per ton, the price of the materials per cu.yd. will be about \$18. It may be possible to decrease appreciably the amount of sulphur necessary and hence



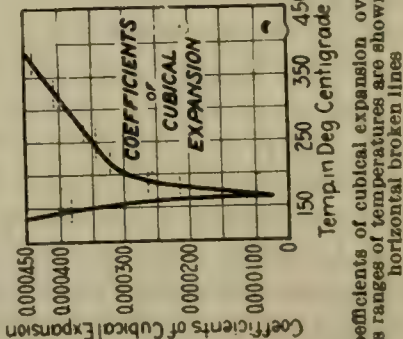
FORMS OF SULPHUR

- Crystalline**
a. *Rhombohedral*. Stable below 96° C. (205° F.).
b. *Monoclinic*. Stable above 96° C. (205° F.).
c. *Malle of Sulphur*. Formed, e. g., by action of diluted acids on polysulphides. Generally called amorphous, but shown by Smith and Brownlee to be crystalline.
There are several other modifications of crystalline sulphur of scientific interest but not of general importance.
- Liquid**. At 113° C. (235° F.). Contains Sulphur (liquid, soluble), S₈ Sulphur (liquid, insoluble or amorphous), S₂. The proportion of S₂ to S₈ increases with the temperature.
- Amorphous**. S₂ (solid). Formed by heating sulphur above 400° C. or 752° F. and pouring in a thin stream into liquid air. Its elastic properties are soon lost.
- Black Sulphur**. "When sulphur mixed with very little oil is thrown into a hot platinum dish, a black substance is obtained which has been looked on as a modification of sulphur. The product contains 55% of sulphur and 33% carbonaceous material."—Watts, *Dictionary of Chemistry*.

Elastic Sulphur. Formed by heating sulphur above 400° C. or 752° F. and pouring in a thin stream into liquid air. Its elastic properties are soon lost.

Black Sulphur. "When sulphur mixed with very little oil is thrown into a hot platinum dish, a black substance is obtained which has been looked on as a modification of sulphur. The product contains 55% of sulphur and 33% carbonaceous material."—Watts, *Dictionary of Chemistry*.

Black Sulphur. "When sulphur mixed with very little oil is thrown into a hot platinum dish, a black substance is obtained which has been looked on as a modification of sulphur. The product contains 55% of sulphur and 33% carbonaceous material."—Watts, *Dictionary of Chemistry*.



The coefficients of cubical expansion over various ranges of temperatures are shown at horizontal broken lines

ELECTRICAL CONDUCTIVITY
Measured as reciprocal value of resistivity in ohms or 1 cm. cube.

C. Temp. F.	Conductivity
22	1 × 10 ⁻¹⁷
69	0.254 × 10 ⁻¹⁶
115	0.105 × 10 ⁻¹¹
130	0.5 × 10 ⁻¹⁰
430	0.1 × 10 ⁻⁷

Compare:
Porcelain..... 1 × 10⁻¹⁴
Mica..... 1 × 10⁻¹²
Ebonite..... 1.5 × 10⁻¹¹

FRICTIONAL ELECTRICITY

when rubbed with practically any other substance, e. g., glass, fur, silk, wool or hard rubber—sulphur becomes charged with negative electricity.

COEFFICIENT OF LINEAR EXPANSION

Temp. F.	Ex. Coeff.
0-13	32-56
13-50	56-122
50-78	122-173
78-97	173-207
97-110	207-230

SURFACE TENSION

Temp. F.	Surface Tension, mg./mm.
120	248.0
131	267.8
146	294.8
195	383.0



COMPRESSIBILITY

Average fractional change of volume caused by 1 megabar change in pressure between 100-500 megabars 0.0000125.
1 megabar = 0.987 atmosphere

CONDUCTIVITY OF HEAT

Measured as the number of gram-calories transmitted in 1 second through a plate 1 cm. thick and having surfaces 1 sq. cm. in area when opposite faces differ in temperature by 1° C. 20-100° C. (68-212° F.). 0.0006

Compare:
Ice..... 0.002
Copper..... 1.00

International Atomic Weight, 1920 = 32.06

Vapor Density:

At boiling point corresponds approximately to formula S₈.
At 1,000 deg. C. (1,832 deg. F.) corresponds approximately to formula S₂.

ECONOMICS OF NATURAL SULPHUR

Until 1900, 95% of world's supply from Sicily
In 1912, 50% of world's supply from Sicily
In 1917, 14% of world's supply from Sicily
In 1917, 80% of world's supply from U. S. A.

UNITED STATES EXPORTS AND IMPORTS

1909 exports....	37,142 long tons
1909 imports....	30,589 long tons
1918 exports....	131,092 long tons
1918 imports....	82 long tons

UNITED STATES PRODUCTION

1894, 494 long tons	1909, 303,000 long tons
1899, 1,590 long tons	1914, 347,491 long tons
1904, 196,888 long tons	

1919 TEXAS GULF SULPHUR CO.

Only nine months production after start
348,380 long tons

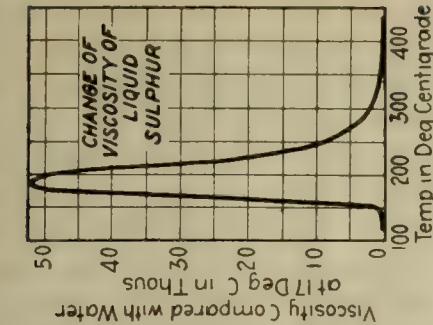
PROPERTIES OF COMMERCIAL SULPHUR

Insoluble in water
Insoluble in most acids

Tensile strength, 200 lb. per sq. in. (approx.)
Heat conductivity, low: $\frac{1}{2}$ that of cork, $\frac{1}{4}$ that of ice
Electrical conductivity lower than that of practically any other solid substance
Melting point, depending on conditions, 110.2-119.25 deg. C. (230.4-246.7 deg. F.).
Ignition temperature, 248 deg. C. (478 deg. F.).
Boiling point, 444.6 deg. C. (832.3 deg. F.).

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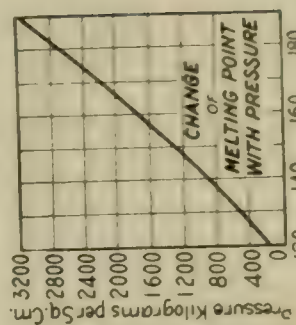
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CHANGE IN VISCOSITY WITH TEMPERATURE

Solubilities in Various Solvents

Solvent	Temp. C.	Temp. F.	Solubility, G. in 100-g. Solution
Amyl alcohol.....	95	203	1.5
Aniline.....	110	230	2.1
Benzene.....	89.5	193.1	8.3
Carbon disulphide.....	130	266	46.2
Carbon tetrachloride.....	25	77	2.1
Chloroform.....	70	158	8.0
Coal-tar oil, sp. gr. 0.87.....	-20	-4	10.5
Ethyl ether.....	10	50	13.5
Linseed oil.....	20	68	18
Olive oil (Sp. gr. 0.885).....	50	122	29.5
Sulphur chloride.....	100	212	59
Phenol.....	15	59	92
Toluene.....	25	77	77
Turpentine (oil of).....	15	59	71.6
	100	212	1.2
	15	59	2
	100	212	13
	15	59	6.5
	110	230	53.5
	23	73	0.97
	15	59	0.4
	160	320	9.0
	15	59	2.2
	130	266	30
	0	32	11
	55.2	131.4	43
	86	186.8	89
	175	346	26.7
	23	73.4	1.48
	16	60.8	1.33



CHANGE OF MELTING POINT WITH PRESSURE

From rhombic... 14.5
From monoclinic... 11.1

From rhombic... 14.5
From monoclinic... 11.1

From rhombic... 14.5
From monoclinic... 11.1

the cost by imbedding larger pieces of crushed rock or some such substance in the mass. Tests of the material in sea water are being made, but it is too early to give results. It is apparently standing up well to date.

Pipes cast of this sulphur-sand mixture show no deterioration after one year in 5 per cent hydrochloric or 5 per cent sulphuric acid. The ordinary organic acids have no effect on such a mixture. The following extract is pertinent in this connection:

THE USE OF SULPHUR AND SAND IN SEWER PIPE JOINTS^a

In constructing a main line 36-in. sewer for the conveyance of acid waste for a pulp mill in Quebec the question arose as to what material should be used in pouring the joints. Cement was out of the question on account of the deteriorating effect acid would have upon it. A number of mills were corresponded with upon the subject, but no very satisfactory method was recommended.

Ultimately the use of sulphur and sand was suggested by the engineering department. Lead wool was considered but rejected upon the ground that the cost was high. On the other hand, sand was available on the ground from excavations and sulphur could be purchased at the dockside in Three Rivers.

The method used was as follows:

An ordinary iron boiling cauldron over an open wood fire was used for heating the sulphur and sand. The proportions were one to one. The whole was heated until the sulphur melted and a semi-liquid mass formed. Three pipes were placed vertically in the trench and by means of a galvanized conductor pipe bent at one end to fit into the flange of the pipe the mixture was poured from a ladle on the top of the trench directly into the joint. The joints of each section of the three pipes in the trench were then poured in the ordinary manner with the use of a runner.

The insides of the joints were pointed with wet clay. The joints cast and became solidified in about one hour after pouring. The length of time for solidification of course depended upon the coldness of the weather.

The joints so far have been all that could be desired, having neither blowholes nor cracks. The solidified sulphur and sand is extremely hard and the only impression made on it with a large knife was to scrape fine particles away. In appearance it is almost metallic.

One possible tonnage use for sulphur which has been arousing a great deal of interest in the last two years is its application as a fertilizer. There are two methods of application which have received attention from experiment stations. During the war, when sulphuric acid was needed for munition manufacture, Lipman, of the New Jersey Experiment Station, showed that if sulphur is composted with ground raw phosphate rock the phosphate is rendered available within a reasonably short time. Bacteria in the soil oxidize the sulphur to sulphuric acid, which acts on the raw phosphate to give available plant food. It is thus possible to make available as high a percentage of phosphoric acid as is found in commercial acid phosphate. The work has been confirmed by other experiment stations and would undoubtedly have been of great importance if the shortage of sulphuric acid had continued. Lipman has since improved the procedure by isolating and growing pure cultures of the most active sulphur oxidizing bacteria and has prepared sulphur inoculated with these. Such a product is put on the market under the name "Bac-Sul" and it is understood that the Union Sulphur Co. is interested in its sale. Although we believe that a product of this kind will do all that is claimed for it, it is doubtful whether it means any immediate tonnage outlet for sulphur. Competent agricultural authorities advise that it is nearly impossible to get the American farmer to do composting and at best the introduction

of any new type of fertilizer is a slow and tedious process. The other use of sulphur as a fertilizer consists in its direct application to the soil. The Oregon Agricultural College Experiment Station has shown very conclusively that certain soils in southern Oregon are immensely benefited in this way, so that the alfalfa crops have been greatly increased. Several of the other state experiment stations have reported the same experience for certain types of soils. In fact, results obtained by the use of sulphur as a fertilizer have in some cases been so remarkable as seriously to raise the question whether some of the standard theories on fertilizers will not have to be revised. Nearly all the experimental work through which phosphate has been given its high place as a fertilizer has been done with an acid phosphate containing considerable quantities of sulphates. Similarly, in experiments with potassium and ammonium fertilizers, the sulphates have often been used. Any change in growth or yield has been ascribed to the phosphates, the potassium or the nitrogen. The question now arises as to how much of this change in plant growth was due to the sulphur entirely apart from the other fertilizing constituents.

Correspondence with virtually all the experiment stations in the United States on the subject of sulphur as a fertilizer has elicited opinions which virtually all boil down to the following: Very many of our soils either contain enough sulphur for plant requirements or receive sufficient in the rainfall and other water. There are also very many soils on which sulphur would undoubtedly prove to be an advantageous fertilizer either because of a deficiency in sulphur or because sulphur during its oxidation would make available from the soil other needed plant foods. Work is either under way or in project in almost every experiment station in the country to obtain more knowledge on this subject, especially to find out what soils in each particular state have need of sulphur. It is probable that in time this may mean a tonnage market for sulphur, but when it is considered that there is today definite proof that the farmers of the country as a whole could use to their own profit at least ten times as much fertilizer as they do it will be realized that the building up of a tonnage use of any new fertilizer promises nothing large in the near future.

The greatest problem of the American sulphur industry at the present time is to obtain immediately available new tonnage outlets for sulphur. The solution of this problem would mean a continued prosperity to the sulphur industry and a continuance of low-priced sulphur for the greater chemical industry.

Mellon Institute of Industrial Research.
Pittsburgh, Pa.

Value of Magnesium Salts as Fertilizers

Magnesium plays an important rôle in the process of plant assimilation and it has been shown that the chlorophyll is an organic magnesium compound with a content of about 30 per cent magnesium. In a paper recently read before the German Chemical Society Dr. A. Jacob described the experimental work done during 1917-19 by the agricultural department of the Kalisyn-dicat on the influence of various magnesia-containing fertilizers on harvest yields and showed that potassium-magnesium sulphate and potassium chloride-kieserite ($\text{MgSO}_4 \cdot \text{H}_2\text{O}$) constitute efficient fertilizers for sandy and brackish soils.—*Chemical Trade Journal and Chemical Engineer*, Dec. 25, 1920.

^a*Pulp and Paper Magazine*, vol. 17, 1920, p. 998.

Physical Properties of Nickel

Compilation of Literature References and Original and Unpublished Work on the Various Physical, Mechanical, Thermal, Electrical and Optical Properties of Pure Nickel

By PAUL D. MERICA

Superintendent of Research, International Nickel Co.

THE density and specific gravity of nickel vary greatly according to its chemical composition, physical condition and the mechanical treatment which it has received. Metal which has been reduced by carbon, or carbon monoxide, to a powder or sponge contains numerous voids and may have a density as low as from 7.7 to 8.0, values which have been obtained for powder and rondelles, or grain nickel.

Dense nickel, such as electro- or malleable nickel, will vary in density from 8.70 to 8.90, averaging about 8.84, which may be taken as quite closely representing the bulk of commercial material. This corresponds to 552 lb. per cu.ft., or 0.319 lb. per cu.in. (8.84 g. per cu.cm.).

CHANGE OF STATE

The melting point of nickel is given by the Bureau of Standards¹ as 1,452 deg. C. The element undergoes a magnetic transformation, accompanied possibly by a phase change at from 340 to 360 deg. C.^{2,3} The transformation point in commercial nickel, containing impurities, is lower, usually in the neighborhood of 320 deg. C.^{3,4} The boiling point of nickel has never been determined.

The heat of transformation is 1.33 cal. per gram according to Wüst,⁵ and the heat of fusion 56.1 cal. per gram.

SPECIFIC HEAT

Wüst⁵ has recently determined the specific heat of nickel (analysis not given) from 0 to 1,520 deg. C. in cal. per gram per deg. C.; his results are given in Table I.

TABLE I. SPECIFIC HEAT OF NICKEL

Temperature	Mean Specific Heat $\frac{q_t - q_0}{t}$	True Specific Heat $\frac{dq}{dt}$
0		0.1095
100	0.1147	.1200
200	.1200	.1305
300	.1252	.1409
320	.1263	.1430
330	.1306	.1294
400	.1304	.1294
500	.1302	.1294
600	.1301	.1294
700	.1300	.1295
800	.1299	.1295
900	.1299	.1295
1000	.1298	.1295
1100	.1298	.1296
1200	.1298	.1296
1300	.1298	.1296
1400	.1298	.1296
1451 (solid)	.1298	.1296
1451 (liquid)	.1684	.1338
1500	.1673	.1338
1520	.1668	.1338

Jaeger and Dieselhorst⁶ determined the true specific heat at 18 and at 100 deg. C. of a sample of nickel

containing Co 1.36, Fe 0.44, Mn 1.04, Cu 0.15, Si 0.06. They find the following values:

At 18 deg. C. = 0.1065 cal. per gram per deg. C.

At 100 deg. C. = 0.1160 cal. per gram per deg. C.

Schimpff⁷ finds the following values of the mean specific heat of nickel containing 1.5 per cent Co, 0.6 per cent Fe and 97.9 per cent Ni:

At 17 to 100 deg. C., 0.1084 cal. per gram per deg. C.

At 17 to —79 deg. C., 0.0973 cal. per gram per deg. C.

At 17 to —190 deg. C., 0.0830 cal. per gram per deg. C.

THERMAL EXPANSIVITY

Guillaume⁸ finds the thermal expansivity between 0 and 40 deg. C. of five bars of commercial nickel to be represented by the equation:

$$\frac{\Delta l}{l_0 t} = (a + bt) 10^{-6}$$

in which the values of the coefficients a and b had the following values:

	a	b
1	12.66	0.0055
2	12.52	0.0066
3	12.49	0.0070
4	12.49	0.0079
5	12.55	0.0054

Tutton⁹ finds the following values of a and b for same equation, holding between 0 and 120 deg. C.:

$$a = 12.48, b = 0.0074$$

Between 0 and 300 deg. C. Harrison¹⁰ finds that the expansivity of "pure nickel" can be represented by the following equation:

$$\frac{\Delta l}{l_0 t} = (12.80 + 0.0075t + 0.000035t^2) 10^{-6}$$

Between 300 and 1,000 deg. C. Holborn and Day¹¹ give the following equation for the expansivity, as calculated from their measurement on a nickel of which no analysis is given:

$$\frac{\Delta l}{l_0 t} = (13.46 + 0.0033t) 10^{-6}$$

THERMAL CONDUCTIVITY

The best determinations of the thermal conductivity of nickel are those of Lees¹² on electrolytic nickel, and of Jaeger and Dieselhorst⁶ on nickel of composition 1.36 Co, 0.44 Fe, 1.04 Mn, 0.15 Cu, 0.06 Si. The values obtained by them are:

Lees:

$$K_0 = 0.140 \text{ calories per second per cm. per deg. C.}$$

$$K_{18} = 0.140 \text{ calories per second per cm. per deg. C.}$$

Jaeger and Dieselhorst:

$$K_{18} = 0.142 \text{ calories per second per cm. per deg. C.}$$

$$K_{100} = 0.138 \text{ calories per second per cm. per deg. C.}$$

Fig. 1, curve 1, gives the results of determinations of Lees¹² on 99 per cent nickel bar and curve 2 by Angell¹³

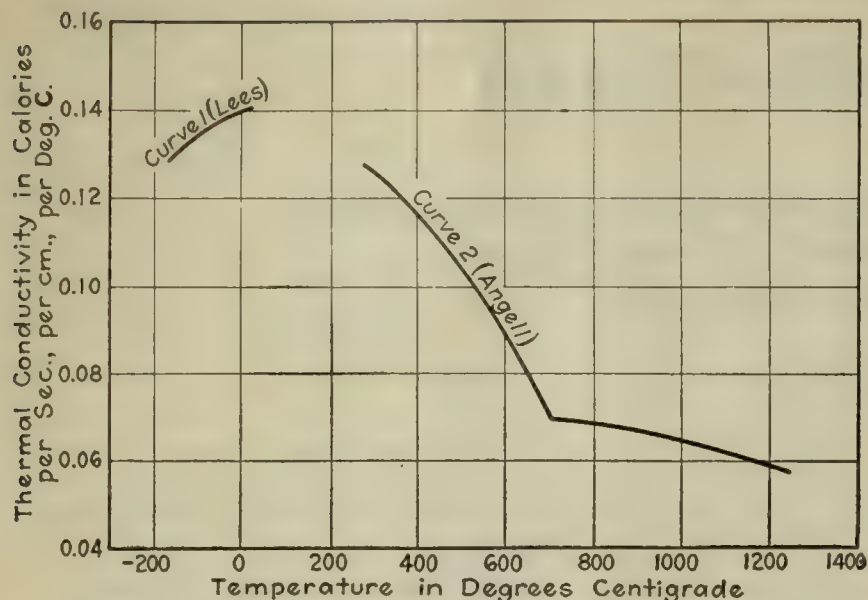


FIG. 1. THERMAL CONDUCTIVITY OF NICKEL

on a nickel rod from Boker (no analysis) of the thermal conductivity at higher and lower temperatures.

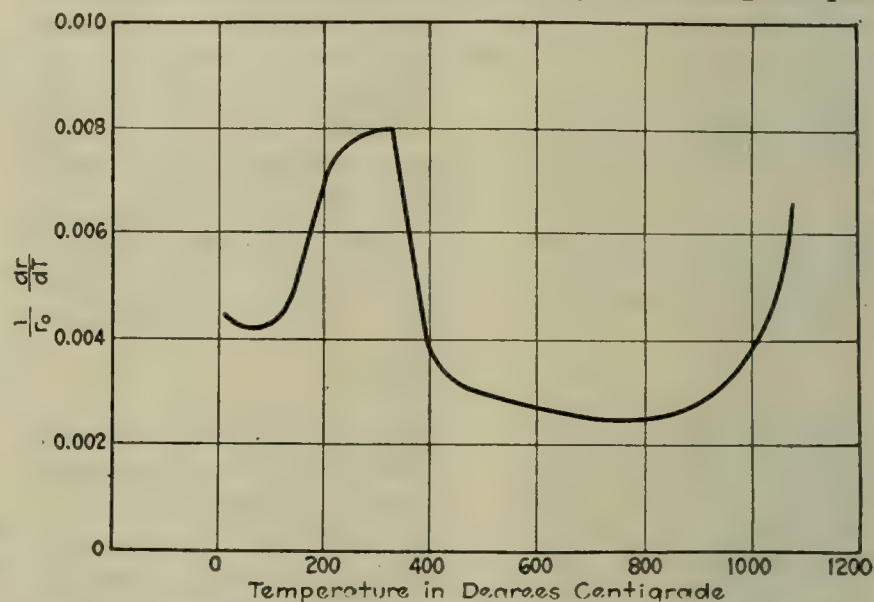
ELECTRICAL RESISTIVITY

A number of precise determinations of the electric resistivity of nickel have been made, but the nickel used was in many cases quite impure and the values of the resistivity so obtained are much higher than the value for pure nickel. Table II gives several of the values which have been observed.

The most probable value for the resistivity of pure nickel from these determinations is the lowest, that of Copaux; with this lowest value is associated also the highest temperature coefficient (also the most probable). Other values are higher due to the presence of impuri-

These are as follows: Curve 1 is by Lees,¹² on a 99 per cent Ni bar. Curve 2 is by Angell¹³ on a nickel rod from Boker (no analysis). Curve 3 is by Niccolai¹⁴ on Kahlbaum nickel (no analysis). Curve 4 is by Harrison¹⁵ on a "nickel wire." Fig. 3 gives the results of one series of determinations of the influence of temperature on the temperature coefficient of resistivity by Somerville.¹⁷ At the transformation point the resistivity-temperature curve changes its slope and there is a marked change in the value of the temperature coefficient.

The Driver-Harris Co. reports its 99 per cent nickel (Grade A) wire as having a resistivity of 64.3 ohms per mil-foot (10.68 microhm per cu.cm.) at 24 deg. C., with a temperature coefficient at 24 deg. C. of 0.0041. Other grades of malleable nickel of higher manganese content have higher values of resistivity and temperature coefficient; thus, Grade D nickel, containing 4.5 per

FIG. 3. TEMPERATURE COEFFICIENT OF ELECTRICAL RESISTANCE ACCORDING TO SOMMERVILLE¹⁷

cent Mn, has a resistivity of 20.0 microhm per cu.cm., with a temperature coefficient of 0.0020.

THERMO-ELECTROMOTIVE FORCE

The curves of Fig. 8 give the results of determinations of the thermo-electromotive force of nickel to platinum, lead, copper and silver. These are as follows:

Nickel against silver is, according to determinations of Hevesy and Wolff¹⁸ on nickel wire, no analysis given, furnished by the Vereinigte deutsche Nickel Werke. Ni: Pt is calculated from the preceding results on the Ni: Ag couple, together with those of Holborn and Day on the Ag: Pt couple. Ni: Cu is according to determinations of Pecheux²⁰ on nickel wire of the following composition: Cu 0.20, Fe trace, Co 0.15, C and Si none; total impurities 0.35. Ni to Pb is according to determinations of Dewar and Fleming²¹ on Mond nickel. The electromotive force developed is such that the current flows at the 0 deg. C. junction from the Ag, the Cu or the Pt to the Ni, when the emf. is positive.

MAGNETIC PROPERTIES

Nickel is ferromagnetic at ordinary temperatures and up to the temperature of its magnetic transformation,

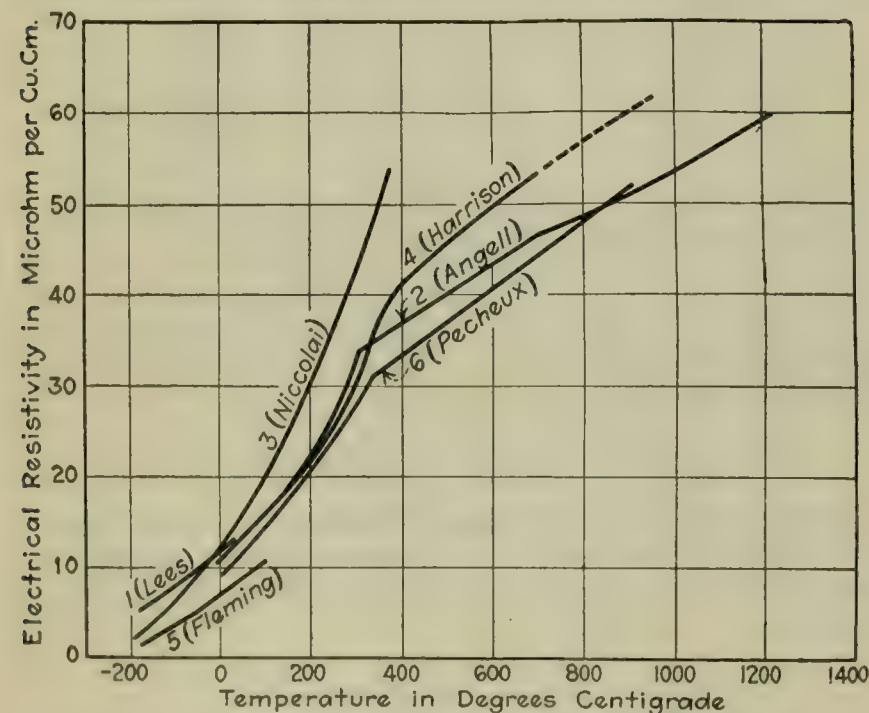


FIG. 2. ELECTRICAL RESISTIVITY OF NICKEL

ties which depress also the value of the temperature coefficient.

Fig. 2 gives the results of several determinations of the electrical resistivity at higher and lower temperatures.

TABLE II. ELECTRICAL RESISTIVITY OF NICKEL

Reference	Material	Electrical Resistivity Microhms per c.c.	Temperature Coefficient	Curve No in Fig. 2
Fleming ¹⁴	Electrolytic, no analysis given. Annealed in hydrogen and drawn into wire.....	6.926 at 0° C.	0.0061 (0-100° C.)	5
Copaux ²	Pure, reduced from oxalate, no analysis.....	6.4 at 0° C.	0.0066 (0-100° C.)	..
Campbell ¹⁵	Purchased in Germany in 1901.....	8.0 at 0° C.	..	..
Pecheux ³	0.20 Cu, 0.15 Co, no C or Si, trace Fe; 0.35 total impurities.....	9.0 at 0° C.	0.0058 (0-100° C.)	6
Ruer and Kaneko ¹⁶	Kahlbaum, 0.035 C.....	7.7 at 0° C.	..	..
Jaeger and Dieselhorst ⁶	1.36 Co, 0.44 Fe, 1.04 Mn, 0.15 Cu, 0.06 Si.....	11.76 at 18° C.	0.0044 (1-100° C.)	..

340 to 360 deg. C. Above this temperature it is paramagnetic and follows Curie's law.²² Fig. 5 gives the results of some magnetic tests of nickel. In this figure curve 1 shows the induction curve for malleable nickel (International Nickel Co.) containing Ni 98.82, Cu 0.18, Fe 0.46, Mn 0.27, C 0.11, Si 0.13, S 0.022, as determined by the Burrows method. Curve 2 gives the permeability curve for same material. Curve 3 represents the induction of nickel of unknown composition as determined by Perkins,²⁴ while curve 4 gives the induction of nickel of unknown composition reported by Ewing.²³

The susceptibility of nickel in any direction is markedly diminished by the application of a tensile stress and augmented by that of compressive stress in that direction.

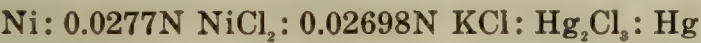
The permeability of nickel increases with temperature up to 300 to 340 deg. C. (Ewing²³).

SOLUTION POTENTIAL

The true reversible potential of nickel in a normal aqueous nickel sulphate solution is given by Schoch²⁵ as 0.48 volt, measured against the normal calomel electrode. Schoch attributes the higher values obtained by other investigators to occluded hydrogen.

Schweitzer²⁶ gives the value 0.612 volt for the potential of nickel powder in contact with N/1 NiSO₄ and 0.596 volt for nickel powder in contact with N/1 NiCl₂, both measured against the normal calomel electrode.

Measurement has been made by N. Isgarischew²⁷ of the potential of nickel against a solution of NiCl₂ in methyl alcohol. The combination was:



At a temperature of 25 deg. C. the potential difference was 0.247 volt.

Nickel becomes markedly passive—i.e., it behaves like a noble metal—to a greater degree than do other metals of high solution potential. This state may be established by simple immersion in strong oxidizing agents like nitric acid or bichromate solutions. This condition

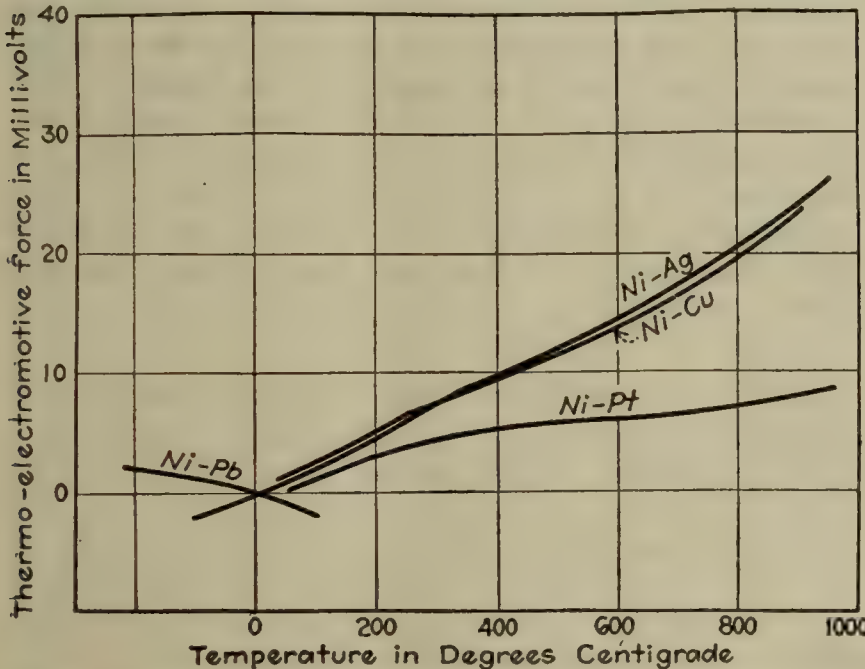


FIG. 4. THERMO-ELECTROMOTIVE FORCE OF NICKEL

of passivity may often be destroyed by slight changes in the chemical environment or by scratching or mechanical shock. Pure nickel as an anode is readily rendered passive in electrolytes containing salts of oxygen acids, especially at high current densities. The presence of impurities in the anodes as well as of the chlorides or fluorides in the electrolyte tend to prevent passivity.

Coincident with the establishment of passivity, there is a pronounced drop in the solution potential.

OPTICAL PROPERTIES

One of the most important commercial properties of nickel is its ability of taking and retaining a high polish and of reflecting a large percentage of light incident on such a polished surface. For example, this is one of the properties which make the metal valuable

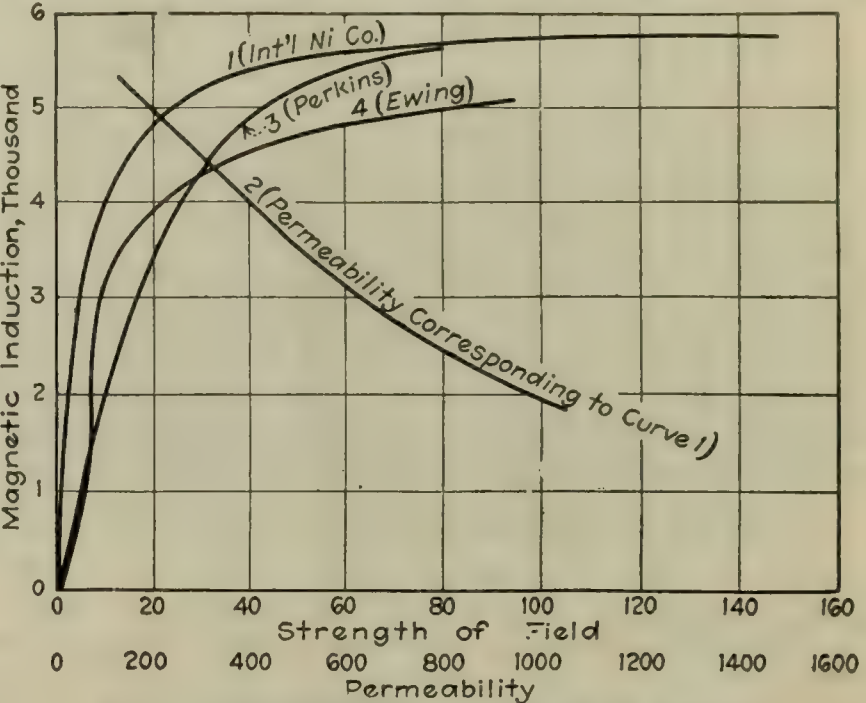


FIG. 5. MAGNETIC PROPERTIES OF NICKEL

for electroplating. In Table III are given the best values of the reflectivity of both nickel and Monel metal; those of the Bureau of Standards are recent (1920) and were obtained on samples of typical commercial rolled materials.

TABLE III. REFLECTIVITY OF NICKEL AND MONEL METAL

Wave Length of Light, Microns	Hagen and Rubens Values on Electrically Deposited Nickel, Per Cent	Bureau of Standards Values (1920) on Commercial Rolled Nickel, Per Cent	Bureau of Standards Values (1920) on Commercial Rolled Monel, Per Cent
0.42	56.6	61.5	57.7
0.50	60.8	63.2	59.0
0.55	64.9	64.0	60.1
0.60	68.8	65.1	61.6
0.65	68.8	67.1	62.8
0.70	68.8	68.5	64.5
0.75	68.8	67.2	67.2
0.80	68.8	72.5	72.5
1.00	68.8	83.8	83.8
2.00	68.8	88.7	88.7
3.00	68.8	91.0	91.0
4.00	68.8	91.0	91.0

TABLE IV. MODULUS OF ELASTICITY OF NICKEL

Temperature, Deg. C.	Modulus of Elasticity in Torsion, Kg. per Sq.mm.	Young's Modulus Kg. per Sq.mm.
20	7,300	22,000
27.5	7,300	21,300
96	6,430	20,300
110	6,860	17,800
200	7,390	15,700
222	7,120	11,900
300	7,120	11,900
329	7,120	11,900
400	7,120	11,900
401	7,120	11,900
465	6,080	11,900
600	4,940	11,900
800	3,730	11,900
1,000	2,900	11,900
1,200	2,480	11,900
1,300	2,480	11,900

Meyer²⁸ gives the following values for the other optical constants of nickel:

Reflectivity.....	=	65.5 per cent for $\lambda = 0.589 \mu$
Absorption index (K).....	=	3.42 per cent for $\lambda = 0.589 \mu$
Refractive index (n).....	=	1.58 per cent for $\lambda = 0.589 \mu$

ELASTICITY

According to determinations of Harrison,²⁹ Grüneisen,³⁰ Schaefer,³¹ Searle³² and Guillaume,⁸ the value of Young's modulus for nickel varies from 21,000 to 23,000 kg. per sq.mm. (30,000,000 to 33,000,000 lb. per sq.in.)

Koch and Dannecker³³ and Harrison²⁹ have determined the values of the modulus of torsional elasticity and of Young's modulus, respectively, at higher temperatures; their values are given in Table IV.

Poisson's ratio for nickel is 0.33 according to Benton³⁴.

HARDNESS

In the annealed condition the scleroscope hardness of nickel of low carbon (0.10 per cent) and manganese (0.30 per cent) will vary from 9 to 12, using a universal hammer. The Brinell hardness under 3,000 kg. pressure determined on the same material varies from 80 to 100. The effect of carbon and manganese on the hardness of annealed metal will be discussed in a subsequent article under the effect of impurities on nickel. When hardened by cold working the scleroscope hardness may be raised to 40 to 45, the Brinell hardness to 250 to 350.

TENSILE PROPERTIES

Table V gives the values usually obtained for the tensile properties of nickel of low carbon and man-

TABLE V. TENSILE PROPERTIES OF NICKEL

	Tensile Strength, Lb. per Sq.In.	Yield Point, Lb. per Sq.In.	Elongation in 2 In.	Reduction in Area
Rolled and annealed malleable nickel.....	65,000 to 75,000	20,000 to 25,000	40-50	40-60
Hot rolled rods.....	68,000 to 78,000	21,000 to 26,000	40-50	40-60
Sheet { Hard rolled.....	120-130,000	110-120,000	5-10	20-40
Annealed.....	65- 75,000	20- 25,000	40-50	40-60
Wire { Hard drawn.....	120-160,000	.....	.....	.....
Annealed.....	65- 75,000	.....	.....	.....
Cast nickel (deoxidized)...	55,000	20,000	25	.....

TABLE VI. TENSILE STRENGTH AT HIGH TEMPERATURES

Temperature, Deg. C.	Tensile Strength	Yield Point
21	38,000	23,800
149	40,900	25,100
232	36,700	25,100
315	35,900	22,900
399	36,600	22,600
460	28,500	.....
482	27,800	14,200
499	31,900	.....
538	16,800	.....

gane content in various conditions. These values refer to malleable A nickel of the International Nickel Co.

Table VI gives the results of tests by Bregowsky and Spring³⁵ of the tensile properties at higher temperatures of nickel of unknown purity.

²⁵Am. Chem. J., vol. 41, p. 208 (1909).

²⁶Z. Elektrochem., vol. 15, p. 607 (1909).

²⁷Z. Elektrochem., vol. 18, p. 568.

²⁸Ann. phys., vol. 31 (4), p. 1017 (1910).

²⁹Proc. Phys. Soc. (London), vol. 27, p. 8 (1915).

³⁰Ann. Physik, vol. 22, p. 801 (1907).

³¹Drude's Ann., vol. 5, p. 220 (1901); vol. 9, pp. 665, 1124 (1902).

³²Phil. Mag., vol. 49 (5), p. 193 (1900).

³³Ann. Physik, vol. 47, p. 197 (1915).

³⁴Phys. Rev., vol. 12, p. 36 (1901).

³⁵Proc. Int'l Asso. Testing Materials, 1912, Sec. 1, VII.

Prevention of Sugar Deterioration

The phenomenon of raw sugar deterioration is described in Bulletin 175 of the Agricultural Experiment Station of the Louisiana State University, Baton Rouge. A summary of the findings is as follows:

By the use of superheated steam in centrifugals it was possible to reduce the number of micro-organisms over 90 per cent, thereby eliminating one of the most important factors in sugar and molasses deterioration. This method is simple, economical and efficient.

A survey was made of the deterioration of a large variety of Cuban raw sugars during normal storage. The results show that the number of micro-organisms together with moisture ratio (or factor of safety) is the determining factor in sugar deterioration.

It was possible to predict from the above data whether or not deterioration would take place, thereby preventing serious losses.

Mold spores contain an enzyme capable of forming gum in sucrose solutions of all concentrations up to the saturation point.

The gum formed is levan, as indicated by its physical and chemical properties, having a specific rotation of -40 deg. a melting point of 200 deg. C., and forming levulose on hydrolysis.

The Invertase method has been successfully applied in the determination of true sucrose in the presence of gum. The gum may be quantitatively determined polariscopically by combining the Clerget and Invertase methods.

Levan is formed from nascent levulose and dextrose (obtained by the inversion of sucrose). There is evidence that the former is used to a greater extent in gum formation. In the absence of sucrose and nascent reducing sugars, slight gum formation was obtained with c.p. reducing sugars. Levan is not formed directly from sucrose, but may be formed when the latter undergoes inversion.

Appreciable concentrations of acidity or alkalinity inhibit the activity of levanase, the optimum reaction being about P_H 7.0.

Estimating Impurities From Melting Point Curve

Walter P. White, of the Geophysical Laboratory, has discussed the limitations and described the experimental procedure for using the freezing curve of nearly pure substances for estimating the amount of impurity. The results are independent of the true melting point of the pure substance and even of the absolute accuracy of the thermometer or pyrometer. In checking purity by the capillary method it is customary to work until further purification produces no change. This condition, of course, may occur when by decomposition, solution of containers or absorption from air, an attempted purification causes no change in a substance already nearly pure. Such a large source of error, as well as a heavy wastage of time, is eliminated by the new method. (*J. Phys. Chem.*, vol. 24, p. 393; May, 1920).

¹Bureau. Standards, Circ. 35 (1915).

²Copaux, *Ann. chim. phys.*, vol. 6 (8), p. 508 (1905).

³Pecheux, *Lumiere elec.*, vol. 10, p. 232 (1910).

⁴Guertler and Tammann, *Z. anorg. allgem. Chem.*, vol. 52, p. 25 (1907).

⁵Wüst, F., "Die Temperature-wärmeinhalt Kurven der technischen wichtigen Metallen." Forschungsarbeiten Gebiete Ingenieurwesens, No. 204 (1918).

⁶Wiss. Abhandl. Reichsanalt, vol. 3, p. 269 (1900).

⁷Z. physik. Chem., vol. 71, p. 257 (1910).

⁸L'Eclairage Elec., vol. 16, p. 287 (1898).

⁹Proc. Roy. Soc. (London), vol. 65, p. 306 (1899).

¹⁰Phil. Mag., vol. 7 (6), p. 626 (1904).

¹¹Ann. phys., vol. 4 (4), p. 104 (1901).

¹²Trans. Roy. Soc. (London), vol. 208, p. 381 (1908).

¹³Phys. Rev., vol. 33, p. 421 (1911).

¹⁴Proc. Roy. Soc. (London), vol. 66, p. 50 (1900).

¹⁵Elcc. Rev., vol. 48, p. 1014 (1901).

¹⁶Ferrum, vol. 10, p. 257 (1913).

¹⁷Phys. Rev., vol. 30, pp. 268, 532 (1910).

¹⁸Phil. Mag., vol. 3 (6), p. 177 (1902).

¹⁹Physik. Z., vol. 11, p. 478 (1910).

²⁰Lumiere elec., vol. 7, p. 137 (1909).

²¹Phil. Mag., vol. 40, p. 95 (1895).

²²Phys. Rev., vol. 9 (2), pp. 255, 394 (1917).

²³"Magnetic Induction of Iron and Other Metals," D. Van Nostrand Co. *Trans. Roy. Soc. (London)*, vol. 179A, p. 327 (1888).

²⁴Silliman's *Am. Journal*, vol. 30 (3), p. 218 (1885).

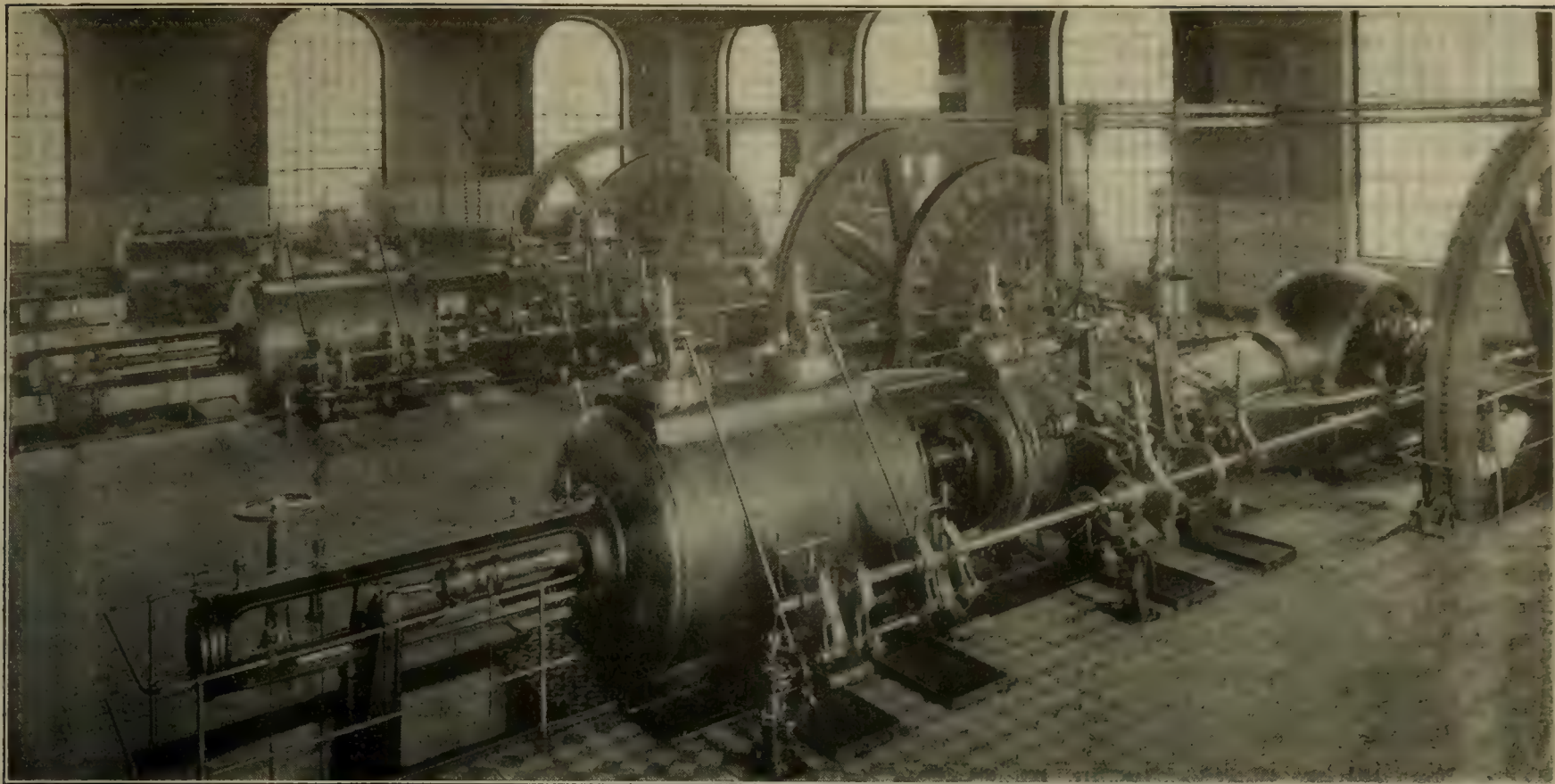


FIG. 1. GENERATING MACHINERY AT THE ELEKTROCHEMISCHE WERKE, BITTERFELD, GERMANY

Rise and Development of the Electrolytic Alkali and Chlorine Industry in Europe—I

An Outline of the Electrolytic Cells Employed in the Electrolytic Alkali and Chlorine Industry of the United Kingdom, Germany, Austria, France, Italy, Switzerland, Russia and Belgium

By JOHN B. C. KERSHAW

THE production, upon an industrial scale, of alkali and of free chlorine by the electrolysis of solutions of sodium or potassium chloride is now well established, for it is rather more than thirty years since the first successful installation of this kind was started by the Elektron Co., at Griesheim, near Frankfurt, in Germany. Today electrolytic alkali works exist and are being operated in all the leading manufacturing countries where the raw materials of the industry are found; and even those who control the operation of the old Le Blanc process of alkali manufacture in the United Kingdom have found themselves at last compelled by the force of circumstances and by the changing conditions of the trade and industry to adopt the newer method of decomposing salt.

It must be remembered, however, that although Germany was the first country to operate an electrolytic alkali cell successfully upon a commercial scale, the early experimental and pioneer work in connection with this new branch of chemical industry was carried out in the United Kingdom.

An Englishman (Sir Humphry Davy) in 1807 first employed an electric current to decompose a fused salt, and in this way separated and discovered the metals potassium and sodium. Another Englishman (Michael Faraday) in 1833 discovered and formulated the laws

that govern the action of an electric current in aqueous salt solutions and determined the electrochemical equivalent of various metals; and a third Englishman (Charles Watt) in 1851 applied for a patent which may be regarded as the master-patent of the electrolytic alkali and chlorine industry, since in this patent Watt described the conditions which must be observed in an electrolytic cell in which sodium or potassium chloride is being decomposed in order to obtain caustic hydrate, hypochlorite or chlorate.

Watt's patent (No. 13,755 of 1851) is of great historical interest; but at that date the dynamo had not been perfected, and as there was no practical means of obtaining large currents for electrochemical work, the electrolytic process of alkali and chlorine manufacture described by Watt remained dormant for another thirty-five years. Had Watt been able, however, to generate larger currents of electricity for his experimental work, he would have found that the production of alkali and chlorine in an electrolytic cell upon an industrial scale was not such a simple process as he had imagined, and that the choice of materials for and construction of durable anodes and diaphragms offered problems of considerable difficulty. The secondary reactions which occur in the cells between the chlorine ions liberated at the anode and the sodium or potassium

hydrate produced at the cathode also added considerably to the difficulties of manufacturing caustic alkali by this method.

Charles Watt in fact in his patent of 1851 recognized and referred to this possible cause of loss; but in spite of his warning, the inventors and exploiters of the Richardson and Holland type of cell failed to recognize or appreciate this difficulty; and it was owing to this defect that the first electrolytic alkali works built in the United Kingdom ended in a financial failure.

CLASSIFICATION OF CELLS

The cells now being operated industrially may be classified as diaphragm and non-diaphragm cells. In the former class a porous diaphragm, composed of cement, asbestos or other material unacted upon by the electrolyte (or by the ions produced by the electrolysis), is employed to separate the cell into two or more compartments; and in this way the chlorine liberated at the anode is to a large extent prevented from taking part in secondary reactions with the sodium or potassium hydrate formed at the cathode.

The "Elektron," Hargreaves-Bird, Outhenin-Chalandre, Basel, Billiter-Siemens, Nelson, Allen-Moore, Gibbs and Townsend cells are all of this type, the chief difference between them being in the construction or design of the diaphragm and in the arrangements made for withdrawing the sodium hydrate solution from the cathode compartment of the cell before it has had time to be decomposed by the electric current. The defects of all diaphragm cells are the higher voltage required per cell and the increased costs of maintenance due to the lack of durability on the part of the diaphragm.

For these reasons the other class—namely, non-diaphragm cells—have always attracted the electro-chemist, and many of these have been patented and tried. Only two types have survived industrial trial—namely, (1) the Castner-Kellner, Whiting and Solvay cells, which employ a moving mercury electrode in the cathode compartment of the cell, and thus produce an amalgam of sodium which can be removed from the cell before it is decomposed by water with formation of sodium hydrate; and (2) the "bell" type of gravity cell, which makes use of the different specific gravities of the brine and of the newly-formed sodium or potassium hydrate solution in order to effect a separation of the two. The Aussig "bell" cell and the Billiter-Leykam cell are the only two representatives of this class in actual operation; the Richardson and Holland cell, which was tried on a large scale at St. Helens in 1896-1900, having proved a failure.

The attempts to use molten lead in place of the more expensive mercury in the liquid or moving electrode cells have also failed, after trial upon an industrial scale; the wear and tear of the cell structure and the fire dangers with this type of cell having caused the suspension of operation of the Hulin cell at Les Clavaux in France, and of the Acker cell at Niagara Falls, in America. The works where the latter cell and process were operated in fact was burned down and has not been rebuilt.

Electrolytic Alkali and Chlorine Industry in the United Kingdom

The first attempt to carry out the manufacture of caustic alkali and chlorine by electrolysis upon a large scale in the United Kingdom was made at St. Helens in

1895 by a company named the Electro Chemical Co., with a capital of \$720,000. This company operated the Richardson and Holland bell type of gravity cell, and after a disastrous career of five years the works was closed down and the plant was sold in 1900 for the reasons already mentioned.

In the meantime the British Aluminum Co., of Oldbury, Birmingham, had been experimenting and developing the mercury cathode type of cell designed and patented by their chemist (H. Y. Castner) in 1892 and 1893; and in 1895-96 a company was formed and a works was planned for operation of what is now known as the Castner-Kellner process, at Weston Point, near Runcorn. This works started manufacture in 1897, and today is the largest and most successful electrolytic alkali works in the United Kingdom.

The Middlewich works, of what was originally the Electrolytic Alkali Co., was erected in 1899-1900, a very long interval having been allowed to elapse between the patenting of the Hargreaves-Bird type of diaphragm cell, in 1892-93, and its industrial development upon a large scale.

The last-named company and works have had a very checkered career, for at the end of 1910 they were forced into liquidation, and the plant, after lying idle for some time, was purchased for a comparatively small amount in 1914 by a new company (the Electro-Bleach & Byproducts Co.) and is again in operation.

In that same year the board of directors of the United Alkali Co., which controls the manufacture of alkali and bleaching powder by the Le Blanc process in the United Kingdom, decided to adopt and work an American type of electrolytic cell for the decomposition of brine and to gradually change over from the Le Blanc to the newer process. The outbreak of the war, however, delayed this change, and the large electrical generating station (the erection of which is now nearly completed) on the banks of the River Mersey, at Widnes, represents the first stage of this most interesting and striking development of the electrolytic process of alkali manufacture in the United Kingdom.

As the chairman of the company remarked at the annual meeting of the shareholders at which this change was announced, it was fortunate for the Allies that the change in the process of manufacture had not been made before the war broke out, since the large plants for sulphuric acid manufacture possessed by the United Alkali Co. were immediately placed at the disposal of the government in 1914 for the purpose of the war department, and the works at Widnes contributed a very large proportion of the concentrated sulphuric and nitric acids required for the production of high explosives during the period 1914-1918. Now that peace is once more restored, the delayed plans are being proceeded with, and it is expected that the first unit of the generating plant and of the connected installation of Gibbs cells will be in operation in the works of the United Alkali Co., at Widnes, before the end of this year.

THE CASTNER-KELLNER CELL AND PROCESS

The original Castner cell was constructed of slate, and was of comparatively small dimensions—namely, 72 in. long by 36 in. broad, and 6 in. deep. The cell is shown in sectional elevation in the diagram Fig. 2, and is seen to consist of three compartments, formed by two hanging slate partitions which dip into the

mercury lying on the floor of the cell. The solution of brine was fed into the two end compartments of the cell, which were completely closed and contained the anodes of graphite or carbon. The center compartment of the cell was open, and contained water. On passing an electric current of 1,300-1,400 amp. at 4½ volts through this cell, chlorine gas of exceptional

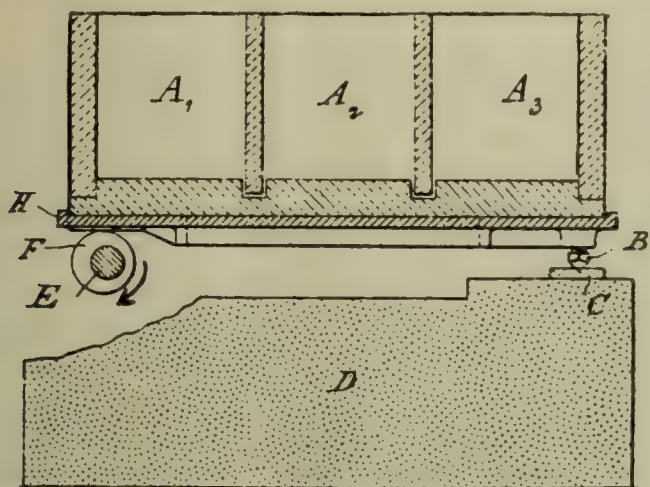


FIG. 2. THE CASTNER-KELLNER MERCURY CELL

purity, owing to the absence of OH anions, was liberated in the closed anode-chambers, and was conducted away; while the metallic sodium liberated at the surface of the mercury was at once absorbed by this and formed an amalgam. The cell was mounted with one end fixed and the other free, in such a manner that a slight but slow rocking movement could be given to the free end of the cell by means of an eccentric mounted upon a revolving-shaft which ran the whole length of the building in which the cells were placed; and the transfer of the sodium mercury amalgam from the anode-chambers of the cell to the central compartment, where it came into contact with water, was thus automatically effected.

The Kellner improvement of the Castner mercury cell consisted in making use of iron as the cathodic terminal of the cell in place of the mercury, a group of iron rods being so arranged in the central compartment of the cell that they were in electrical contact with the sodium mercury amalgam, and on treatment and decomposition of the amalgam by the water acted as the discharge point for the hydrogen gas. This improvement prevented the loss of mercury which had occurred due to the discharge of the hydrogen ions at its surface, and also reduced the emf. required to operate the cell, since the series $\text{Hg.Na-H}_2\text{O-Fe}_2$ pro-

duced a plus emf. The solution of sodium hydrate obtained in the central compartment of the cell was almost entirely free from chloride and could be concentrated to yield a very pure solid caustic without removal of the NaCl and other impurities by the usual "salting-out" process.

The original installation of the Castner-Kellner cells at Weston Point (Fig. 2) comprised 250 cells of the type just described, connected up in ten series of twenty-five cells each, the whole being supplied with electrical energy from 1,000-hp. steam-plant consisting of Willans and Robinson high-speed engines and Mather and Platt dynamos.

The works was quite successful from its start in 1897, and its record since that year has been one of continuous expansion of its manufacturing activity and of increasing profits for its shareholders. By 1905 the capacity of the plant had increased to 4,000 hp., and a change from steam to gas as source of electric power was inaugurated in that year by the erection of the first 800-hp. unit of a Mond gas plant, the original steam plant being scrapped as uneconomical and out of date.

The development of the manufacturing operations has proceeded even more rapidly during the last ten years. According to the latest official information, the works now (1920) has a total capacity of generating and decomposing plant of 25,000 kw. and the gas power plant, erected in 1907-1910, has been scrapped in its turn, in order to install a modern steam-turbine generating plant. In this new plant the boilers are of the Babcock & Wilcox marine type, having a steaming capacity of 34,000 lb. per hr., and generate steam at 200 lb. pressure for the turbo-generators.

THE SOLVAY CELL

The mercury cell now used at this works, however, is of another form from the earlier type, since the

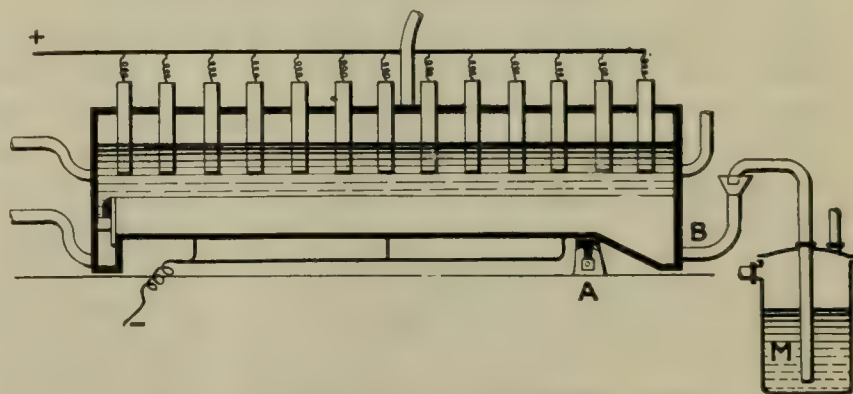


FIG. 4. THE SOLVAY MERCURY CELL

original Castner-Kellner cell described above was not adapted for operating upon a very large scale. According to Allmand, the cell now used is of the Solvay type, first employed at the Solvay works at Jemeppe in Belgium and worked there up to the outbreak of war. The cell (see Fig. 4) consists of a large slightly inclined rectangular cement trough, through which the mercury is circulated by means of an Archimedean screw. The brine flows through the trough from end to end in the same direction as the mercury, and carbon anodes are employed, terminating only 10 to 15 mm. above the surface of the mercury. The layer of the latter metal maintained on the floor of the cell is a very thin one, and the rate of movement is such that an amalgam of suitable concentration is obtained. This amalgam is decomposed in a separate vessel with the



FIG. 3. CASTNER-KELLNER ALKALI WORKS. ORIGINAL CELL ROOM AT WESTON POINT

aid of water, and the regenerated mercury is then returned to the electrolytic cell.

The cells at Weston Point take 4,000 amp. and make use of carbon in place of platinum as anode material. From 8 to 10 amp. of current is stated to pass per kg. of mercury employed in the whole cell.

The chief manufactures of this works during the war were pure alkali and liquid chlorine, the chlorine gas obtained from the mercury cell being exceptionally pure and therefore specially suitable for liquefaction. The manufacture of caustic potash of a very high degree of purity is another product; and metallic sodium is also

reason a mixture of steam and carbonic acid is blown into the cathode chamber of the cell; and these chambers, containing only steam and gas in place of any liquid electrolyte, are the distinctive feature of the Hargreaves-Bird cell. The cells were made of large dimensions, 5 ft. high, 10 ft. long and 14 in. wide, and decomposed about 224 lb. of sodium chloride per twenty-four hours. The current used was 2,000 amp. at 4½ volts.

As already stated, the first patents for the Hargreaves-Bird cell were taken out in 1892-93, and the cell received a very lengthy trial at Farnworth, near Widnes, before the Electrolytic Alkali Co. was formed, and a large works was erected at Middlewich, in Cheshire, in 1899.

The original installation comprised a steam-driven electrical generating plant of 2,000 hp. and eighty cells of the type described above. The anodes were built up from gas-carbon, by the method shown in Fig. 6. The cathodes were constructed, as already stated, of copper gauze, and were pressed tightly against the outer surface of the diaphragms, thus assisting to support these against the hydrostatic pressure of the liquid in the central (anode) compartment of the cell.

The construction of large and durable porous diaphragms, which could not be made too thick lest they should increase unduly the emf. required for working each cell, was one of the chief difficulties attending the operation of the Hargreaves-Bird process; the other was that carbonate of soda was not so profitable to manufacture as caustic soda. For these and other reasons the Electrolytic Alkali Co. was not able to earn adequate profits upon its capital, and as already stated it was obliged to cease manufacture and to go into liquidation about ten years ago.

The new company, entitled Electro-Bleach & By-

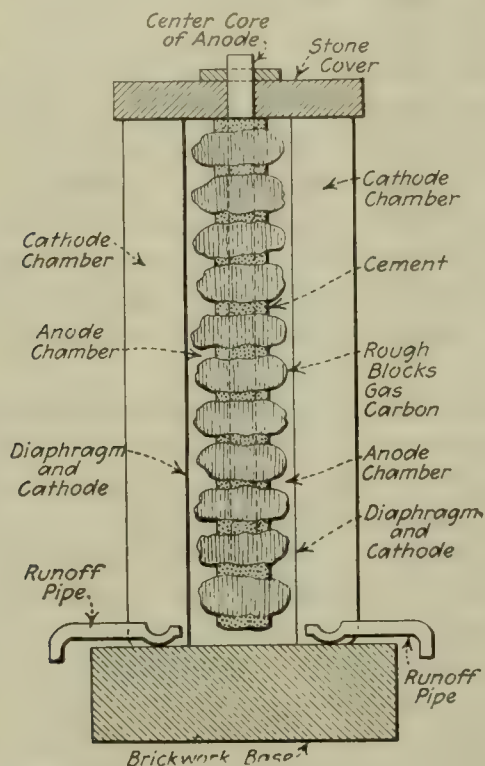


FIG. 5. VERTICAL SECTION OF HARGREAVES-BIRD CELL

manufactured by the electrolysis of fused caustic soda, according to the method patented by Castner in 1890.

THE HARGREAVES-BIRD CELL AND PROCESS

The Hargreaves-Bird cell differs from the Castner-Kellner and Solvay cells in nearly every respect, for it is of the diaphragm type and contains liquid only in the closed central anode compartment or chamber. The construction of the cell may be best understood by reference to Fig. 5, which is a vertical cross-section of the cell, somewhat diagrammatic in form. The inner chamber contains the anodes, which are built up from blocks of gas-carbon; it is entirely closed, and is fed with a solution of common salt or (as at Middlewich) with natural brine from the salt-beds, after a preliminary treatment to remove impurities. It is closed on each side by a porous diaphragm, strengthened on its outer side by a screen of copper-gauze, which also functions as cathode of the cell. The two outer cathode chambers contain no liquid beyond the condensed steam and CO_2 gas, which is passed into these chambers and removes the soda as it forms upon the surface of the wire gauze cathodes. This solution trickles down the cathodes and is drawn off at the base; a solution containing from 10 to 16 per cent sodium carbonate is obtained.

It has been found more economical to produce carbonate of soda than caustic soda in this style of cell, since the union of carbonic acid gas with the sodium hydrate at the surface of the cathode produces a plus emf. and also assists in removing the sodium hydrate as it is formed from the action of the current. For this

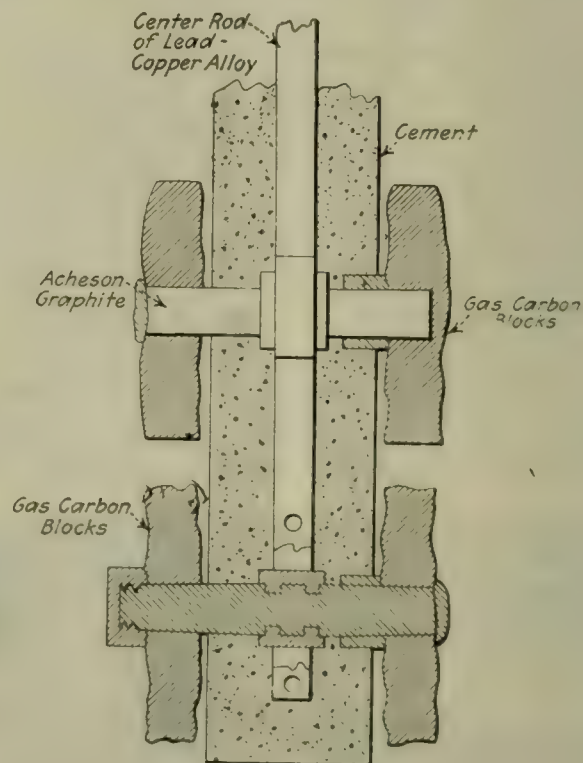


FIG. 6. ANODE OF HARGREAVES-BIRD CELL

products, Ltd., which purchased the plant in 1914 at a very low price and remodeled a large portion of it, still operates the Hargreaves-Bird cell and process at Middlewich in all essentials as described above. The cells, however, are now constructed of iron, lined with cement, and are built of 2,500 amp. capacity. The electrical generating machinery has been increased to

a capacity of 7,000 kw., and a change has been made from the use of high-pressure steam to low-pressure steam in certain of the processes, resulting in a very large economy. To enable the steam to be employed to the best advantage non-condensing reciprocating engines, direct-coupled to the generators, have been installed; while the additional power required is made up by condensing turbines. A further change made has been to increase the pressure of steam for the turbines from 150 to 210 lb., the steam being superheated to a temperature of 450 deg. F. The boiler-plant consists of seven large Babcock & Wilcox boilers, working at a pressure of 210 lb. and carrying a superheat of 150 deg. F. The plant within the power house consists of four reciprocating horizontal non-condensing steam engines driving direct-current generators, and three turbine sets, which by means of speed-reduction gearing drive also direct-current generators. The greater part of the current is employed for electrolytic work and is generated at the comparatively low emf. of 150 volts.

During the last five years, or since its inception, this company has been operating under the war conditions of inflated prices and has been able to earn very satisfactory profits for its shareholders. Whether it will be able to do so under the post-war conditions of trade and industry remains for the future to disclose.

Its products are bleaching powder, carbonate of soda, caustic soda, hyposulphite of soda and vacuum salt.

The managing director of the company in a recent letter stated that he has from time to time compared the results obtained by other types of cell with those obtained by the Hargreaves-Bird cell, and that he is satisfied that with the improved type of cell now employed the Hargreaves-Bird cell can easily hold its position.

The controlling interest in this company and in the Castner-Kellner Co. has now been obtained by Brunner, Mond & Co., which by an exchange of shares with the holders of the ordinary share capital in the two electrolytic alkali companies has secured the amalgamation of these two undertakings with its own larger firm.

THE GIBBS CELL AND PROCESS

The Gibbs cell is of the vertical diaphragm type, and in this respect resembles the Hargreaves-Bird cell. The cell and diaphragm, however, are constructed of cylindrical form, in order to obtain greater strength in the diaphragm; and the cathode which surrounds the latter is constructed with a number of inward projections or points, which are imbedded in the diaphragm and thus reduce its electrical resistance.

Both faces of the diaphragm are submerged, and in this respect also the cell differs from the Hargreaves-Bird cell.

The construction of the cell will be understood from Fig. 7, which gives the sectional elevation and is reproduced from the English patent of 1907. The combination of diaphragm and cathode is seen in section at the points marked 8 and 9, the diaphragm being made thicker at the bottom than at the top, in order to contract the increasing rate of percolation of the brine from the anode chamber due to hydrostatic pressure. The diaphragm may be made of asbestos or any other suitable material which is permeable and is not attacked by the brine or by the products of the electrolysis. The cathode jacket may consist of a sheet of steel or other

suitable metal, held in place by clamping bands or by other means.

The projections and indentations of the cathode plate which form the novel feature of the Gibbs cell are obtained either by simply punching holes through the annular sheet and then pressing it round the diaphragm with the rough edges on the inside or the sheet may be corrugated longitudinally and pressure be used again to force the projecting ridges of metal into the material of the diaphragm. According to the patent specification, the special advantages of this form of cathode

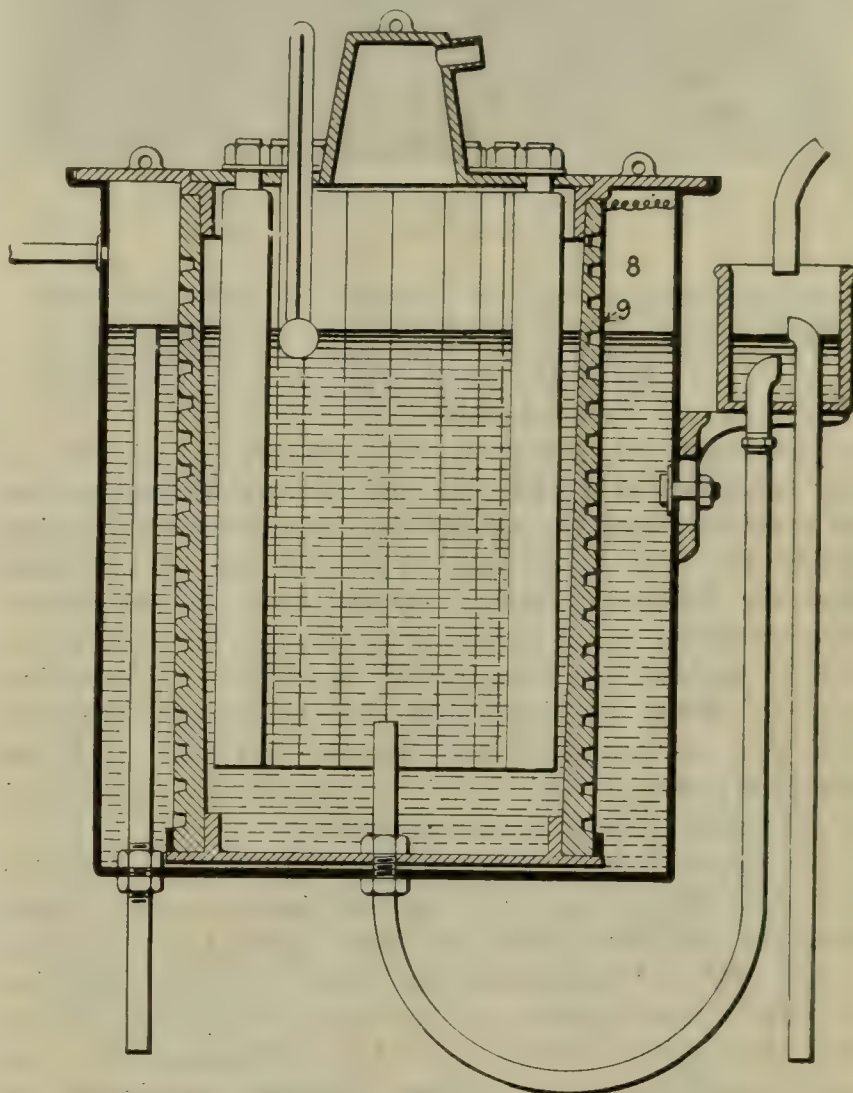


FIG. 7. THE GIBBS CELL

result particularly "from the same having points or projections entering the diaphragm" and also from the creation of "take-off" chambers or cups, which remove the caustic soda formed in their interior from the action of the current, and thus reduce the electrical losses due to the liberation of OH anions.

A further advantage claimed for this type of diaphragm is that the same permeability can be maintained for a very considerable time, whereas according to the patentee the permeability of the ordinary diaphragm decreases gradually, owing to clogging of its pores with the impurities of the electrolyte.

The following description of the action of the points on the cathode is taken from the patent specification:

As the solution passes outwardly through the diaphragm where alkaline chlorides are treated, the caustic alkali will form upon the projections or points of the cathode. The bulk of the electrolysis takes place at these points or projections, and as the caustic alkali is formed, the flow of electrolyte carries it outwardly through the holes in the cathode and out of the region of electrolytic action. By thus carrying it away as it is formed, I avoid decomposing of the caustic alkali itself, and increase the efficiency of the cell.

In the case of the cathode having the vertical passages, the liquid will flow either up or down along these passages and obtain the same result of carrying away



FIG. 8. UNITED ALKALI CO.'S PLANT AT WIDNES, UNDER CONSTRUCTION (EARLY IN 1920)

the products as they are formed. In both cases the electric current will flow mainly to the points or projections imbedded in the diaphragm, and there will be little or no electrolytic action in the troughs or portions more remote from the anodes.

The outer body of the cell is constructed of iron or any other suitable material, and the carbon anodes are securely fastened to the annular heavy flat ring which forms the top of the cell. This top can be removed, together with its attached carbon rods, in one operation by means of an overhead traveling crane when the cell is undergoing cleaning or repairs. The annular ring to which the diaphragm and cathode are attached can also be removed in a similar manner, and the rapidity and ease with which the cell can be dismantled is considered one of its good points.

No figures for its current or energy efficiency or for the strength and purity of the chlorine and caustic soda solution produced have yet been published; but the Gibbs cell had been used for some years in America by the Pennsylvania Salt Co., at Wyandotte, Mich.; and the United Alkali Co. before adopting it for its new installation at Widnes became convinced by exhaustive tests there and elsewhere that the claims made for it can be substantiated.

PROXIMITY TO WATER SUPPLY MORE IMPORTANT THAN NEARNESS TO FUEL SUPPLY

Fig. 8 shows the power station which is now under construction at Widnes for the supply of electrical energy to the new plant. The station is situated on the banks of the River Mersey, near the L. & N. W. Ry. bridge connecting Widnes and Runcorn. The site is convenient for fuel supplies and for disposal of ashes; and, being situated on the banks of the River Mersey, a full supply of cold water is always insured. Experience has shown that an abundant supply of condensing water is even more important than proximity to coal-supply, the transport of fuel being a much cheaper proposition than the transport of condensing water or the use of cooling towers. The station has therefore the great advantage of an ample supply of condensing water.

The boiler house will be equipped with eight Babcock & Wilcox boilers, provided with up-to-date mechanical coal and ash-handling plant.

(The second part of the article, dealing with the Electrolytic Alkali and Chlorine Industry in Germany and Austria, will be published in a subsequent issue.)

Industrial Possibilities of Chia Seed Oil

A new drying vegetable oil said to rival linseed oil is claimed to have been discovered and patented by Sebastian Lomanitz, of Bryan, Tex. He states that a plant chia, belonging to the genus *Salvia* and known as *Salvia hispanica* of the *Labiatae* family, yields a seed the oil of which has all the good properties of linseed oil, even the odor. The seeds of chia are used for the preparation of a beverage which is sold publicly in the streets of Mexico. There are a number of varieties of such seeds.

The chia plant is a shrub that reaches about 5 to 6 ft. in height and the seeds are oval shaped, about 1 mm. in the longest diameter and about $\frac{1}{2}$ mm. in the shortest diameter. The yield per hectare varies between 4,000 and 1,000 kg. and in certain parts of the country two crops a year may be obtained. It is remarkable that in all classic books on vegetable oils, such as those by Lewkowitsch, Chershefsky, Beilstein and Abderhalden, there is no mention whatever that oil can be derived from this species.

Experiments performed with seven varieties of seed gave the following results: Average weight of 1,000 seeds, 1,166 g.; moisture, average, 7.33 per cent; oil average inseed, 32 per cent.

It will be noticed that the yield of oil from chia seeds exceeds the yield of oil from linseed. The test of oil obtained from seeds coming from different parts of the country gave the following data:

Sp.gr. 15.5/15.5.....	0.9341
F. F. A. (as oleic).....	1.45
Index of refraction n_D 40 deg. C.....	1.4757
Index of refraction n_D 17.5 deg. C.....	1.48354
Reichert-Meisel number	0.1
Iodine value	187.59
Hehner value	94.16
Ester value	187.49

The oil remains fluid at low temperatures, similarly to linseed oil. The residue left after the extraction of the oil was found to contain substantially 30 per cent protein and could be utilized as a valuable cattle feed.

Particular attention is called to the specific gravity of the oil, to the index of refraction, the iodine value and the Reichert-Meisel value and also the fluidity at temperatures below normal, all indicating the close relation in drying qualities between this vegetable oil and that derived from linseed. The iodine value, which is the index of the drying qualities of the oil, is substantially that of the best linseed oils.

While it is possible to derive only 29 per cent of oil from linseed, it is possible to obtain about 33 per cent of oil from seeds of chia, the method of extraction being in no way more difficult than that of linseed oil. The great yield of oil from chia seeds and the value of the residue reduce considerably the price of the finished product. In view of the fact that two crops a year may be obtained, it is natural that the oil could be manufactured at a cost considerably lower than linseed oil.

Mr. Lomanitz has introduced this seed into Texas, growing it in Houston and Bryan on a small scale with a yield of about 20 bu. an acre. He harvested the crop by hand, picking out the spikes which contain the seeds and getting out the seeds from their tiny envelopes by rubbing them against a wire screen, sifting and blowing off the chaff.

The seed is very small and it is estimated that about 5 lb. would plant an acre.

American Association for the Advancement of Science, Chicago Meeting

Notes on Papers of Interest to Chemists Which Were Presented at Chicago — Phosphorescence, Fluorescence, Activated Sludge, Single Potentials, Crystalloid Filters, Ionization and Resonance Potentials, and the Theory of Chemical Reactions

CHICAGO UNIVERSITY entertained the annual meeting of the American Association for the Advancement of Science during Christmas week with representatives from sixteen branches of science ranging from mathematics, physics and chemistry to geology, medicine and education.

GENERAL SESSIONS

Robert W. Wood gave a lecture Wednesday night on "High-Power Phosphorescence and Fluorescence," in which he defined a phosphorescent body as one which when subjected to light rays, or perhaps to ultra-violet invisible rays, itself becomes luminous and continues to emit light after the excitation has been removed. It is possible that all solids have this property, but if so most of them have periods of self-luminosity following excitation so short that they cannot be detected by present methods. A high-power apparatus has been devised which generates ultra-violet rays of singular intensity, yet invisible to the ordinary eye. They have been used for the purpose of naval signaling, in particular for finding invisible running lights for convoys. The rays are detected at the receiving point by means of a wide angle telescope with a screen which phosphoresces under the influence of the ultra-violet rays from the signaling apparatus. A similar device is of use in cancer hospitals for diagnosing pathological condition in tissues by phosphorescence.

Two lamps were exhibited which made the entire audience and auditorium phosphorescent. Faces became self-luminous with a gray tint, teeth with bright blue, while artificial teeth remained an inky black. Different dress materials phosphoresced with different colors corresponding to the properties of their various dyes, the lenses of the eyes became themselves phosphorescent, emanating rays of a light blue or lavender color.

A fluorescent body is one which receives light rays of one type and, as a result of the excitation so produced, re-emits light of a different character. There are, for example, substances which when illuminated by red light give out again rays which are green. Some varieties of red ink show this property slightly. Prof. Wood has demonstrated that fluorescence of this character is always accompanied by a chemical decomposition of some sort in the fluorescent substance. A particular example is rhodamine, which when first illuminated with blue light produces orange red. Later it gives green, and at a first stage in its chemical transformation it becomes non-fluorescent.

CHEMISTRY SECTION

Some Properties of Activated Sludge, by A. M. Buswell and C. C. Larson.—It is known from published analyses that the quantity of nitrogen in septic tank contents varies from 1 to 3 per cent, in intermittent

filter contents from 1 to 4.5 per cent, while activated sludge has from 4.5 to 6.5 per cent nitrogen content, making it useful as a fertilizer. This activated sludge is in general produced by blowing air through the sewage, causing the milkiness to disappear and the sludge to flocculate. If the material is not handled quickly, it soon decomposes again to a putrescent mass which cannot be used. It is filtered or centrifuged to remove 85 per cent of the water and then dried by heat. Acidification is beneficial to the filtering process, as it tends to cause the solids to contract. Acid also prevents the material from becoming septic and so allows slow separation by gravity. One-third of the amount of acid determined by titration with methyl orange indicator is actually necessary, for it has been found that the action depends on the intensity or H-ion concentration rather than the capacity factor.

On the Single Potentials of Arsenic and Its Position in the Electrochemical Series of Metals, by Louis Kahlenberg and Vernon Steinle.—The electrodes used were solid arsenic, arsenic plated on gold and platinum and the arsenic mirror from AsH_3 plated on a glass tube. Powdered arsenic was pressed to a bar and coated with paraffine. Finely divided metal was imbedded in gelatine or cellulose acetate. The single potentials secured were as follows:

With sawed piece of arsenic.....	—0.554 volts
and.....	—0.553 volts
With paraffine coated piece.....	—0.549 volts
With arsenic mirror.....	—0.552 volts
With pressed stick of arsenic	—0.548 volts
With powder in gelatine.....	—0.544 volts
With powder and cellulose acetate on platinum	—0.551 volts
On gold	—0.554 volts

Membranes for Separating Crystalloids From One Another, by Louis Kahlenberg.—There is no record in the literature where crystalloids in aqueous solution are separable by a membrane. The author found that a membrane prepared from thin china silk dipped in melted lanoline, the fat from sheep's wool, will separate sugar from salt or potassium iodide in aqueous solution.

An Attempt to Activate Chlorine Photometrically, by Gerald L. Wendt.—In line with the research work carried out by the author where he successfully prepared activated or ozone forms of nitrogen and hydrogen by the brush electric discharge, he has unsuccessfully attempted the same with chlorine, using mercury electrodes. The next step was to set up an apparatus consisting essentially of an ultra-violet light in a central glass tube surrounded by a second glass tube to form an annular space through which dry chlorine was passed and subsequently conducted into the dark, where it was mixed through a three-way cock with hydrogen. Tests of the mixed gases showed that no HCl was found. In other words the chlorine was not activated. The two

gases were inert compared to Draper's experiments where rapid combination is secured by exposing the mixture to light.

PHYSICS SECTION

The American Physical Society co-operated in presenting some valuable papers having a bearing on chemical topics.

The work done by such physicists as Dr. Foote and Dr. Mohler of the Bureau of Standards in determining the "Ionization and Resonance Potential" of various chemical elements and compounds is going to be very valuable to the chemist in obtaining a more intimate insight into the mechanism of activation which precedes all chemical reactions. Most chemical reactions, especially those involving carbon compounds, are not accompanied by actual ionization, so that the resonance potentials are apt to be more valuable from our standpoint. When the electron hits a molecule in such a way that its energy is absorbed, probably by the displacement of a valence electron, and the absorption is measured, the quantity is known as its resonance potential. This corresponds to a state of activation which may result in chemical action. Thus zinc ethyl has a resonance potential of 7 volts and an ionization potential of 12 volts. Carbon monoxide has a whole series of resonance potentials indicating several degrees of activation.

From the chemical standpoint this means that during the first stage it might react with chlorine or ozone. During a second stage it might react with the more active oxygen molecules and when at some of the higher stages it might react with some form of hydrogen to form formaldehyde. At all events something of the sort does take place in the leaves of plants, carbon dioxide being reduced and combined with hydrogen to form formaldehyde. This suggests a possible artificial synthesis of carbohydrates.

Another interesting thing noted by these gentlemen was that the vapors of sodium or potassium chloride at 2 mm. pressure are highly ionized, while metallic calcium vapor is not ionized. Does this mean that these salts are ionized at the same time that evaporation occurs? According to Langmuir they are already ionized in the solid crystal, and on evaporation, while there is a tendency to form pairs, there is also a tendency for some of the ions to stay apart as they do in solutions. In the calcium vapor there is nothing to remove the electrons from the metallic nucleus as there is in the salts where chlorine has a far greater attraction for the valence electron than has the metallic nucleus.

Dr. Davey, of the General Electric Co. Research Laboratory showed how X-ray crystal analysis confirmed Langmuir's postulates as to atomic structure. Langmuir has shown how the Cl^- ion and the K^+ ion have the same outer shape as the argon atom, so that all are isoteric. As each of these has eight electrons in the outer shell, they should be cubical. As a matter of fact all crystals of all the alkali halides are cubical. In a similar manner the alkaline earth oxides and sulphides are usually cubical. The iron atom having eight electrons in its outer shell is cubical. Then the Ni^{++} ion should have the same shape, making NiO a real cube, as it is. The Tl^+ ion and Pb^{++} ion lack six electrons of completing the stable arrangement corresponding to the inert gas, niton, so that they should have a cubical shape with rounded corners. This results in the formation of cubical crystals of TlCl and PbS .

A. J. Dempster of Chicago University, using the

apparatus described in *Physical Review*, April, 1918, has shown that magnesium consists of isotopes of atomic weight 24, 25 and 26 as referred to nitrogen of molecular weight of 28.

An entirely new method for the determination of isotopes has been developed by F. W. Loomis of New York University. By observing the infra-red absorption spectra of various gases with a high degree of dispersion he has shown that bands due to hydrogen chloride contain two peaks corresponding to chlorine of atomic weights 35 and 37. Fluorine and bromine do not show any isotopy by this method.

Dr. Farrington Daniels of the University of Wisconsin gave a very able summary of the present status of the radiation hypothesis of chemical reactions which is receiving attention in this country from men like Langmuir and Tolman [*J. Am. Soc.*, vol. 42, pp. 2190, 2506 (1920)]: The first part of his discussion was presented at the Chicago meeting of the American Chemical Society [*CHEM. & MET.*, vol. 23, p. 563 (1920)]. Daniels has shown that the decomposition of nitrogen pentoxide is monomolecular in gaseous condition and also when dissolved in carbon tetrachloride even at 15 atmospheres pressure. He has calculated the heat necessary for activation and compared it with the total black body radiation at temperatures from 20 to 100 deg. C. At the higher temperature there is not enough radiant energy to produce the actual activation observed. These facts are unfavorable to the radiation hypothesis.

OTHER SECTIONS

Among the excellent papers given at other sectional meetings was one presented by Frank B. Dains of the University of Kansas before the section of Historical and Philological Sciences entitled "Applied Chemistry in Prehistoric and Classical Times." Chemical information was current in considerable amount about 2,000 years ago, but remained without much development until the time of Paracelsus, 1,400 years later. Chemistry is said to begin when copper and tin were mixed together in certain proportions by weight to make bronze, but really began when ores were first smelted to produce metals, or even before, when fire was discovered—or perhaps when man or animal first breathed, or perhaps, in Biblical terms, In the beginning, when God created the universe. Investigations in the valley of the Nile revealed a complete plant equipped with crushers, concentrating tables and cupels for producing metallic gold. Mercury was derived from artificial HgS about 1000 B.C.

Iron was probably first produced in Asia Minor. The Romans had blast furnaces similar in shape to the present-day furnaces but the metal was not completely melted. The mass was alternately heated and hammered to produce the crude metal.

Zinc and tin were made about the time of Paracelsus. Lead was used in Rome for piping water, for coffins and for household utensils. Copper and antimony were known in antiquity, as were red and yellow sulphides of arsenic. The historical development of the Mediterranean nations was in direct proportion to the development of their technical arts.

While it is well to study the literature for the history of chemistry, even more may be gleaned by making analyses of ancient products. Such work reveals the ancients' knowledge of indigo and alizarin dyes. Analyses of ancient glasses and ceramic ware may throw new light on their work. Historical research, then, should look to the analytic methods.

British Chemical Industry

(FROM OUR LONDON CORRESPONDENT)

London, Dec. 13, 1920.

THE chemical trade is, as usual at this time of the year, inclined to be slow, but the slackness has been accentuated by the adverse conditions prevailing in the cotton, paper, leather and other trades. Heavy chemicals are maintaining their price well in spite of foreign competition and in most cases are still far above the actual cost of manufacture.

DYESTUFFS BILL APPROVED BY PARLIAMENT

The dominant feature of the past month has been the dyestuffs campaign, culminating in a partly agreed bill which, like nearly all British safeguards and expedients, will, it is hoped, save the industry literally at the eleventh hour. Under the terms of the bill the importation, subject to a system of licenses, of all synthetic organic dyestuffs and colors and of intermediates used in their manufacture is forbidden for a period of ten years. The Board of Trade is the licensing authority and is to act under the guidance of an advisory committee comprising five users, three manufacturers and three members of the public. The merchant is apparently left out in the cold, but will derive comfort from the fact that the act does not apply to goods for re-export.

Apart from the natural doubts and misgivings with which this last-minute compromise has been received by the cotton trade and other users, many important sections of the chemical industry are greatly troubled in regard to the possibility of a very wide interpretation of the term "organic intermediate products." Some of the products which may fall within this category may have only a restricted use for dyestuffs and the like as compared with their consumption in the chemical and allied industries as a whole. The infant fine chemical trade in particular, which in the past manufactured completely only a small proportion of the goods sold, seems to be particularly affected and efforts are again being made—probably too late—to put this industry also on an economically satisfactory basis.

BRITISH CELLULOSE Co.'s \$1,000,000 DEFICIT

As foreshadowed in these notes of September and October last, the facts and figures presented at the second annual meeting of the British Cellulose Co. held last month are not encouraging. The change over from war to peace conditions has proved a very slow business and for its future prosperity the company seems to rely mainly upon the success of its artificial silk processes. The deficit is quite comprehensible in view of the fact that production has hardly commenced, but even now there seems no prospect of achieving the production originally promised, although the chairman stated that with a one-ton-per-day plant in commercial operation the loss in trading would cease. The problem of dyeing cellulose acetate silk satisfactorily under all circumstances does not yet appear to have been solved, but this is perhaps only a matter of time and experience. Meanwhile much stress is laid upon its special insulating properties, which are stated to be several times greater than those of natural silk. The general feeling seems to be that the cellulose acetate industry will ultimately be firmly established, but meanwhile the enor-

mous value—about \$7,000,000—placed upon good will and patents is having a deterrent effect upon the average investor and it certainly seems difficult to justify.

FAILURE OF INJUNCTION AGAINST BRUNNER, MOND

It will be remembered that the proposal of the directors of Brunner, Mond & Co., Ltd., to devote \$400,000 in aid of research was negatived at the annual meeting by a show of hands, but it was subsequently confirmed at a special meeting called for that purpose. A shareholder endeavored by process of law to oppose this decision on the ground that the directors had exceeded the powers conferred upon them by the articles of association of the company. Most of the large companies and corporations in this country have realized that money spent on scientific research and for the benefit of the chemical industry generally may be relied upon to pay good dividends and an adverse decision would have been most unfortunate. Moreover, the appeal for \$2,000,000, which is now to be launched for the establishment of a central home for the leading chemical societies and for an ambitious scheme of chemical publications was obviously dependent in some measure upon the support and generosity of the large chemical firms. It remains to be seen whether the legality of a donation to such purposes will also be called into question.

WAVE POWER TRANSMISSION

This novel form of transmission of energy was mentioned in a recent note (see CHEM. & MET. ENG., Nov. 10, 1920, p. 913). The details of this invention are difficult to describe in a short note and possibly the following supplementary particulars may therefore be welcome. If we imagine two cylinders fitted with plungers and connected together by a long pipe completely filled with water, this represents the simplest form of wave transmission. If one of the plungers is now moved rapidly up and down, it will set up at each downward stroke harmonic waves of compressed water, which, traveling along the pipe at high speed, will exert their energy on the plunger at the far end and if there is a suitable resistance to the movement of that plunger, a simple synchronous reciprocating motion will be produced. The two cylinders in their developed form are the wave generator and wave motor respectively of the previous note on this subject, but of course the actual development of this harmonic series of impulses into actual practical use is a more complicated matter than the above statement. The main underlying principle involved is really the fact that water is compressible. If a piston is forced under pressure into a pipe 1 in. in diameter and 500 ft. long by about $\frac{1}{4}$ in. in thickness, closed at the far end, the decrease in the volume of the water due to its being compressed is about seventeen times as great as the increase in volume due to the expansion of the pipe line under pressure. The net result is that the piston would enter the containing pipe for a distance of about 11 in. The resulting power wave when this principle is applied in suitable machinery enables practical use to be made of this harmonic motion, which offers an excellent analogy in many ways to alternating current practice in that their laws, formulas and conceptions are very nearly interchangeable. Readers who are more closely interested should write to W. H. Dorman & Co., Ltd., Stafford, England, who would no doubt be glad to give them full particulars.

Current Events

in the Chemical and Metallurgical Industries

Tariff Commission's Surveys of the Chemical Industries

When the Ways and Means Committee held its hearings on chemicals Jan. 6, 7 and 8 in Washington it had at its disposal comprehensive information regarding the complicated and extremely technical tariff problems of the chemical industry. This information was prepared by the United States Tariff Commission in the form of reports known as "Tariff Information Surveys," each of which presents, without suggestion of tariff policy or rates of duty, the main facts and figures pertinent to tariff legislation.

In general the survey follows a standardized form, consisting of a description of the article; uses to which it is put; methods and processes of its manufacture; notable divergences between American and foreign methods of production; the nature and source of its raw materials, and statistical data concerning domestic production, imports and exports, prices, and costs of production, as far as are obtainable, in the United States and in foreign countries.

Schedule A of the tariff act—chemicals, oils and paints—consists of seventy paragraphs, many of which contain provisions for several different products. In some cases the Tariff Commission prepared a single survey to cover a whole paragraph in the tariff act; in other cases, where a paragraph enumerates several unrelated articles, a separate survey was prepared for each article.

The hundred or more surveys of the chemical industry have been grouped into nineteen pamphlets, each of which has been published by the Ways and Means Committee of the House of Representatives, from whom they can be obtained on request.

1. "Acids of Paragraph 1 and Related Materials," includes surveys dealing with boric, citric, formic, gallic, lactic, oxalic, pyrogallie, tannic and tartaric acids, and all other acids and acid anhydrides not specially provided for in that section.

2. "The Wood Chemical Industry," includes surveys dealing with acetic anhydride, acetone, formaldehyde, acetic acid, wood alcohol, calcium acetate, charcoal, and tar and pitch from wood.

3. Paragraphs 4 to 9 inclusive. This includes aluminum and ammonium compounds, egg albumen, copaiba, Peru, tolu and other balsams, as well as the general provision in paragraph 5 for "all chemical and medicinal compounds, preparations, mixtures and salts, and combinations thereof not specially provided for in this section."

4. "Barytes, Barium Chemicals, and Lithopone," includes all of the barium salts in paragraph 10, crude barytes, ground barytes and blanc-fixe in paragraph 51, and lithopone in paragraph 60.

5. Paragraphs 11 to 17 inclusive. This includes blacking of all kinds, bleaching powder, caffeine and tea waste, mercurial preparations, chalk, and chemical and medicinal compounds containing alcohol or imported in capsules, pills, ampoules, etc. Liquid chlorine, whiting and paris white are also discussed in this pamphlet.

6. Paragraphs 18 to 26 inclusive. This includes chloral hydrate, salol, phenolphthalein, aspirin, thymol and other medicinals, chloroform, carbon tetrachloride, cobalt oxide, collodion and pyroxylin plastics, and coloring for brandy, wine, etc. Sulphur chloride is also discussed in connection with the surveys of chloroform and carbon tetrachloride.

7. "Botanical Drugs." This consists of a general survey of the crude botanical drug industry, whose products are dutiable under paragraph 27 or free under paragraph 477, and in addition there have been included the surveys of ergot, paragraph 28, and of the ethers and esters dutiable under paragraph 29.

8. "Tanning Materials and Natural Dyes." This includes all natural tanning materials and vegetable dyes, such as sumac, logwood and other dyewood extracts, chlorophyll and saffron of paragraphs 30 and 31. The following paragraphs from the free list are also discussed in this connection: 399, 455, 469, 475, 492, 536, 538, 553, 564, 618, 624, 630, 634 and 639.

9. Paragraphs 32 to 38 inclusive. This includes surveys of fusel oil, butyl alcohol, gelatine and glue, glycerine, camphor, gum arabic, dextrine and other gums, inks and ink powders, iodine, iodoform and potassium iodide.

10. Paragraphs 39 to 43 inclusive. This includes surveys of buchu leaves, coca leaves, gentian, licorice and sarsaparilla roots, magnesia and magnesium compounds, and menthol.

11. "Animal and Vegetable Oils." This includes all of the fish and animal oils of paragraph 44 and the expressed vegetable oils of paragraph 45. In addition the following oils, free of duty under paragraph 561, are discussed: Chinese nut oil, coconut oil, cod and cod liver oil, cottonseed oil, palm and palm kernel oil, perilla and soya bean oil.

12. "Essential and Distilled Oils." This includes surveys of all essential oils enumerated in paragraph 46, and, in addition, the following essential oils from the free list: Cajeput, ichthyol and juglandium.

13. "Opium." This includes the surveys of opium, cocaine and related alkaloids.

14. "Perfumery, Cosmetics and Toilet Preparations." This includes perfumery, cosmetics and toilet preparations under paragraph 48, and the natural and synthetic perfume materials under paragraph 49; also healing and court plasters under paragraph 50.

15. "Paints and Pigments." This includes all of the surveys dealing with paints and pigments in paragraphs 51 to 63 inclusive, with the exception of barytes, blanc-fixe and lithopone, which have been discussed under paragraph 10.

16. "Potassium Compounds." This includes the surveys of potash and the potassium salts, dutiable under paragraph 64, or free of duty under paragraph 580.

17. Paragraphs 65 to 66. This includes the surveys of salts and compounds of bismuth, gold, platinum, silver, tin, etc.; also the surveys of soaps, dutiable under paragraph 66.

18. "Sodium Compounds." This includes all the sodium salts, dutiable under paragraph 67 or free of duty under paragraph 605; also potassium prussiates, potassium nitrate, potassium chromate and bichromate, dutiable under paragraph 64; chromic acid and silicic acid, free of duty under paragraph 387; chromium hydroxide, paragraph 449; calcium nitrate, paragraph 440; potassium nitrate, crude, and potassium cyanide under paragraph 580.

19. Paragraphs 68 to 70, inclusive. This includes surveys of sponges, talc and soapstone, vanillin, vanilla and tonka beans.

American Engineering Council Assumes Activities of Former Engineering Council

On Jan. 1, 1921, American Engineering Council of the Federated American Engineering Societies assumed the continuation of such activities as have been conducted for the past three and one-half years by Engineering Council of the United Engineering Society. This transfer of activities was made effective by the action of Engineering Council on Dec. 16 in recommending to United Engineering Society that Engineering Council be discontinued. Subsequently United Engineering Society amended its bylaws so as to disestablish Engineering Council.

Symposiums on Drying and Filtration Planned

For the Rochester meeting of the American Chemical Society the division of industrial and engineering chemistry plans to have a symposium on drying. Plans for the program are in charge of the committee now being formed under the chairmanship of Charles O. Lavett of the Buffalo Foundry & Machine Company of Buffalo, N. Y. Those interested in this symposium should communicate their suggestions to the chairman of the committee.

On the occasion of the fall meeting, in New York City, the industrial division program will include a similar symposium on the subject of filtration. The chairman and committee in charge of this program have not yet been selected, but further arrangements will probably be perfected in the near future, as the secretary of the division, Dr. H. E. Howe of the National Research Council, has the matter actively in charge at present.

International Chamber Committee Organized

The American committee to represent in this country the International Chamber of Commerce has fully organized and held its first meeting in New York City on Jan. 6. This agency is the direct representative and point of contact in the United States with the International Chamber of Commerce, which has its headquarters in Paris. Chemical, metallurgical and other engineering interests are represented on the board by the following gentlemen, among others: Herbert C. Hoover, representing Federated American Engineering Societies; Thomas S. Grasselli, Grasselli Chemical Co.; E. A. S. Clark, Consolidated Steel Corporation; A. C. Bedford, Standard Oil Co.; C. F. Kelley, Anaconda Copper Mining Co.; E. G. Miner, Pfaudler Co.; William H. Nichols, General Chemical Co.; Thomas A. O'Donnell, American Petroleum Institute; John J. Raskob, Dupont Co.; Charles M. Schwab, Bethlehem Steel Corporation; Charles A. Stone, American International Corporation; E. P. Thomas, U. S. Steel Products Co.

Nitrate Plant Controversy Grips Senate and House

The nitrate plants at Muscle Shoals, the proposed United States Fixed Nitrogen Corporation and the Wilson dam have come in for extended discussion in Congress during the past two weeks. The Nitrogen Corporation bill became the unfinished business in the Senate after Senator Underwood, the Democratic leader, had threatened to delay the Republican legislative program unless the bill were taken up. In the House the nitrate plant controversy was precipitated by the failure of the Appropriations Committee to provide funds for the continuation of the work on the Wilson dam.

Division of opinion on the matter, however, was not along party lines. The Democrats are not a unit for it, nor are the Republicans uniformly against it. In fact, Representative Mann, of Illinois, one of the Republican leaders, proved to be an effective champion in favor of continuing the work. Opinion in the House is evenly divided, as is indicated by the close vote on the first test of strength, when 125 votes were cast to override the committee, against 132 in support of the committee's position.

An unexpected development in the Nitrogen Corporation discussion came when Senator Wadsworth, of New York, submitted amendments withdrawing the corporation entirely from the jurisdiction of the War Depart-

ment and proposing that it be placed under the Treasury Department, because he believes "soldiers ought not to be running a business concern." Another amendment by Senator Wadsworth proposes material changes in the plan for capitalization. He would give the corporation the power to sell common stock in any amount not to exceed \$20,000,000. Another amendment by Senator Wadsworth limits the activities of the corporation to the manufacture of ammonium nitrate, ammonium sulphate and cyanamide from atmospheric nitrogen.

In submitting his estimates to Congress the Secretary of War requested \$10,000,000 for the continuation of the work on the Wilson dam. This item was entirely omitted by the committee in framing the sundry civil bill on the ground that the policy with respect to carrying forward the project had not been worked out.

In the course of his remarks Mr. Good, chairman of the Committee on Appropriations, said: "I can but feel that a great blunder was made when the American Cyanamid Co. was given a free hand in the making of the plans for building Plant No. 2, which is the large plant. I have forgotten whether it is the American Cyanamid Co. or the American Chemical Co., but the two were in very close relation. One of them prepared the plans and constructed this plant. One or the other of these companies, which have been working very closely together, has the patent rights for the Haber process. The Haber process is covered by a great many letters patent and these companies, or one of them, hold the letters patent. True, the basic patent was granted seventeen years ago, but when this company was given the power to make the plans for this plant it made its plans for the manufacturing plant to fit in with its patents. So every unit of the building, every piece of construction, everything that was done was in order to turn out nitrates at Plant No. 2 under the Haber process, which is covered by these patents, and the company receives royalties on every ton produced—\$5 a ton royalty on cyanamide and \$10.11 a ton on nitrates of ammonia. The royalties under the present contract for 100,000 tons of nitrates of ammonia, the estimated annual production, would be \$2,200,000."

At another point in his remarks Mr. Good said: "We will have to become accustomed to some higher Government salaries if the Government is going to engage in this kind of enterprise. You cannot compete with the American Cyanamid Co. in the manufacture of fertilizer and nitrate if you are going to have \$2,500-a-year men or \$5,000-a-year men to manage the plant when a competing company pays from five to ten times such sums for their managers in order to secure the best talent available. You must apply to Government affairs the same business principles that a business man adopts in connection with his affairs if you want the Government to succeed in business."

Among the champions for the continuance of the project was Representative Garrett, of Tennessee. At one point in his address he stated that some chemists are of the opinion that eventually the Haber process will be developed to a point when nitrates can be fixed at a cheaper cost by that method than by the cyanamide process, but he continued: "We must bear in mind that however hopeful gentlemen may be of the eventual development of the Haber process it still is speculative in this country and the cost of production by it necessarily is speculative."

At another point in his remarks Mr. Garrett expressed the opinion that it is not possible to dispose

of the nitrate plant to private parties at any price that would approach, even remotely, a just return to the Government. "So far as I know," he continued, "no one ever has believed that it is possible for private capital to construct this dam economically."

Representative Graham, of Illinois, deprecated the spirit of "let the Government do it." So far as the nitrate plant controversy is concerned, he said, the parting of the ways has been reached. "We must either embark on the national management and manufacture of fertilizers or we must take the other road which leads to individual initiative and enterprise." He expressed the opinion that the real purpose of the power development is to erect at Muscle Shoals, at Government expense, a water-power project for the development of that part of the country. "I am opposed to junking this plant," he declared. "I am equally opposed to the Government running it, if there is any other way to do it. I favor its operation by private capital. Plant No. 1 is a failure, always has been a failure and always will be a failure. At the time it was built they knew considerable about the Haber process, which, by the way, is the coming process in this country. The method to be used in Plant No. 2 is obsolescent. Inside of ten years it probably will not be used at all. The Haber process is a simpler process. It has grown by leaps and bounds during the war. The Haber patents are open to the use of any man. I am informed privately that there are at present organizations in the United States, with great capital behind them, organized for the manufacture of synthetic ammonia by the Haber process. If the United States goes into the business that industry perishes, as do all others related to the production of nitrates from the atmosphere. How can any privately owned industry compete with the United States Government?"

Representative Almon, of Alabama, said: "Who is opposing the proposition that the Government should operate this plant? No one has come out in the open in opposition except Mr. Washburn, who operates a similar, but much smaller, plant at Niagara Falls, on the Canadian side. This plant would be his competitor."

Representative Mann, in concluding his speech, said: "Shall we scrap a plant simply because we feel resentment at its cost? Shall we throw away an opportunity because we do not like the men who have created it? Shall we waste the thing that we have because we do not like the methods that have been followed? We ought to rise above that. We ought to be willing to continue the work which is of benefit to the country and which utilizes Nature's power to draw from the air this plant food."

National Public Works Association Final Report

The final report of the National Public Works Association has just been completed by C. T. Chenery, secretary, dated Dec. 30. American Engineering Council will take over the work of this association, together with the work of Engineering Council, the first of the calendar year. This report of the public works activities is, therefore, its final summary of association affairs.

In addition to the effort to obtain passage of a bill to create a department of public works, known as the Jones-Reavis measure, this association has been active in support of the resolution recently passed by Congress known as the Smoot-Reavis resolution, providing

a Congressional commission for the investigation of the need of and basis for reorganization of the executive departments. In fact, the Public Works Association can properly be credited with having been one of the most influential agencies in obtaining the early passage of this resolution, which has just become a law through the failure of the President to act on the measure within ten days following its submission to him, which ten days expired December 30. It is hoped by those interested in the public works department that the need for it will be quickly demonstrated and that the first measure approved by the commission will be this particular part of Government reorganization.

Comments on Dye Development

A brief historical summary of the history of the dye industry in the United States, showing its growth from a small unit in the general industrial machine to a tremendous factor in the manufacturing life of the country, was given at the December meeting by Dr. C. G. Derick, in charge of the Research Laboratory of the National Aniline & Chemical Co., Buffalo, N. Y., before the Rochester Section of the American Chemical Society, in the Eastman Building of the University of Rochester. In addition to his historical remarks Dr. Derick also touched upon the problems confronting the industry at present.

Before 1914 about 70 per cent of the annual output of 400,000,000 lb. of dyestuffs was produced in Germany, no other one country producing as much as 10 per cent. England produced about 6½ per cent, France 5½, the United States 5, and Switzerland about 8 per cent. Scientific research can be considered the backbone of the German monopoly. However, had there not been a small industry in this country since 1870 the situation would have been much worse. In speaking of the history of the dye industry in this country Dr. Derick said that back in 1869 out on Buffalo Creek J. F. Schoelfkopf started a small factory. The same building served as stable, factory, laboratory, office and restaurant. The beginning was small and the difficulties were many, such as the Buffalo River rising and floating away part of the factory. This small concern was dependent upon Germany for its apparatus and the intermediates from which the dyes were made. Competition was keen with Germany, which held the monopoly and intended to keep it.

About twenty years ago, however, Schoelfkopf worked out a new black dye and patented it. It proved to be one of the most popular dyes. When he tried to get patents in other countries, however, Germany stepped in and said she had known about it for a long time. Then started one of the hardest fights the dye industry in this country ever had. Germany, seeing she was losing ground, tried then to compromise, divide up markets, etc. There was great rejoicing when the first carload of dye left the small Schoelfkopf factory. The value of an American patent backed by American law cannot be overestimated.

In 1914 Schoelfkopf thought the war would not last very long and having a large supply of intermediates on hand made up dyes and sold them at good profit. But it soon became evident that the war would not soon be over and the dye industry would suffer. Schoelfkopf made contracts with his older men to work out new dyes and share in the profits. In May, 1916, the old building was torn down, in August the research

chemists, Dr. Derick being in charge, went into the new building, and by Christmas of that same year twenty buildings were in operation and putting out from 60 to 70 per cent of the total consumption of this country. This wonderful work was made possible through the thirty-five years of research, experience and hard work. The contractors also deserve much credit for putting up the buildings in record time.

Dr. Derick went on to speak of the work involved in research, which may be divided into two classes—the exploratory function and the developmental function. In the United States about 99 per cent of the research has been along the latter line and this cannot go on; more work must be done in exploration. The research work in dyes must develop the dyestuffs, patent them and work out methods for qualitative analysis. Twenty per cent of the total business was dyes the constitution and components of which were unknown. The great problem then was to work out these unknowns, and this has now been done; there is not an important German secret in the dye industry that has not been solved in the laboratory, but some have not been as yet developed. Another phase of the work is the realization of the fundamental relation between constitution and color. The principal coal-tar products used in the making of dyes are benzene, toluene, naphthalene and anthracene.

The problems of the research man which must be solved in the laboratory are the materials that enter into the specifications, methods of analysis to back up the specifications, study of operations, study of variables and methods of control. The hazard study involving explosives likely to be produced and the effect of materials on the health of the workers is most important.

After the work leaves the research chemist it goes to the research engineering division, where apparatus is decided upon and estimates are made. Then the process goes to the factory and is worked out by a special set of workers under the supervision of the research chemist long enough to get accurate records of cost, etc.

Special difficulties that must be met and overcome are the effect of shutdowns of engineering service, such as of steam or electricity at an important point, which may result in an explosion, death of workers, or spoiled products. Other difficulties are the destructive action of bacteria and yeast to the finished dyestuffs. The patent situation must be continuously watched.

General Fries Advocates Plan to Stimulate Inventive Initiative in C.W.S.

General A. A. Fries, the head of the Chemical Warfare Service, states that some plan of systematic handling of inventions by Government employees is very necessary in the Chemical Warfare Service. As it is there is great need for stimulating inventive initiative and effort. He believes this applies to the whole Government service, but it is of unusual importance in his organization, where the field is so new. Under present conditions, he points out, many Government employees leave the service to develop their ideas so that they may participate in its benefits. Greater incentive must be given Government research workers if maximum progress is made in such matters as the development of war gases, General Fries said. He characterized the attitude of some of the concerns opposing such a plan as being narrow and an inheritance from the days of the alchemist, when all chemical research was hedged about with deep secrecy.

Industrial Investigations in Universities

On Friday evening, Jan. 7, the New York Section of the American Chemical Society was addressed by two prominent professors.

Dr. Warren K. Lewis reported that the new co-operative system established at Mass. Inst. of Tech. is proving highly advantageous both to the graduate students and to the score of industries represented. Co-operative students are chosen competitively on the basis of scholarship shown in their undergraduate work, reliability, personality and ability. A great amount of plant philosophy is imparted to the students and industry is saved the trouble of training raw recruits.

Drs. Ralph H. McKee and E. E. Lyder presented a very comprehensive report of their investigations on the pyrolysis of shale kerogens. The primary decomposition product at about 400 deg. C. was shown to be viscid tarry hydrocarbons which break down under destructive distillation (at 500 to 600 deg. C.) to form secondary products—oils, vapors, gases and free carbon. The investigations also included the determination of physical constants which may be of importance in process design.

Personal

H. FOSTER BAIN has been recommended by the Secretary of the Interior for the directorship of the Bureau of Mines. Dr. F. G. Cottrell's resignation has been accepted by Secretary Payne, effective Jan. 1. Dr. Cottrell has resigned to become chairman of the Division of Chemistry and Chemical Technology of the National Research Council. Both Mr. Bain and Dr. Cottrell will enter upon their new duties immediately. Mr. Bain during the war was assistant director of the Bureau of Mines and is widely known for his work as a consulting mining engineer and as a geologist. He has just returned from a trip to the Far East, where he made examinations of mining properties in ten countries.

Dr. C. B. CLEVENGER has resigned as instructor in the department of chemistry, University of Wisconsin, Madison, Wis., to accept a professorship of agricultural chemistry and head of the department of chemistry of the Manitoba Agricultural College, Winnipeg, Canada.

WILL H. COGHILL of the U. S. Bureau of Mines has gone to Platteville, Wis., to study the sludge problem in the Wisconsin zinc district.

W. C. GRAHAM, formerly of the Great Western Sugar Co. and now having his own business in the Coronado Bldg., Denver, Col., left New York on Jan. 8 to be away for several months on a special mission for the South Porto Rico Sugar Co.

Dr. RALPH E. HALL, formerly of the Geophysical Laboratory of the Carnegie Institution, Washington, D. C., has resigned from the Firestone Rubber Co., Akron, Ohio, to accept a position with the Koppers Co. of Pittsburgh, Pa.

FREDERICK A. HARVEY has resigned from the Semet-Solvay Co. to become technical assistant to the president of the United States Refractories Corporation, which prior to Jan. 1 was known as the Mt. Union Refractories Co.

ELLWOOD HENDRICK, consulting editor of CHEMICAL & METALLURGICAL ENGINEERING, lectured before the Polytechnic Section of the American Institute of the City of New York on Jan. 3 on "The Sense of Smell."

E. L. JORGENSEN, formerly general superintendent of reduction for the Chile Exploration Co. at Chuquicamata, Chile, has after fifteen years with Guggenheim Companies opened an office as consulting engineer in Suite 1429, 150 Nassau St., New York City.

CHARLES H. MILLER of Auburn, N. Y., has started a chemical and physical laboratory for the McIntosh & Seymour Corporation, maker of Diesel engines. The materials used in the manufacture, as well as the coal, oil, etc., will be tested chemically and physically.

PROF. JAMES F. NORRIS has been elected to the chairmanship of the committee in charge of the C. M. Warren Fund of the American Academy of Arts and Sciences, in place of Prof. H. P. Talbot, resigned. The income from the fund is available for the "encouragement and advancement of research in the science or field of chemistry," and may be used to provide the materials required for such investigations or assistant in their execution. The committee will be glad to receive and consider requests for grants from this fund. They should be addressed to Prof. James F. Norris, Massachusetts Institute of Technology, Cambridge, Mass.

A. A. RACKOFF, Wilkinsburg, Pa., is now specializing on special steel works and labor-saving machinery, teeming devices and coke-oven accessories.

Dr. L. I. SHAW lectured before the Franklin Institute Jan. 6, 1921, on "Smoke and Incendiary Material."

DR. EDGAR FAHS SMITH has been elected president of the American Chemical Society for the year 1921.

At the College of the City of New York Prof. HERBERT R. MOODY has been appointed professor of chemical engineering within the department of chemistry; Asst. Prof. W. L. PRAGER has been promoted to an associate professorship and JOSEPH A. BABOR has been promoted to an instructorship.

The Royal Society of England has awarded the Coply medal to H. T. BROWN for his work on the chemistry of carbohydrates, on the assimilation of atmospheric carbon dioxide by leaves, and on gaseous diffusion through small apertures; the Rumford medal to Lord RAYLEIGH for researches into the properties of gases at high vacua; the Davy medal to C. T. HEYCOCK for his work in physical chemistry, especially on the composition and constitution of alloys, and the Hughes medal to Prof. O. N. RICHARDSON for his work in experimental physics on the passage of electricity through gases, and especially for those relating to the electrons from hot bodies, which he has termed "thermionies."

The British Institution of Mining and Metallurgy has awarded its gold medal to Sir THOMAS KIRKE ROSE in recognition of his eminent services in the advancement of metallurgical science with special reference to the metallurgy of gold.

Current Market Reports

The Chemical and Allied Industrial Markets

New York, Jan. 10, 1921.

Large inquiries were not numerous during the past week in the chemical market but the situation showed signs of recovering from the effects of the recent holidays and producers seemed confident of a slow but gradual improvement in business during the rest of the month. Buyers are generally holding off and seem to be waiting for someone to start the ball rolling. There seems to be little doubt that should someone break the ice consumers will come into the market in force. Prices generally continue weak and subject to shading among leading dealers. Producers are still holding quotations well up to their recently quoted levels for contracts over 1921 in spite of the lack of any considerable business.

Resale *bichromate of soda* was offered at 9½c. per lb., with some sellers, however, asking 9¼c. Trade conditions were not very active and buyers appeared content to await new developments in the market before operating. Offerings were not heavy and February shipments were held at about 1c. premium over spot goods. *Solid caustic soda* opened steady on the spot market with sales recorded at

\$3.75@3.80 per 100 lb. This was the general quotation named for domestic and export use and the tone appeared quite steady. No change was noted in contract prices and producers continued to quote 3¼c. per lb., basis 60 per cent works, for forward shipments.

Small lots of American *cyanide of soda* were held at 30c. per lb. by dealers. The French variety sold at prices ranging from 21c to 24c. per lb. Some high-test German was on the market at 23c. English material was rather scarce on spot and was held at 24@26c. per lb. Moderate business in *formaldehyde* was booked at 18½c. per lb. spot in barrels. The market is quoted quite steady at this figure, with small lots held as high as 19@19½c. Wide differences of opinion were held as to the *arsenic* market. Some lots of white material were said to have sold as low as 9c. per lb. c.i.f. New York for immediate shipment from Japan. Other holders were quoting 10c. per lb. Spot quotations ranged from 10½ to 11½c., according to quantity and sellers.

The market on *caustic potash* remained in an unsettled condition. Imported material 88-92 per cent strength caused further weakness to the spot market. Consumers were unwilling to enter the market in spite of the bargain prices which were offered through second hands. Prices ranging from 14c. to 16c. per lb. for imported seemed to represent a fair low mark for this material. Domestic producers' quotations were far above these figures.

Producers on American *chlorate of potash* continued to quote 18c. per lb. for goods in warehouse. Second hands offered imported goods as low as 11c. per lb., with practically no response from leading match and powder factories. Demand of late has generally been of a very limited nature. There were some sellers of *nitrite of soda* as low as 6c. per lb. for spot goods and quotations were heard from 6¼ to 6½c. per lb. The inside figure was said to be for round lots and was not general in the open market. The low figure compares with 14c. per lb., the initial price last January, and with the high point touched, 60c. per lb. last March. Resale *bleaching powder* was quoted by dealers at 2½@2¾c. per lb. Some fair sales were recorded in small drums at intermediate prices. The inquiry appeared to be moderate, although enough supplies were around to meet all requirements. A feature of the market was the persistent demand for carload lots of light *soda ash* in single bags at the works. Producers seemed well sold up for immediate business and dealers were not anxious to quote the present market. Spot goods have been taken off the market during the past few days and the general undertone appeared quite steady. Prices ranged from \$1.90 to \$2.10 per 100 lb. for single bags. Barrels were held at 5c. per 100 lb. premium.

COAL-TAR MARKET

The new year has revealed nothing startling and most factors reported a light demand for small quantities of staple products that have a routine call. Inquiries from European sources showed an increase and seemed to indicate that there is a real need for some items. Opinions from different producers, on the other hand, were that these inquiries of the moment are in the nature of feelers trying out the market. Crude materials are quiet and prices are quotably unchanged from previous reports. While there has been no heavy demand for *anthracene*, there is nevertheless a healthy look and the steady developments along the vat dyes are keeping producers rather light on available material. Manufacturers of intermediates are steady in their views and dealers are also more conservative than they have been as to prices. What little is offered on the open market is held on a firmer basis than heretofore.

Small lot trading of *aniline oil* constituted about the extent of business during the week. The market seemed more steady around 23@25c. per lb., although supplies were easy in most quarters. The market on *aniline salt* showed little change from the former quiet stand. There were no new developments featuring the trade and prices held along the regular range from 27c. to 30c. per lb. Reports from most quarters stated that the market for *dinitrobenzene* is quiet. Supplies were said to be available in moderate volume on a basis of 27@30c. per lb. Consumers of *orthotoluidine* are showing little interest at this time. Producers are steady

in their views around 25@30c. per lb., with fair supplies available. While there were some resale lots of *paranitraniline* floating around the market, the quantity is not large and a firmer view is held as to prices, which range from 93c. to \$1 per lb.

WAXES

The wax market in the past few weeks has been exceptionally quiet, with only small orders from domestic consumers noted. The inquiry for *crude beeswax* was moderate but trading in the refined material was very dull. The spot market for *Carnauba wax* saw no change in action, but a fair amount of interest was shown in shipments. No. 3 North Country was held at 20@25c. per lb., with futures available at about 18c. per lb. A limited inquiry was in evidence for *Japan wax*, and with spot material not pressing the market prices remained unchanged at 19@20c. per lb. The market for *scale wax* was unsettled, with offerings in some directions of a liberal nature. *Crude wax* 124 m.p. was available at 6½c. per lb., with carload lots a trifle under the figure. Refined 133 m.p. wax was offered at 10½c., with no new business noted.

COAL-TAR PRODUCTS MARKET FOR 1920

The sensational rise of the coal-tar, intermediate and dyestuff markets was directly due to the wave of export business that flooded the country immediately after the severe slump during the latter part of 1919. It was generally supposed that Germany had accumulated a tremendous surplus stock of dyes during the war and the entire world was waiting to see whether this condition was a reality. Rumors were current that German interests were about ready to ship in continuous quantities to the outside markets dyes of every description, and as a result consumers were narrowing their orders to the barest necessities. Stocks were reduced to await the time when prices and quality would reach pre-war levels by the Germans in their efforts to once more rehabilitate themselves to their former commercial supremacy.

During the later months of 1919 there were no signs of any importations of dyes and buyers became pessimistic as to the truth about these hoarded stocks. This was an impetus for live buying and immediately orders were noted in large volume for American-made material. Prices soared to their highest peak during the early months of 1920. With this sudden turn in the trend of business it became evident that American manufacturers were not entirely prepared to meet this overwhelming demand. General conditions in other lines prevented any expansion in the industry, and as stocks became depleted with the demand greater than the supply prices fluctuated. Speculation became the order of the day here and abroad. Buyers were paying fabulous prices in order to get what little there was on the spot market. Principal among export buyers were Japan and the Far East countries. Japan, as was noticed in the chemical industry, speculated blindly. Material was bought at any price and it soon became evident that stocks had accumulated which were sufficient to cover her requirements over a period of a few years. The result was inevitable. A chaotic condition arose in Japan when banks began to call their loans on speculative holdings and also to refuse any additional credits. In order to save themselves the Japanese turned from the buying end to the selling. Large holdings were brought back to the American market at sacrifice prices. Prices began to break rapidly and domestic consumers, who had been willfully neglected during the foreign rush, took the upper hand. Stocks moved sluggishly in view of the fact that material was offered at bargain prices. The market became demoralized through these forces and it is in this condition that the coal-tar and intermediate markets find themselves at the turn of the year.

There were many factors together with the enormous export demand that hindered any additional production. The coal strike reduced supplies of all crude-tar manufacturers. Shortage of coal forced practically all of the byproduct coke plants to work on greatly reduced schedules. The car shortage, railroad inefficiency and the unusually hard winter

COMPARATIVE PRICES OF COAL-TAR PRODUCTS. JANUARY-DECEMBER, 1920

	Jan.	March	July	Oct.	Dec.
Benzene, c.p. gal.....	\$0.30	\$0.31	\$0.37	\$0.37	\$0.32
Cresylic acid, 95-97%, gal.....	.90	.95	1.10	1.05	.90
Cresylic acid, 97-99%, gal.....	.94	1.00	1.20	1.15	.95
Dip oil, lb.....	.45	.45	.45	.40	.38
Solvent naphtha, water white, gal.....	.26	.27	.32	.32	.30
Toluene, water white, gal.....	.32	.36	.43	.40	.33
Xylene, pure, gal.....	.45	.50	.50	.50	.42
H-acid, per lb.....	2.00	1.95	2.25	1.70	1.40
Phthylid anhydride, lb.....	.85	.75	.60	.65	.60
Salicylic acid, U.S.P., lb.....	.60	.60	.55	.37	.35
Alpha naphthylamine, lb.....	.42	.45	.55	.50	.40
Aniline oil, lb.....	.36	.38	.36	.30	.22
Aniline salt, lb.....	.40	.44	.45	.38	.27
Anthracene, 80%, lb.....	.80	.85	1.00	1.00	.90
Benzaldehyde, (F.F.C.), lb.....	2.00	2.00	2.00	2.00	2.00
Benzidine, base, lb.....	1.35	1.35	1.40	1.20	1.00
Benzidine, sulphate, lb.....	1.05	1.10	1.25	1.10	.85
Beta Naphthol, tech., lb.....	.55	.65	.85	.75	.40
Dichlorobenzene, lb.....	.10	.10	.09	.08	.08
Dinitrobenzene, lb.....	.30	.32	.36	.35	.35
Diethylaniline, lb.....	1.40	1.60	1.50	1.50	1.35
Dimethylaniline, lb.....	.90	.90	1.30	1.00	.70
Dinitrophenol, lb.....	.40	.45	.42	.40	.40
Diphenylamine, lb.....	.80	.82	.87	.80	.70
Naphthalene, flake, lb.....	.08	.10	.16	.13	.08
Naphthalene, ball, lb.....	.09	.11	.17	.14	.08½
Nitrobenzene, lb.....	.16	.17	.17	.15	.14
Orthonitrotoluene, lb.....	.23	.27	.28	.25	.25
Paraphenylenediamine, lb.....	3.00	3.00	3.00	2.50	2.25
Para amidophenol, base, lb.....	2.60	2.60	2.60	2.50	2.10
Para amidophenol, HCl, lb.....	2.85	2.85	2.85	2.75	2.20
Paradichlorobenzene, lb.....	.15	.15	.15	.15	.12
Paranitraniline, lb.....	1.30	1.45	1.45	1.20	.93
Phenol, lb.....	.14	.20	.18	.12	.12
Resorcinol, tech, lb.....	4.50	4.50	4.50	2.85	2.75
Resorcinol, pure, lb.....	7.50	7.50	6.50	4.00	3.60
Toluidine, lb.....	1.65	1.65	1.70	1.70	1.35

added to the difficulties of American producers. It became evident that some material had to be imported. Naphthalene led among speculators and soon an oversupply followed the rapid slump in business. Large holders began to offer their purchases for resale at prices far below manufacturers' quotations. The same condition held true on all other coal-tar products.

The 1921 prospect for business seems very indefinite and will remain so until some settlement is reached on the tariff question. No point is of such crucial significance to the industry at the present time as the passage of suitable protective measures by Congress. The present scale of operation as well as the expert supervision required causes enormous expenses and makes it necessary for the American manufacturer to charge more for his product than the German. Some definite action in this matter will immediately set the industry on a firm basis and development work which will follow will be one of the greatest factors in reducing the cost of American products to the consumers. Prices will probably rise without any resumption of new business, as present stocks have been generally reduced to a minimum. It is problematical whether this will occur during the first quarter. The only logical solution is that the rebound will be gradual and that business will increase until a normal volume of trade is reached. Prices are much lower now than at the beginning of 1920 and in some cases are even below the cost of production. Any inequalities will undoubtedly be removed in the immediate future and legitimate prices will be set forth which will include legitimate profits.

The St. Louis Market

St. Louis, Jan. 5, 1921.

A more cheerful tone has been evident in the heavy chemical market during the last week. Producers report many domestic consumers renewing contracts at the price levels established around the middle of December. Shipments on contracts have picked up appreciably since the first of the year also. Although spot sales have not increased to any great extent the number of inquiries has increased. One helping factor is the almost complete absence from the market of small distressed lots of heavy chemicals.

Quotations have changed in only one instance, and producers are manipulating their production in such a manner that their stocks of heavy chemicals will not accumulate beyond control. In a few instances a quickening demand has found supply low.

Demand for the 98 deg. *sulphuric acid* is still slow and the price has dropped to \$24 per ton f.o.b. works from the previous quotation of \$25 per ton. The 66 deg. acid continues in strong demand, the greater portion of the production going to the oil refineries. Quotations are stable at \$20@21 per ton and 1½c. per lb. in carboys, carload lots. The demand for the 60 deg. sulphuric acid has shown flashes of activity in the last few days and the current price is \$16 per ton and 1½c. per lb. in carboys. *Oleum* has shared in this increased activity, producers reporting inquiries good, although orders have picked up only slightly. It is being offered at \$28.50 per ton.

Producers report that users are calling more actively for *muriatic acid*. Stocks were not large and prices are holding firmly at \$25 per ton in bulk and 1¾@2c. per lb.

Sodium bisulphate is quiet, but there are no very large lots to offer and the greater part of the production is being shipped on contract. The nominal quotation is \$7@\$8 per ton.

Zinc chloride is not in exceptionally strong demand, but there has been no further decrease in quotations. It is being offered at \$4.15 per 100 lb.

The *nitric acid* market is quiet and quotations are \$7 per 100 lb. for the 36 deg. test and \$10 per 100 lb. for 42 leg. Quotations on standard mixed acid are unchanged.

The Chicago Market

Chicago, Jan. 5, 1921.

A very definite tendency toward a stronger market is felt on all sides since the turn of the calendar. This has not been evidenced by any marked price advances nor by increased demand, but rather by the very definite decrease in the volume of supplies in the stocks of second hands. The trend of the past few months has been toward the elimination of the speculator and the vest-pocket trader, who were so largely responsible for the extreme height to which prices rose last year. With their activity reduced to a minimum and with markets largely in the hands of producers, prices are bound to be more stable and to be based on actual worth.

With consumption going on at a day-to-day rate and with production materially retarded, no oversupply in any item seems probable. From this it is deduced that while prices may not necessarily be at their bottom level they are very near to it. Dealers and manufacturers are a unit in expressing the opinion that business during the coming season is going to be good.

HEAVY CHEMICALS

Little action, but prices firmly held, in general, has been the story of the past two weeks. In the soda group only routine orders are being placed, but spot stocks seem to be getting low. *Soda ash* offerings are at \$2 per 100 lb. now, against \$1.85 ten days ago. All supplies are firmly held at the quoted price. *Caustic soda* has been moving in good volume, orders averaging small but running to a good total. Today's quotation is \$3.85@\$4.15 per 100 lb. *Sal soda*, at \$2.25 per 100 lb., is in routine demand only. No large stocks of *sodium bichromate* are to be found and prices are held at 12@13c. per lb., with demand steady.

The *alcohol* market is still in a bad way. Production of *methyl* grade has been seriously curtailed and with the gradual depletion of resale stocks current quotations of \$1.80 per gal. for 97 per cent should represent about the bottom of the market. *Ethyl* grade, owing to the uncertainty of future production costs, is uncertain as regards supply. At present the market is quiet at \$5.15 per gal. for 190 proof. Supply of *denatured* is still greatly in excess of demand, and quoted price of 80@90c. indicated the wide range of price offerings.

Glycerine remains at a very low ebb, buyers showing no interest and holders of stock apparently being content to hold. The c.p. grade, held at 19c. per lb. f.o.b. works, is exciting no interest and saponification grade is offered at 12c., with but little business resulting. *Quicksilver*, quoted at \$43@\$45 per flask, is said to be cheaper than production cost, in spite of which demand remains light.

Acids are facing a weak market. Price range does not seem to mean much to consumers, who are content to limit purchases to their day-to-day requirements. Current quotations, most of which can be shaded, are: 66 deg. *sulphuric*, \$24 per ton; 36 deg. *nitric*, \$6.50@\$6.75 per 100 lb.; *muriatic*, 18 deg., \$1.85@\$2 per 100 lb.; *acetic*, glacial, 10½@11½c. per lb., 56 per cent, 5½@5¾c. per lb. Production of all acids is being curtailed.

VEGETABLE OILS

Continued weakness is noted in this line, small volume of transactions and lowering prices being the order of the day. Quotations are largely nominal as large stocks are still in second hands and most any offer will be made to induce sales. *Linseed oil*, unchanged in quotation, could actually be bought at 76c. per gal. in car lots. *Cottonseed oil*, quoted at 6c. per lb. f.o.b. point of production, is not only below cost but is also lower than the appraisement value upon which bank loans were made a few months ago. Actual transactions are few. *Corn oil*, firmed up in price by reduced production, is held at 7c. per lb. f.o.b. Chicago, but no reports are heard of any sales of importance. *Coconut oil*, in spite of rumored impending shortage, excites no interest at the current price from local warehouse of 12½c. per lb. for crude and 15c. for deodorized.

NAVAL STORES

Owing to the widespread depression in the various industries which use naval stores prices are held at low levels and but little real business is being done. Very recent improvements in foreign exchange rates may make possible increased export business, which has been negligible for some weeks. Current quotation on *turpentine* in barrels by the carload f.o.b. Chicago is \$1.09½ per gal.; in drums it is 6c. lower. Better grades of *rosin* are quoted at \$10.25 per 100 lb., and lower grades at \$9.90@\$10. Distilled *pine oil*, under fair demand, remains unchanged.

COAL-TAR PRODUCTS

The dye trade shows every indication that stocks in consumers' hands are low, which promises well for the future. The recently reported resumption of work in numerous textile plants, although on a reduced scale, is another favorable factor. Great interest is shown in the action to be taken by Congress in placing a protective tariff on products of the coal-tar industry. Quotations on crudes, while firm, are largely nominal, as transactions are few. *Phenol* is offered at 10@12c. per lb., sales at any figure being light. Spot stocks are reported as diminishing. *Toluol* shows a similar wide price range, offerings ranging from 32c. to 36c. per gal. *Benzene*, 90 per cent, is quoted at 33c. per gal., and *naphthalene* in both ball and flake form at 9@10c. per lb. All coal-tar acids are reported as very quiet, current quotations being purely nominal. *Benzoic* is offered at 65c. per lb. for technical grade and 70c. for U.S.P.; *picric* at about 35c.; *salicylic* at 36@38c. for U.S.P.

The Iron and Steel Market

Pittsburgh, Pa., Jan. 7, 1921.

Independent pipe mills have reduced their prices to the Steel Corporation level. The movement was inaugurated by the Republic Iron & Steel Co., which distributed new list prices under date of Dec. 31, other independents following in short order, some lists being dated Jan. 1 and others Jan. 3. The difference in dates is immaterial, they merely fixing the time for readjustment of prices on current shipments against old contracts, and Jan. 1 was not a shipping date.

Pipe was the only important steel mill product requiring readjustment from the advanced independent market, and thus the return of the independent steel market to the Steel Corporation or Industrial Board level was completed, without a day to spare, within the limits of the calendar year. The real flight of the independent market had only begun in 1920. There were some advanced prices secured late in 1919, but at the time the advances were regarded as simply involving a premium for early delivery. Later, or in 1920,

the independents would not sell for any delivery except at their advanced prices, while formerly they simply refused to sell for extended delivery at all.

OPERATIONS

The trend in independent mill operations is downward, but there has been no general closing. Many mills are closed but others are operating at rates up to perhaps 50 or 60 per cent of capacity. The general average among independents is perhaps not over 20 per cent. The Carnegie Steel Co. has been producing ingots at fully 96 per cent of rated capacity, while the National Tube Co. is running full. These two subsidiaries have 53 per cent of the Steel Corporation's total ingot capacity. The Illinois Steel Co. is reported to be operating at 85 per cent. The general average of the Steel Corporation is probably about 92 per cent.

If the independents are operating at 20 per cent and the Steel Corporation at 92 per cent, the general average for the industry is about 52 per cent of capacity, or about 65 per cent of the average rate during the period of heavy demand, the first nine months of 1920. In that period the mills averaged only 80 per cent, being held down by shortages of cars and fuel, and in spots a little labor shortage.

Predictions that were being made in December that there would be an "improvement" in the steel trade immediately after the turn of the year need not be taken seriously. There could be an increase in buying without its offsetting the exhaustion of old contracts, and no signs even of that are now seen. With steel production and shipments at 65 per cent of the former rate one may doubt whether the present rate can be maintained, for it is not reasonable to suppose that steel consumption has decreased by only 35 per cent. Indeed, some steel producers candidly state that they know some of the steel they are shipping is not going into actual consumption, although their customers are willing to receive it. The trend of the next few weeks, therefore, is likely to be a downward trend in production. It is from a rate lower than the present that recovery is to start.

PRICE PROSPECTS

A common prediction was that almost as soon as the independents reduced their prices to the Steel Corporation level they would begin to shade the new prices. The prediction did not reckon with present conditions, when no new business of importance is developing. At the moment the chief recourse of the independents, in endeavoring to secure business, would be to take business from the Steel Corporation. That would be difficult if not impossible, but in any event would not be attempted, for obvious reasons.

The present prospect seems to be, therefore, that prices will remain as they are for a time, with occasional shading, no doubt, until some substantial volume of new business develops. With a light operation costs are high, but a little additional operation would not mend matters a great deal. The lowest prices will probably be seen when there is hope that by cutting prices a reasonably full operation can be secured. Meanwhile costs will be coming down. There is scarcely any doubt that eventually, and before there is an upturn in prices, there will be a somewhat lower level than now obtains, but that is not for the immediate future.

While there have been some wage reductions among the independent steel producers the movement is very far from general. It appears to be the common impression that the present is not an appropriate time. The independent mills are largely idle in any event. As to the Steel Corporation, there is no expectation that it will take any action in the matter of wages for quite a while.

PIG IRON

The prediction made last week as to bessemer and basic pig iron prices is borne out, as there are furnace offerings this week at \$3 decline, \$32 for bessemer and \$30 for basic at valley furnaces. Foundry is not clearly defined, but seems quotable at \$33, a decline of \$2. There is no inquiry, and the few furnaces still in blast contemplate going out as they complete orders or make up enough iron to take care of orders in hand. No unsold pig iron is being made.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.		\$0.55 - \$0.60
Acetone.....lb.	\$0.13 - \$0.13½	13½ - 14
Acid, acetic, 28 per cent.....100 lbs.	3.00 - 3.25	3.50 - 3.75
Acetic, 56 per cent.....100 lbs.	6.00 - 6.25	6.50 - 6.75
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.50 - 11.00	11.25 - 11.50
Boric, crystals.....lb.	14½ - 15	15½ - 16
Boric, powder.....lb.	15½ - 16½	17 - 18
Citric.....lb.		50 - 52
Hydrochloric.....100 lb.	1.85 - 2.25	2.75 - 3.00
Hydrofluoric, 52 per cent.....lb.	15 - 16	16½ - 18
Lactic, 44 per cent tech.....lb.	10 - 11	11½ - 12
Lactic, 22 per cent tech.....lb.	04½ - 05½	06 - 07
Molybdic, C. P.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.		
Nitric, 40 deg.....lb.	07 - 07½	08 - 08½
Nitric, 42 deg.....lb.	08½ - 09	09½ - 10
Oxalic, crystals.....lb.	18½ - 18½	19 - 20
Phosphoric, Ortho, 50 per cent solution.....lb.	18 - 18½	18½ - 19
Picric.....lb.	28 - 35	40 - 50
Pyrogallol, resublimed.....lb.		2.30 - 2.40
Sulphuric, 60 deg., tank cars.....ton		14.00 - 15.00
Sulphuric, 60 deg., drums.....ton		
Sulphuric, 66 deg., tank cars.....ton	18.00 - 19.00	
Sulphuric, 66 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 - 24.00	
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 - 35.00	40.00 -
Tannic, U. S. P.....lb.		1.30 - 1.35
Tannic (tech.).....lb.	48 - 50	51 - 52
Tartaric, crystals.....lb.		33 - 35
Tungstic, per lb. of WO.....lb.		1.20 - 1.40
Alcohol, Ethyl (nominal).....gal.		5.25 - 5.50
Alcohol, Methyl (see methanol).....gal.		
Alcohol, denatur ed, 188 proof.....gal.		70 - 72
Alcohol, denatur ed, 190 proof.....gal.		75 - 77
Alum, ammonia lump.....lb.	04½ - 04½	05 - 05½
Alum, potash lump.....lb.	05½ - 06	06½ - 07
Alum, chrome lump.....lb.	13 - 13½	14 - 14½
Aluminum sulphate, commercial.....lb.	02½ - 03	03½ - 03½
Aluminum sulphate, iron free.....lb.	03½ - 03½	04 - 04½
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	06½ - 07	07½ - 08½
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	30 - 32	33 - 35
Ammonium carbonate, powder.....lb.	14 - 14½	14½ - 15
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	10½ - 11	11½ - 11½
Ammonium chloride, granular (gray salamoniac).....lb.	09½ - 09½	10 - 10½
Ammonium nitrate.....lb.	09 - 09½	10 - 10½
Ammonium sulphate.....lb.	03½ - 03½	04 - 04½
Amylacetate.....gal.		4.25 - 4.50
Amylacetate tech.....gal.		3.50 - 3.75
Arsenic oxide, lumps (white arsenic).....lb.	10½ - 11	11½ - 11½
Arsenic, sulphide, powdered (red arsenic).....lb.	15 - 15½	15 - 15
Barium chloride.....ton	75.00 - 80.00	85.00 - 90.00
Barium dioxide (peroxide).....lb.	24 - 25	26 - 27
Barium nitrate.....lb.	10 - 10½	10½ - 11
Barium sulphate (precip.) (blanc fixe).....lb.	04½ - 05	05½ - 06
Bleaching powder (see calc. hypochlorite).....lb.		
Blue vitriol (see copper sulphate).....lb.		
Borax (see sodium borate).....lb.		
Brimstone (see sulphur, roll).....lb.		
Bromine.....lb.	50 - 52	54 - 56
Calcium acetate.....100 lbs.	2.00 - 2.05	
Calcium carbide.....lb.	04 - 04½	04 - 05
Calcium chloride, fused, lump.....ton	27.00 - 29.00	30.00 - 32.00
Calcium chloride, granulated.....lb.	02 - 02½	02½ - 03
Calcium hypochlorite (bleach'g powder).....lb.	02½ - 03	03½ - 03½
Calcium peroxide.....lb.		1.25 - 1.30
Calcium phosphate, monobasic.....lb.		16 - 18
Calcium sulphate, pure.....lb.		05 - 05
Camphor.....lb.		88 - 90
Carbon bisulphide.....lb.	08 - 08½	09 - 09½
Carbon tetrachloride, drums.....lb.	11 - 11½	11½ - 12
Carbonyl chloride (phosgene).....lb.		60 - 75
Caustic potash (see potassium hydroxide).....lb.		
Caustic soda (see sodium hydroxide).....lb.		
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	09 - 09½	10 - 10½
Chloroform.....lb.		43 - 50
Cobalt oxide.....lb.		3.90 - 4.00
Copper as (see iron sulphate).....lb.		
Copper carbonate, green precipitate.....lb.	22 - 22½	24 - 25
Copper cyanide.....lb.		40 - 50
Copper sulphate, crystals.....lb.	06½ - 06	07 - 07½
Cream of tartar (see potassium bitartrate).....lb.		
Epsom salt (see magnesium sulphate).....lb.		
Ethyl Acetate Com. 85%.....gal.		1.05 - 1.10
Ethyl Acetate pure (acetic ether 98% to 100%).....gal.		
Formaldehyde, 40 per cent.....lb.	18½ - 18	19 - 19½
Fusel oil, ref.....gal.		3.50 - 3.60
Fusel oil, crude.....gal.		2.75 - 3.00
Glauber's salt (see sodium sulphate).....lb.		
Glycerine, C. P. drums extra.....lb.		20 - 21
Iodine, resublimed.....lb.		3.85 - 4.00
Iron oxide, red.....lb.		10 - 20
Iron sulphate (copperas).....100 lb.	1.50 - 1.75	2.00 - 2.25
Lead acetate, normal.....lb.		14½ - 16
Lead arsenate (paste).....lb.	13 - 14	14½ - 15
Lead nitrate, crystals.....lb.		90 - 1.00
Litharge.....lb.	10 - 10½	10½ - 11½
Lithium carbonate.....lb.		1.50 -
Magnesium carbonate, technical.....lb.	10½ - 11	11½ - 12
Magnesium sulphate, U. S. P.....100 lb.	3.00 - 3.25	
Magnesium sulphate, commercial.....100 lb.		1.50 - 1.75
Methanol, 95%.....gal.		1.60 - 1.65
Methanol, pure.....gal.		1.85 - 1.95
Nickel salt, double.....lb.		12 - 12½
Nickel salt, single.....lb.		13 - 13½
Phosgene (see carbonyl chloride).....lb.		
Phosphorus, red.....lb.	45 - 46	47 - 50
Phosphorus, yellow.....lb.		35 - 37
Potassium bichromate.....lb.	17 - 17½	17½ - 18

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$.38 — .40	\$0.38 — \$0.40
Potassium bromide, granular..... lb.	.35 — .40	.35 — .40
Potassium carbonate, U. S. P..... lb.	.11 — .11½	.11 — .12
Potassium carbonate, crude..... lb.	.11 — .12	.13 — .18
Potassium chlorate, crystals..... lb.	.14 — .14½	.15 — .16
Potassium cyanide..... lb.	75.00 — 80.00	3.00 — 3.20
Potassium hydroxide (caustic potash)..... lb.	11½ — 12	12½ — 13
Potassium iodide..... lb.	.60 — .63	.65 — .70
Potassium nitrate..... lb.	.60 — .62	.63 — .65
Potassium permanganate..... lb.	.31 — .31½	.32 — .33
Potassium prussiate, red..... lb.	\$225.00 — 230.00	
Potassium prussiate, yellow..... lb.		
Potassium sulphate (powdered)..... ton		
Rochelle salts (see sodium potas tartrate)		
Salammoniac (see ammonium chloride)		
Sal soda (see sodium carbonate)		
Salt cake..... ton	40.00 — 45.00	
Silver cyanide..... oz.	1.25 — 1.45	
Silver nitrate..... oz.	.43 — .45	
Soda ash, light..... 100 lb.	1.90 — 2.00	2.10 — 2.30
Soda ash, dense..... 100 lb.	2.30 — 2.50	2.75 — 3.00
Sodium acetate..... lb.	.05½ — .05¾	.06 — .06½
Sodium bicarbonate..... 100 lb.	2.45 — 2.60	2.65 — 3.00
Sodium bichromate..... lb.	.09¼ — .09½	.09½ — .10
Sodium bisulphate (nitre cake)..... ton	7.00 — 7.50	8.00 — 11.00
Sodium bisulphite powdered, U.S.P..... lb.	.06½ — .07	.07 — .08
Sodium borate (borax)..... lb.	.07 — .07½	.07½ — .08
Sodium carbonate (sal soda)..... 100 lb.	2.00 — 2.25	2.50 — 2.75
Sodium chl rate..... lb.	.10 — .10½	.10½ — .11
Sodium cyanide, 96-98 per cent..... lb.	.21 — .23	.24 — .30
Sodium fluoride..... lb.	.17 — .17½	.17½ — .18½
Sodium hydroxide (caustic soda)..... 100 lb.	3.75 — 4.00	4.25 — 4.35
Sodium hyposulphite..... lb.	.03 — .04	.03 — .04
Sodium nitrate..... 100 lb.	2.85 — 3.00	3.00 — 3.00
Sodium nitrite..... lb.	.06 — .06½	.06½ — .07
Sodium peroxide, powdered..... lb.	.30 — .31	.32 — .34
Sodium phosphate, dibasic..... lb.	.03½ — .04½	.04½ — .05
Sodium potassium tartrate (Rochelle salts) lb.	.33 — .35	.33 — .35
Sodium prussiate, yellow..... lb.	.17 — .17½	.17½ — .18
Sodium silicate, solution (40 deg.)..... lb.	.01½ — .01¾	.02 — .02½
Sodium silicate, solution (60 deg.)..... lb.	.03 — .03½	.03½ — .04
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.75 — 2.00	2.25 — 2.50
Sodium sulphide, crystal, 60-62 per cent (conc.) lb.	.06 — .06½	.07 — .07½
Sodium sulphite, crystals..... lb.	.04 — .04½	.04½ — .05
Strontium nitrate, powdered..... lb.	.20 — .20½	.21 — .22
Sulphur chl ride, red..... lb.	.08 — .09	.10 — .10½
Sulphur, crude..... ton	16.00 — 20.00	
Sulphur dioxide, liquid, cylinders..... lb.	.09 — .10	.10 — .12
Sulphur (sublimed), flour..... 100 lb.		3.70 — 4.35
Sulphur, roll (brimstone)..... 100 lb.		3.40 — 3.90
Tin bichloride, 50 per cent..... lb.	.18 — .19	
Tin oxide..... lb.		.50 — .51
Zinc carbonate, precipitate..... lb.	.16 — .18	.19 — .20
Zinc chloride, gran..... lb.	.11½ — .12	.12½ — .13
Zinc cyanide..... lb.	.45 — .49	.50 — .60
Zinc dust..... lb.	.12 — .13	.13½ — .14
Zinc oxide, XX..... lb.	.10 — .10½	.11 — .11½
Zinc sulphate..... lb.	.03½ — .03¾	.04 — .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 — \$1.15
Alpha-naphthol, refined..... lb.	1.45 — 1.50
Alpha-naphthylamine..... lb.	.40 — .44
Aniline oil, drums extra..... lb.	.23 — .25
Aniline salts..... lb.	.27 — .30
Anthracene, 80% in drums (100 lb.)..... lb.	.85 — 1.00
Benzaldehyde (f.f.c.)..... lb.	2.00 — 2.10
Benzidine, base..... lb.	1.00 — 1.10
Benzidine sulphate..... lb.	.85 — .90
Benzoic acid, U.S.P..... lb.	.70 — .75
Benzoate of soda, U.S.P..... lb.	.75 — .85
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.30 — .35
Benzene, 90%, in drums (100 gal.)..... gal.	.28 — .32
Benzyl chloride, 95-97%, refined..... lb.	.35 — .40
Benzyl chloride, tech..... lb.	.25 — .35
Beta-naphthol benzoate..... lb.	3.50 — 4.00
Beta-naphthol, sublimed..... lb.	.75 — .80
Beta-naphthol, tech (nominal)..... lb.	.38 — .42
Beta-naphthylamine, sublimed..... lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)..... lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums..... gal.	.95 — 1.00
Cresylic acid, 95-97%, dark, in drums..... gal.	.90 — .95
Cresylic acid, 50%, first quality, drums..... gal.	.65 — .75
Dichlorobenzene..... lb.	.06½ — .15
Diethylaniline..... lb.	1.35 — 1.40
Dimethylaniline..... lb.	.65 — .90
Dinitrobenzene..... lb.	.27 — .30
Dinitrochlorobenzene..... lb.	.25 — .30
Dinitronaphthalene..... lb.	.40 — .45
Dinitrophenol..... lb.	.40 — .45
Dinitrotoluene..... lb.	.27 — .30
Dip oil, 25%, tar acids, car lots, in drums..... gal.	.38 — .40
Diphenylamine..... lb.	.70 — .75
H-acid..... lb.	1.40 — 1.55
Meta-phenylenediamine..... lb.	1.25 — 1.30
Monochlorobenzene..... lb.	.15 — .16
Monoethylaniline..... lb.	1.75 — 2.25
Naphthalene crushed, in bbls. (250 lb.)..... lb.	.08 — .08½
Naphthalene, flake..... lb.	.08 — .08½
Naphthalene, balls..... lb.	.09 — .09½
Naphthionic acid, crude..... lb.	.70 — .75
Nitrobenzene..... lb.	.12 — .15
Nitro-naphthalene..... lb.	.40 — .50
Nitro-toluene..... lb.	.18 — .25
Ortho-amidophenol..... lb.	3.20 — 3.75
Ortho-dichlor-benzene..... lb.	.15 — .20
Ortho-nitro-phenol..... lb.	.75 — .80
Ortho-nitro-toluene..... lb.	.23 — .30
Ortho-toluidine..... lb.	.25 — .30
Para-amidophenol, base..... lb.	1.90 — 2.00
Para-amidophenol, HCl..... lb.	2.20 — 2.25

Para-dichlorobenzene..... lb.	.10 — .15
Paranitroaniline..... lb.	.93 — 1.00
Para-nitrotoluene..... lb.	1.25 — 1.40
Para-phenylenediamine..... lb.	2.20 — 2.35
Para-toluidine..... lb.	1.70 — 1.80
Phthalic anhydride..... lb.	.60 — .70
Phenol, U. S. P., drums (dest.), (240 lb.)..... lb.	.09 — .10
Pyridine..... gal.	2.00 — 3.50
Resorcinol, technical..... lb.	2.75 — 2.80
Resorcinol, pure..... lb.	3.60 — 3.80
Salicylic acid, tech., in bbls. (110 lb.)..... lb.	.30 — .32
Salicylic acid, U. S. P..... lb.	.33 — .35
Salol..... lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.28 — .32
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.16 — .18
Sulphanilic acid, crude..... lb.	.32 — .35
Tolidine..... lb.	1.35 — 1.40
Toluidine, mixed..... lb.	.45 — .55
Toluene, in tank cars..... gal.	.30 — .32
Toluene, in drums..... gal.	.33 — .35
Xylidines, drums, 100 gal..... lb.	.45 — .50
Xylene, pure, in drums..... gal.	.42 — .45
Xylene, pure, in tank cars..... gal.	.45 — .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 — .35
Xylene, commercial, in tank cars..... gal.	.30 — .30

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.24 — \$0.26
Beeswax, refined, light..... lb.	.27 — .28
Beeswax, white pure..... lb.	.35 — .40
Carnauba, No. 1..... lb.	.85 — .90
Carnauba, No. 2, North Country..... lb.	.40 — .42
Carnauba, No. 3, North Country..... lb.	.20 — .25
Japan..... lb.	.19 — .20
Montan, crude..... lb.	.07 — .08
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.06½ — .06¾
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.06½ — .06¾
Paraffine waxes, refined, 118-120 m.p..... lb.	.07 — .07½
Paraffine waxes, refined, 125 m.p..... lb.	.07½ — .08
Paraffine waxes, refined, 128-130 m.p..... lb.	.08½ — .09
Paraffine waxes, refined, 133-135 m.p..... lb.	.10½ — .11
Paraffine waxes, refined, 135-137 m.p..... lb.	.11 — .12
Stearic acid, single pressed..... lb.	.14½ — .15
Stearic acid, double pressed..... lb.	.15½ — .15¾
Stearic acid, triple pressed..... lb.	.15½ — .16½

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.90
Pine oil, pure, dest. dist..... gal.	1.50
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970..... gal.	1.25
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.35
Pinewood creosote, ref..... gal.	.52

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl..... 280 lb.	\$8.75 —
Rosin E-I..... 280 lb.	8.75 —
Rosin K-N..... 280 lb.	8.75 —
Rosin W. G.-W. W..... 280 lb.	9.00 —
Wood rosin, bbl..... 280 lb.	9.00 —
Spirits of turpentine..... gal.	.75 —
Wood turpentine, steam dist..... gal.	.73 —
Wood turpentine, dest. dist..... gal.	.73 —
Pine tar pitch, bbl..... 200 lb.	8.50 —
Tar, kiln burned, bbl. (500 lb.)..... bbl.	15.00 —
Retort tar, bbl..... 500 lb.	15.00 —
Rosin oil, first run..... gal.	.60 —
Rosin oil, second run..... gal.	.62 —
Rosin oil, third run..... gal.	.75 —

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41
70-72 deg., steel bbls. (85 lb.)..... gal.	.39
68-70 deg., steel bbls. (85 lb.)..... gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30

Crude Rubber

Para-Upriver fine..... lb.	\$0.18½ — \$0.19
Upriver coarse..... lb.	.14 — .14½
Upriver caucho ball..... lb.	.14½ — .14¾
Plantation—First latex crepe..... lb.	.17 —
Ribbed smoked sheets..... lb.	.16½ —
Brown crepe, thin, clean..... lb.	.16 —
Amber crepe No. 1..... lb.	.17 —

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.10 — \$0.11½
Castor oil, AA, in bbls..... lb.	.12 — .13
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.08½ — .09
Cocanut oil, Ceylon grade, in bbls..... lb.	.13 — .13½
Cocanut oil, Cochín grade, in bbls..... lb.	.13½ — .14
Corn oil, crude, in bbls..... lb.	.09 — .09½
Cottonseed oil, crude (f. o. b. mill)..... lb.	.06 — .07
Cottonseed oil, summer yellow..... lb.	.08½ — .08¾
Cottonseed oil, winter yellow..... lb.	.09 — .09½
Linseed oil, raw, car lots (domestic)..... gal.	.77 — .79
Linseed oil, raw, tank cars (domestic)..... gal.	.73 — .74
Linseed oil, boiled, car lots (domestic)..... gal.	.78 — .80

Olive oil, commercial.....	gal.	2.60	—	2.70
Palm, Lagos.....	lb.	.07	—	.08
Palm, Niger.....	lb.	.07	—	.08
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.07	—	.07
Peanut oil, refined, in bbls.....	lb.	.13	—	.13
Rapeseed oil, refined in bbls.....	gal.	1.10	—	1.15
Rapeseed oil, blown, in bbls.....	gal.	1.20	—	1.25
Soya bean oil (Manchurian), in bbls. N. Y.	lb.	.08	—	.09
Soya bean oil, tank cars, f.o.b., Pacific coast....	lb.	.06	—	.07

FISH

Light pressed Menhaden.....	gal.	\$0.53	—	\$0.55
Yellow bleached Menhaden.....	gal.	.55	—	.58
White bleached Menhaden.....	gal.	.57	—	.60
Blown Menhaden.....	gal.	1.00	—	....

Miscellaneous Materials

All f. o. b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.	net ton	\$24.00	—	\$30.00
Barytes, ground, off color, f.o.b. Kings Creek	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek...	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	....
Blanc fixe, dry.....	lb.	.05	—	.05
Blanc fixe, pulp.....	net ton	60.00	—	65.00
Caseine.....	lb.	.14	—	.18
Chalk, domestic, extra light.....	lb.	.05	—	.06
Chalk, domestic, light.....	lb.	.04	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04	—	.05
China clay, (Kaolin) crude, f.o.b. mines, Georgia	net ton	8.00	—	10.00
China clay (Kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (Kaolin) powdered, f.o.b. Georgia....	net ton	18.00	—	22.00
China clay (Kaolin) crude f.o.b. Virginia points	net ton	8.00	—	12.00
China clay (Kaolin) ground, f.o.b. Virginia points.	net ton	15.00	—	40.00
China clay (Kaolin), imported, lump.....	net ton	25.00	—	35.00
China clay (Kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fuller's Earth, f.o.b. New York.....	net ton	16.00	—	17.00
Fuller's earth, granular, f.o.b. Fla.....	net ton	25.00	—	....
Fuller's earth, powdered, f.o.b. Fla.....	net ton	18.00	—	....
Fuller's earth, imported, powdered.....	net ton	25.00	—	35.00
Graphite, crucible, 90% carbon, Ashland, Ala....	lb.	....	—	.09
Graphite, crucible, 85% carbon, Ashland, Ala....	lb.	.07	—	.09
Graphite, higher lubricating grades.....	lb.	.11	—	.40
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic, lump.....	lb.	.06	—	....
Pumice stone, ground.....	lb.	.04	—	.07
Quartz (acid tower) fist to head, f.o.b. Baltimore	net ton	....	—	10.00
Quartz (acid tower) 1 1/2 @ 2 in., f.o.b. Baltimore...	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	1.00	—	1.05
Shellac, orange superfine.....	lb.	1.05	—	1.10
Shellac, A. C. garnet.....	lb.	.90	—	.95
Shellac, T. N.....	lb.	.85	—	.95
Soapstone.....	ton	15.00	—	25.00
Sodium Chloride.....	long ton	....	—	17.50
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	50.00	—	60.00
Talc, California Talcum Powder grade.....	ton	20.00	—	30.00

Refractories

Bauxite brick, 56% Al., f.o.b. Pittsburgh.....	1,000	160	—	....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	100-110	—	....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	55-60	—	....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	60-65	—	....
Fire clay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	—	....
Fire clay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	—	....
Magnesite brick, 9-in. straight.....	net ton	110	—	....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	121	—	....
Magnesite brick, soaps and splits.....	net ton	134	—	....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65-70	—	....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56-61	—	....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	55-60	—	....

Ferro-Alloys

All f.o.b. Works

Ferro-carbon-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferro-chrome, per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.16	—	.17
Ferro-chrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.17	—	.18
Ferro-manganese, 76-80% Mn, domestic.....	gross ton	120.00	—	125.00
Ferro-manganese, 76-80% Mn, English.....	gross ton	110.00	—	115.00
Spiegeleisen, 18-22% Mn.....	gross ton	60.00	—	65.00
Ferro-molybdenum, 50-60% Mo, per lb. of Mo....	lb.	2.00	—	2.50
Ferro-silicon, 10-15%.....	gross ton	55.00	—	60.00
Ferro-silicon, 50%.....	gross ton	78.00	—	80.00
Ferro-silicon, 75%.....	gross ton	140.00	—	145.00
Ferro-tungsten, 70-80%, per lb. of contained W....	lb.	.55	—	.60
Ferro-uranium, 35-50% of U, per lb. of U content	lb.	7.00	—	....
Ferro-vanadium, 30-40% per lb. of contained V....	lb.	6.00	—	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al. content, less than 2% Fe ₂ O ₃ , up to 20% silica, not more than H ₂ O 4% moisture...	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min.	unit	60	—	65
Chrome ore, 50%, Cr ₂ O ₃ , f.o.b. Atlantic Seaboard.....	unit	.55	—	.60
Coke, foundry, f.o.b. ovens.....	net ton	6.25	—	7.00
Coke, furnace, f.o.b. ovens.....	net ton	5.00	—	5.50
Coke, petroleum, refinery, Atlantic Seaboard....	net ton	21.00	—	22.00
Fluor spar, lump, f.o.b. Tonuco, New Mexico....	net ton	17.50	—	....
Fluor spar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	—	25.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01	—	.01
Manganese Ore, 50% Mn, c.i.f. Atlantic seaport	unit	.40	—	.45
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport	unit	35.00	—	....
Pyrites, Spanish, fines, c.i.f. Atlantic seaport ...	unit	.12	—	....
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.17	—	....
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.14
Rutile, 95% TiO ₂ , per lb. ore.....	lb.	.15	—	....
Tungsten, Scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.75	—	4.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	4.00	—	4.25
Uranium Ore (Carnotite) per lb. of U ₃ O ₈	lb.	2.75	—	3.00
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.75	—	3.00
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium Ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	....
Zircon, washed, iron free.....	lb.	.05	—	....

Non-Ferrous Metals

New York Markets

	Cents per lb.
Copper, electrolytic.....	15.00
Aluminum, 98 to 99 per cent.....	27.50
Antimony, wholesale lots, Chinese and Japanese ..	5.25 @ 5.37 1/2
Nickel, ordinary (ingot).....	43.00
Nickel, electrolytic.....	45.00
Tin, 5-ton lots.....	34.02 1/2
Lead, New York, spot.....	5.37 1/2
Lead, E. St. Louis, spot.....	6.25
Zinc, spot, New York.....	7.00
Zinc, spot, E. St. Louis.....	6.75

OTHER METALS

Silver (commercial).....	oz.	66 1/2
Cadmium.....	lb.	1.40 @ 1.50
Bismuth (500 lb. lots).....	lb.	2.40
Cobalt.....	lb.	5.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.35
Platinum.....	oz.	75.00
Iridium.....	oz.	350.00 @ 400.00
Palladium.....	oz.	75.00
Mercury.....	.75 lb.	45.00

FINISHED METAL PRODUCTS

Warehouse Price Cents per lb.

Copper sheets, hot rolled.....	21.50
Copper bottoms.....	32.10
Copper rods.....	28.00
High brass wire and sheets.....	20.25
High brass rods.....	18.25
Low brass wire and sheets.....	29.50
Low brass rods.....	18.50
Brazed brass tubing.....	35.25
Brazed bronze tubing.....	40.50
Seamless copper tubing.....	25.00
Seamless high brass tubing.....	24.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	12.00	17.00	10.00	10.50
Copper, heavy and wire.....	11.50	16.00	9.50	10.00
Copper, light and bottoms.....	10.00	14.00	9.00	9.00
Lead, heavy.....	4.00	4.75	4.00	4.00
Lead, tea.....	3.00	3.75	3.00	3.50
Brass, heavy.....	7.00	10.50	7.00	10.00
Brass, light.....	5.50	7.50	5.00	5.50
No. 1 yellow brass turnings.....	6.50	10.00	5.50	5.50
Zinc.....	4.50	5.00	3.00	4.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes.....	\$3.80	\$4.15	\$3.47	\$3.58	\$3.37	\$3.58	\$3.47
Soft steel bars.....	3.70	4.15	3.37	3.34	3.27	3.48	3.37
Soft steel bar shapes.....	3.70	4.15	3.37	3.48	3.27	3.48	3.37
Soft steel bands.....	4.65	5.50	4.07	6.25	....	....	....
Plat.s. 1/2 to 1 in. thick.....	4.00	4.15	3.67	3.78	3.57	3.78	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Connecticut

DANBURY—The Beaver Brook Paper Mills, Inc., Beaver Brook St., plans to build a 1-story, 75x150-ft. addition to its manufacturing plant. Private plans.

Indiana

MARION—The Standard Glass Co. plans to build a 1-story glass factory. Estimated cost, \$75,000. Private plans.

TERRE HAUTE—The Union Hospital will receive bids after Feb. 1 for the construction of a 6-story, 80x120-ft. hospital on North Eighth St. Estimated cost, \$337,000. Johnson, Miller & Miller, archts.

Iowa

COLLINS—The Bd. Educ. will soon award the contract for the construction of a 2-story, 69x109-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$150,000. B. L. Mead, secy. T. Thorson, Forest City, archt.

Massachusetts

LEOMINSTER—The Viscoloid Co. will build a 1-story, 20x95-ft. addition to its plant for the manufacture of viscoloid sheetings. Estimated cost, \$15,000.

Michigan

GLADSTONE—The Bd. Educ. will receive bids until March 1 for the construction of a 2-story, 120x130-ft. junior high school on Main St. A chemical laboratory will be installed in same. Estimated cost, \$140,000. G. Arutzen, Escanaba, archt. and engr.

Montana

MILES CITY—The Custer Co. Free High School will soon award the contract for the construction of a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, \$400,000. G. F. Ingersoll, clk. W. A. Dedrick, Billings, archt. Noted Jan. 5.

New York

BROOKLYN—R. Embers, 209 King St., has awarded the contract for the construction of a 1-story, 60x100-ft. foundry on Richards St., to T. Drysdale, 250 Baltic St. Estimated cost, \$35,000.

North Dakota

MANDAN—The city is having plans prepared for the construction of a filtration plant and new reservoir or repairs to the present one. Estimated cost, \$150,000.

Ohio

COLUMBUS—The Ohio State University plans to build 13 buildings to include a chemistry building. Estimated cost, \$4,000,000.

SALEM—B. M. French, city engr., plans to construct a new building to include a filtering and settling basin with complete pumping and purification plant. Estimated cost, \$800,000.

SANDUSKY—The Hard Color Products Co., South Columbus Ave., has awarded the contract for the construction of a 1-story factory for repair work, to H. K. Ferguson Co., 6223 Euclid Ave., Cleveland. Estimated cost, \$50,000.

Oklahoma

LINCOLNVILLE—The Natl. Tripoli Co., Chamber of Commerce Bldg., Joplin, Mo., will receive bids until Jan. 25 for the construction of a 2-story factory to have a capacity of 100 tons. Estimated cost, \$130,000. G. A. Smith, pres.

Pennsylvania

PHILADELPHIA—The Amer. Eng. Co., Spexiva St. and Wheatshaf Lane, has awarded the contract for the construction of a 1-story, 50x100-ft. foundry and ma-

chine shop to the Austin Co., Bulletin Bldg. Estimated cost, \$25,000. Noted Dec. 29.

PHILADELPHIA—H. T. Potts & Co., Inc., 316 North Third St., has awarded the contract for the construction of a 1-story foundry on D and Erie Sts., to W. Steel & Sons Co., Sixteenth and Arch Sts. Estimated cost, over \$15,000.

South Dakota

EGAN—The Bd. Educ. is having plans prepared for the construction of a 1- or 2-story consolidated school. A chemical laboratory will be installed in same. Estimated cost, \$150,000. Schumacher & Finkelhor, 316 Paulton Blk., Sioux Falls, archts.

Texas

AUSTIN—The city plans an election to vote on \$20,000 bonds to construct improvements to the sewage disposal plant. Address W. D. Yett, Mayor, or C. E. Leonard, engr.

Wisconsin

ANTIGO—The Bd. Educ., c/o R. A. Brandt, is having plans prepared for the construction of a 2-story, 127x225-ft. junior high school on Main St. A chemical laboratory will be installed in same. Estimated cost, \$250,000. Oppenhammer & Obel, Wausau, archts.

GOODMAN—The School Bd. plans to build a 2-story, 90x125-ft. high and grade school. A chemical laboratory will be installed in same. Estimated cost, \$125,000. E. Tough, 24 East Mifflin St., Madison, archt.

Quebec

MONTREAL EAST—The Royal Duke Oil Co., 157 St. James St., Montreal, will receive bids until Jan. 15 for the construction of a plant for the purification of gasoline distilled, etc. Estimated cost, \$50,000. W. B. Richards & Co., 203 Bernard Ave., W., engr.

Industrial Notes

THE FISHER GOVERNOR Co., Marshalltown, Iowa, has taken over the manufacturing of the O-B regulating valve, formerly made by the Ohio Brass Co. In the future the valve will be known as the Fisher pressure regulating valve.

F. J. RYAN & Co., Franklin Trust Bldg., Philadelphia, are completing the installation of a large electric processing oven at the Thermoid Rubber Co., Trenton, N. J. This equipment is the second large processing equipment built by this company. The chief interest surrounds the possibility of solvent recovery owing to the form of heat used.

THE ELECTRIC FURNACE Co., Alliance, O., is installing a complete automatic heat-treating set at the new plant of the C. H. Wills Co., of Marysville, Mich. The set is designed to treat all kinds of automobile parts and consists of a 200-kw. hardening furnace, a motor operated quench and a 200-kw. drawing furnace. A 200-kw. Baily annealing furnace is being installed at the Springfield plant of the Ohio Steel Foundries Co., and a similar outfit but with 300 kw. electrical capacity has been ordered for export to the Oddehome Steel Corp. of Norway.

THE WISE ELECTRO-SHERARDIZING CORP. has started production at 2326 South Western Ave., Chicago, Ill. This company gives a sherardizing treatment to metal by an electric process as distinguished from the gas process of heating.

THE MEMPHIS IRON & STEEL Co. started operations at the first unit of the new mill recently, and is producing bars and round iron.

THE AUSTIN MACHINERY CORP. of Chicago has established a distributing branch in Memphis, Tenn., for the Arkansas and Tennessee territories. J. M. McCampbell will have charge of the new organization.

THE ELECTRIC FURNACE CONSTRUCTION Co., Philadelphia, announces the starting of a "Greaves-Etchells" electric furnace at the Holmes Foundry Co.'s plant, Port

Huron, Mich., for refining and superheating molten cupola metal. It has been found possible by short-treatment in the electric furnace to increase the fluidity of the metal and to largely eliminate sulphur. The cupola iron contained 0.102 per cent average sulphur, and the finished product showed only 0.023 per cent sulphur. Time taken was about forty minutes. Charges of cold scrap have also been run, consisting of 80 per cent cylinder scrap and 20 per cent iron borings. Sulphur in final product from the cold-melted heat was reduced to 0.013 per cent.

Manufacturers' Catalogs

HOLZ & Co., New York, has issued two new bulletins. No. 11 is on "The Eden-Foster Repeater Impact Testing Machine" for investigating the resistance of steel and other metals to fatigue procured by repeated stresses of small force, and No. 41 is on the "Burrows Defectoscope and Magnetic Analyzer" for the inspection of steel rails, rods, wire, cable and all other steel and iron stock of uniform section. Both booklets are illustrated.

INTERNATIONAL OXYGEN Co., Newark, N. J., calls attention to Bull. No. 61, covering the design, construction and operating characteristics of the I.O.C. system electrolytic oxygen-hydrogen generator type 1,000, which has just been published. The company announces that it will forward copies free of charge to anyone interested in the production of oxygen and hydrogen for industrial purposes.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its annual meeting Feb. 21 to 24, at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting Feb. 14 to 17 in New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA will hold its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.

COMPRESSED GAS MANUFACTURERS' ASSOCIATION will hold its eighth annual meeting, Monday, Jan. 17, at 2 p.m., at the Hotel Astor, New York, and its eighth annual dinner at the same place that evening.

NATIONAL PETROLEUM CONGRESS will meet at the Hotel Baltimore, Kansas City, Mo., March 22 to 25.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY holds its Perkin Medal Award Meeting at Rumford Hall, Chemists' Club, New York, on Jan. 14.

THE SEVENTH EXPOSITION OF CHEMICAL INDUSTRIES will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Jan. 14, Society of Chemical Industry, Perkin Medal award; Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

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Number 3

Perkin Medal for Doctor Whitney

THE award of the Perkin Medal to Dr. WILLIS R. WHITNEY, director of the research laboratory of the General Electric Co., will meet with universal approval which will only be heightened by the doctor's generous attempts at self-effacement. He was the unanimous choice of the Committee on Award. Dr. WHITNEY may protest that he cannot graciously accept the medal as a personal tribute and that he shines in the accumulated glory of members of his staff. But even in this recognition of his loyal associates, Dr. WHITNEY'S admirers will find indirect though ample justification for the honor that has come to him. Accepting for the moment his disclaimer to personal achievement, which the record will not sustain, his name is synonymous with one of the first and most successful organizations for industrial and scientific research. This in itself is no light accomplishment, and if Dr. WHITNEY prefers to let his claim to fame rest thereon his friends will still feel that it is quite sufficient to warrant his present recognition.

Senate Muddles The Nitrate Bill

AFTER several weeks of debate on the bill to create the United States Fixed Nitrogen Corporation the Senate passed it in amended form on Jan. 14. It will be recalled that the purpose of this bill was to provide the necessary corporate machinery for federal ownership and operation in the interest of the War Department of the nitrate plants at Muscle Shoals. As the Senate discussion grew in volume the fog in which the entire subject has been enshrouded increased in density until there was little likelihood that the Senate could emerge from it with any intelligent action. One has only to read the debate in the *Congressional Record* for the past few weeks to confirm the forecast which we made months ago when we intimated that on account of the complexity of the subject, the dust created in the course of discussion probably would obscure and defeat the legitimate ends of the bill. The nitrogen question is many-sided. Even if one had to deal only with its economics and technology, the subject would be large enough. But when, as in the present instance, it is so intimately mixed with politics, public and private, there is little hope of intelligent action.

It is true that economic and industrial conditions have changed since the bill was introduced a year ago and it is quite possible that it needed amendment. But such amendments as Senator WADSWORTH introduced on Jan. 4 could have but one purpose and effect—namely, to kill the bill. Their full purport is not evident at this writing, but one of them takes the jurisdiction of the plant out of the War Department and puts it in the Treasury. Another increases the corporation's

financial obligations to the United States by requiring it to issue bonds up to half of the war-time expenditures of the Government in constructing the nitrate plants and for the full value of the hydro-electric installation if and when acquired by the corporation. This has been done in spite of the fact (or maybe in accord with it) that persistent opponents of the bill have testified to Congressional committees that the Plant No. 2 could not possibly be sold for anything like its war-time cost nor even leased on any such basis.

The amendments can scarcely be taken in good faith, because they require the corporation to earn 5 per cent on its securities under penalty of ceasing operations and awaiting further action by Congress. This would kill it in its first year of operation. It would also compel it to operate the plants at the greatest capacity and enter into the stiffest kind of competition with commercial fertilizer manufacturers—something that never was contemplated by any of those who have advocated the control and operation of the plants by the War Department. One of the objections to that control and operation was that the peace-time product of the plants must inevitably compete with certain articles of domestic commerce, and objection was raised to the United States engaging in such competition. The current amendments practically impose upon the corporation the necessity of engaging in such competition, if it is to maintain its existence.

In the consideration of this, as of many other technical subjects with which Congress has to deal, we are repeatedly impressed with the value of the much-maligned "single-track" mind. It is far superior to the "sidetrack" mind which seems to develop in large number and great variety whenever a complicated question is before our national legislature. In the present instance the issues have been so misrepresented, distorted and complicated that the original and legitimate reasons for and purposes of the bill have been lost to sight. Let us keep them clearly in mind. The United States has made a large investment in plants for nitrogen fixation at Muscle Shoals. The Chief of Ordnance is charged with securing and maintaining an adequate supply of munitions for the Army; and at present, as in the past, his only source of nitrate is in a foreign country, Chile. There is no nitrogen-fixation industry now actively functioning in this country, capable of furnishing the Chief of Ordnance with a supply of nitrate in case of emergency. From this point of view and this one alone, CHEMICAL & METALLURGICAL ENGINEERING has seen sufficient justification for the creation of some agency for the utilization of the Muscle Shoals plants by the War Department. Until there is an active nitrogen-fixation industry in this country which can function for the Ordnance Department in case of emergency, just as the steel industry can and does, the Government is justified in controlling so complete an agency for the production of nitrate as the plants at

Muscle Shoals. The purpose of such control and operation is nitrogen preparedness. If the original provisions of S. 3390 will not accomplish this purpose, let us discover and support some other measure that will. In our judgment the bill might as well die as pass in its amended form, because the corporation could not possibly function under the conditions imposed. Let us not forget that the issues involved relate primarily to national welfare. From that viewpoint it is inconceivable that after our war experience we should be guilty of the indefensible folly of dependence on Chile.

Chemists May Become Chemical Ambassadors

THE chemical profession needs more ambassadors in industry. Not chemical politicians, not talkers and salesmen of the chemical idea, but rather ambassadors who, by their action in everyday business relations, individually propagandize the doctrine of technical control of plant operations. The number of men available for this work is large, but few hold to the thought.

Between the two fields of chemical activity—pure research on one hand and betterment of industry on the other—it rests with the individual chemist to choose. Should he decide on the former he is to be congratulated, for all the delights of meandering through the dreamland of technical philosophy, all the honors for original discoveries, all the pleasures of independent thinking and of exploration for new ideas, will be his. The beauty of nature's contour, color and music, and all man-made imitations of these, are formless, achromatic and discordant compared to the joyous travels of the inner scientific mind.

But all cannot follow this beacon light of pure science. The majority must occupy themselves with industry; for industry must eventually support research, that research, in turn, may advance industry. Pure science burdened with sordid matters of money cannot climb the peaks. The great host traveling the industrial highway have, however, one ideal in common—namely, that the chemist may become the top executive with each business organization so he can properly apply the principles of his partner, the research man, to the forwarding of the industry in question.

Accomplishment of this object demands that he seemingly depart far from the ways of theoretical science while inwardly clinging to the ideal. For industry thrives best on practical common-sense sort of procedures. On leaving school after a year or two occupied in a rounding out of the theoretical side of his training, the chemist should enter the production department of his chosen industry and start a new training in common sense. He will learn to appreciate that a large amount of work has been done even by rule-of-thumb methods, and see how he may gradually inculcate technical procedure without disturbing the financial equilibrium of the plant operations. He should never forget that he is the servant of the stockholders, who are vitally interested in cash profits.

Many times a new invention cannot be immediately adopted because of the enormous loss involved in scrapping the equipment of the less remunerative process. If a man were hungry and had only the price of a baking oven, he would not buy the oven but rather spend the money on flour and fuel to make his bread by the open fire. New apparatus is often nice but too expensive. Plain thinking rules industry.

The Opportunist In Research

EXPERIENCED research directors of real achievement condemn the opportunist in research, for such a man will do only that which he sees as promising for increased dividends tomorrow. He cannot see as far ahead as next week and he never thinks of the problems of next year. The condemnation of the opportunist is, indeed, frequent among those who really know how to organize and carry through a research program. On the other hand, the commendation of one who knows how to plan and "gets away with it" is not so frequent, though fully as well deserved. It is a pleasure, therefore, to emphasize examples of successful far-seeing research programs.

One of the most striking examples of this sort recently came about in the work of the research division of a large organic chemical corporation whose name is known throughout America wherever the language of chemists is spoken. This research division had under way for several years a program of investigation for which it had been rather criticized by the management of the company. How the director of research managed under the circumstances to keep the work going is a secret which he alone could tell. But in any event he did so.

The reward of the effort which had been made through several years came in full measure recently. With changing relation between costs of materials, the expense for wages and the margin of profits possible in the plant processes, this corporation found it wholly impracticable to continue upon the war-time basis of plant operation. The directors threw up their hands in horror at the situation. They were virtually helpless when confronted by the new industrial problems. That they were thoroughly terrified by the situation is evident by the fact that they took the initiative in consulting the director of research as to what they should do. Then it was that they learned the purpose of all the research upon which they had previously frowned. They found it possible to abandon the old processes which had previously been financially successful, even to the extent of scrapping equipment and structures on an extensive scale. The new program promises to be even more handsomely successful than the old, simply because the research department had fully worked out through all stages of laboratory and semi-commercial scale the industrial requirements of a new economic situation.

Had this corporation been successful in discouraging the far-sighted research program and had the program of an opportunist been insisted on, it is very doubtful whether the research staff could possibly have answered the appeal when this distressing situation was encountered by the management. Some other organizations, which have not been so sympathetic in research and development work upon a scale suited to long periods of successful plant operation, can only take their losses and hope that their conversion to the newer thought may be sincere and permanent. If they are not converted fully, they can rest assured that they will sooner or later be eliminated from consideration. With conditions which demanded close figuring only the best processes and the most efficient utilization of byproducts and wastes can successfully continue under present conditions in competition with other well-planned and scientifically-controlled business.

Presentation of Perkin Medal to Willis R. Whitney

Addresses Made at the Fourteenth Award of the Perkin Medal by the Society of Chemical Industry—
Personal Remembrances by Elihu Thompson and Arthur D. Little—Presentation by C. F. Chandler—
Acknowledgments and "The Biggest Things in Chemistry" by Willis R. Whitney

THE fourteenth Perkin Medal presentation meeting of the American Section of the Society of Chemical Industry was held in Rumford Hall Friday evening, Jan. 14. In the course of his introductory remarks Sumner R. Church said: "It is my own privilege as chairman of the Medal Committee to state simply that at the meeting when the selection was made there was no word spoken save in unanimity of choice. Since then we have heard no words save of approval and heartfelt pleasure concerning this award. I can testify that Whitney's example has inspired every man in this country who has to do with the direction of chemical research. Whenever he could he gave freely of his time to advise and encourage those who visited him, however slight their claims might be."

TWENTY YEARS OF RESEARCH

Prof. Elihu Thompson gave an excellent review of the work of the General Electric research laboratories, using as an illustration the development of the incandescent lamp. The original carbon filament lamp was not very satisfactory. When operated at a temperature which gave a high ratio of light to energy input, the vapor pressure of carbon was so high that carbon was condensed too rapidly on the bulb. The physical properties of carbon were somewhat improved in the G-E-metallized filament which was the basis of the G-E-M lamp. Tantalum, molybdenum, osmium and tungsten were investigated successively. Coolidge's process for making tungsten ductile so that standardized wires could be drawn is the foundation of the modern incandescent lamp industry.

Biographical Reminiscences

BY ARTHUR D. LITTLE

From the point of view from which I see this audience it is in the main a gathering of young men. To them I am glad to say that years bring their compensation. It is pleasant to be able to remember the fiftieth anniversary of the discovery of mauve, to recall its modest and benign discoverer, to have participated in the festivals which were designed to do him honor and to have shared the desire to perpetuate the memory of that discovery and its momentous consequences by the foundation of the Perkin Medal.

Someone has said that an institution is the elongated shadow of a man. Never was this more true than in the case of the General Electric Laboratory. Its achievements have been discussed with authority by Prof. Thompson and will be fully itemized by Dr. Chandler. They are the work of many men to whom they have brought deserved distinction. None the less, the laboratory as the entity and organization which has made this achievement possible is a projection of the personality of Willis R. Whitney, and in this sense its achievements are his achievements.

Whitney returned from Europe in 1896 with a Ph.D. from Leipzig. He had left home a good American and he came back a truer one. He had absorbed in Germany what were then advanced and difficult theories in chemistry and physics and to their application to the solution of chemical and industrial problems he now brought vision and a contagious inspiration. To him a problem was an opportunity and his reaction to it was as reflex and immediate as a knee jerk. I remember that he once told me after a pleasant dinner in Syracuse, when the conversation had reached the eternal verities, that he didn't want to go to heaven unless there were problems there.

Naturally, therefore, he began at once the brilliant experimental work which has added much to our knowledge of solubility, colloids and the corrosion of metals. His fundamental research demonstrated the effect of the positive and negative ions on the precipitation of colloids. He found that the corrosion of metals was an electrochemical process and he was perhaps the first to focus public attention upon the great economic wastes resulting from preventable corrosion.

Whitney is a pragmatic scientist, and the essential and innate practicability of his mental processes found early expression in the successful method which he developed in association with Dr. A. A. Noyes for the recovery of ether and alcohol from collodion, a process which not only assured the commercial position of the photographic film, but which also in its subconscious and later influence upon the mind of Mr. Eastman undoubtedly played its part in effecting that gentleman's reincarnation as the mysterious and benevolent Mr. Smith to whom the Massachusetts Institute of Technology owes its present superb equipment.

I happen to know, for I had the honor of making the bid, that prior to 1900 he refused a doubled salary and remained an instructor at Technology, because he "would rather teach than be President." At the time I thought it an extraordinary example of devoted self-denial, but since then I have seen what happens to our Presidents and I would, without self-adulation, take the same position myself, much as I hate teaching.

ACADEMIC LIFE

Dr. Whitney's relation to the Massachusetts Institute of Technology has been intimate and concurrent with his professional career. Immediately upon graduation, in 1890, he was appointed assistant instructor in sanitary chemistry in that institution. He had, we may assume, no strong directive impulse toward that branch of the science, but he demonstrated at once his characteristic ability to adapt himself to the job, and with it to identify himself. In 1892, by the slow process of academic preferment, he was promoted to instructor, but after serving for two years his desire for the advanced training and broader contacts with the scien-

tific world then offered by Germany caused him to enter the University of Leipzig. Upon his return to the Institute in 1892 he was appointed instructor in theoretical chemistry and proximate analysis. Fortunate indeed were those students whose schedule brought them under his influence. It would be interesting to know how many of them appreciated the quality and recognized the potentialities of their instructor.

He became, in 1901, assistant professor of theoretical chemistry, in 1904 non-resident professor of theoretical chemistry, and in 1908 non-resident professor of chemical research. More recently he has become a member of the Corporation of the Institute and he has served as chairman of its committee on the department of chemistry and chemical engineering, and is now active as chairman of the committee on the department of physics. It is a matter of general comment and satisfaction within the instructing staff that he has never lost interest in the school. Visiting committees of the Corporation too often do not visit. But Dr. Whitney came upon the job determined to know its every aspect. He spent days in the laboratories. He sat down by students; into them he injected his own enthusiasm. He studied the needs of the departments and he followed his studies by helpful suggestions and constructive criticism.

IDEAL CHARACTERISTICS

One very conspicuous element in Whitney's character is the sincerity of his indifference to monetary rewards. It is the more striking because of the clarity with which he visualizes the economic aspects of research results. He went to the General Electric Co., as I confidently believe, not for money, but because it offered an environment and opportunity for broader and more effective service. I am no less confident that he would return to Tech. tomorrow and readjust his expenditure within the narrow boundaries of a professor's salary if he felt that there he could do a better job.

I wonder how many of you have realized how closely in appearance Whitney resembles Lizst. One expects of him—and is not disappointed—the same fire and enthusiasm, a kindred brilliancy of performance, a similar exothermic quality. Whitney can talk to a man three minutes and inject into him enough enthusiasm to last three months. He can recognize genius and he is big enough to allow the man of genius to develop at his side. He has no wish and makes no effort to dominate. He scrupulously apportions credit where it belongs. Jealousy is alien to his nature. These are the characteristics of the ideal director of research, and it is because they are possessed in superlative measure by Willis R. Whitney that we are present here tonight.

HUMAN ELEMENTS

Willis R. Whitney is a great scientist, but he is not the scientist of fiction or of the stage. He is an intensely human individual. He is extremely fond of outdoor life and it keeps him sane and wholesome. He is a farmer, not a gentleman farmer but a dirt farmer who knows hog cholera and manure and what to do when his hens have the pip. He has hobbies and rides them. He can tell you more about arrowheads than an Algonquin Indian ever knew, and if necessary he can make them. He usually prefers to pick them up in Central Park or Long Acre Square, or at church. He can find them anywhere. He enjoys the lighter things of life and has even been known to sidestep a meeting

of the American Academy of Arts and Sciences, and go to a girl and music show instead. Biological subjects (and I am not now referring to those just mentioned in association with music) interest him keenly. He raises flies and kills them with X-rays to cure their cancer. Some day he may kill the cancer first. He is a serious student of heredity and knows exactly how much red hair is required to tint a large family unto the third and fourth generation. But do not let me convey the impression that Whitney approaches these vocational interests in the spirit of the dilettante. His knowledge of them is not broad and thin, it is both broad and deep. When he cultivates a subject, he does it intensively with all the energy in him. Better than all this, however, Whitney has a genius for friendship. He knows you but likes you.

With this interest in his fellowmen so dominant and characteristic, it is not surprising that Whitney should have proved an ideal teacher or that no later absorption has turned his thought from education. He inspires whole departments in the Massachusetts Institute of Technology; he is the prime mover of Albany Medical College, and as trustee of Union College at Schenectady has so tied his laboratory to the college that they constitute a joint educational institution.

In a very striking way and more nearly, as it seems to me, than any of his contemporaries, Whitney has the mental attitude and scientific breadth of an earlier generation in the scientific world, the ability to correlate and integrate observations and deductions in wide and different fields.

The Perkin Medal is the badge of knighthood in American chemistry. It has never been more worthily bestowed. Its latest recipient has inspired numberless young men; he has brought distinction to a great corporation and proved to financiers that research pays; he has brought new luster to American chemistry. The spirit of research has laid her hands upon him, and the spirit of youth as well.

Presentation Address

BY C. F. CHANDLER

It is my privilege and very pleasant duty as senior past-president of the Society of Chemical Industry, residing in this country, to present to Willis R. Whitney, S.B., Ph.D., the fourteenth impression of the Perkin Medal, in recognition of his most original and valuable work in applied chemistry.

Dr. Willis R. Whitney was born in Jamestown, N. Y., Aug. 22, 1868, and was the son of John and Agnes (Reynolds) Whitney. He was graduated from the Massachusetts Institute of Technology with the degree of S.B. in 1890, and in 1896 received the degree of Ph.D. from Leipzig.

RESEARCH LABORATORY OF THE GENERAL ELECTRIC CO.

His most notable achievement has been the creation and development of the Research Laboratory of the General Electric Co. at Schenectady. This laboratory, one of the earliest of its kind in this country, the embodiment of the application of science to industry, has gained a world-wide reputation by the quality of its work and the importance of its results. These results speak for themselves, but only those associated in the laboratory with Dr. Whitney can realize to what extent they are due to him personally, or how truly the story of the laboratory, from its inception with

a small staff to its present development with 275 people on its payroll, has been the story of his personal achievement. Its growth has followed naturally from the value of its accomplishment, but its accomplishment has been due primarily to him. His broad scientific knowledge, his ability as a chemist, his resourcefulness in experiment, his energy, enthusiasm and optimism, combined with a clear sense of proportionate values, laid the foundation for, and guided and inspired, all the work of the laboratory, while his democratic and magnetic personality created an *esprit de corps* in his staff which has been a powerful factor for success. This must be realized fully to appraise justly his personal achievements in considering the success of the laboratory.

These successes have often been recited specifically to prove the value of the application of organized research to industry. In electric lighting the first radical improvement in the carbon incandescent filament, since Edison first produced it, was due to Dr. Whitney's personal work. The "metallized" filament, or "Gem" lamp, which he developed and which embodied a new form of carbon, gave 25 per cent more light for the same wattage than the standard carbon filament lamp. Millions of these new lamps were sold in a single year. A little later the laboratory made a still greater contribution to electric lighting, by solving the problem of mechanically working tungsten and taught the world how to make the drawn wire which has given the tungsten lamp its universal application. The latest achievement of the laboratory in incandescent lighting is the gas-filled or half-watt lamp, which, in its larger sizes, has twice the efficiency of the vacuum lamp, and nearly equals the most efficient arcs. In arc lighting

the laboratory developed the magnetite electrode, and thereby produced the most successful arc lamp of today.

The laboratory has produced many new and useful forms of insulations and molded compounds, many new alloys for resistance units and other purposes, new processes, like "calorizing," for giving metals protective coatings; new articles of manufacture, like "sheath wire," with its core of resistance alloy, its mineral insulation and its metal sheath, adapted for heating devices; new materials, like "water japan" and "Genelite"; new electric-furnace products, like boron carbide, useful as a flux for casting copper, and titanium carbide for arc lamp electrodes; new laboratory tools, such as the Arsem vacuum furnace, the tungsten tube furnace and the Langmuir condensation vacuum pump; high-resistance units for lightning arresters, improved carbon and graphite and Metite brushes.

The development of wrought tungsten has been followed by several important applications worked out entirely in the laboratory. Tungsten contacts have practically replaced platinum in spark coils, magnetos and relays, and tungsten targets have replaced platinum in X-ray tubes.

As a result of a study of high vacuum, the laboratory devised means and methods for producing much higher vacua than before obtained, and the study of the phenomenon of electron discharge in high vacuum has produced a number of new types of vacuum tubes which have revolutionized more than one art. The Coolidge X-ray tube was the earliest result of this investigation and has practically displaced all other types of X-ray tubes. It has made possible many results not otherwise obtainable, as, for instance, the development of a truly portable X-ray outfit. Another result was the plotron,

the first real power tube suitable for radio transmission. The plotron practically created radio telephony and has revolutionized radio telegraphy. Other types of these tubes resulting from this investigation are the dynatron, magnetron, pliodynatron, etc. The contributions of the laboratory to pure science have been numerous, varied and important, as is indicated by the titles taken from the list of laboratory publications:

Factors Affecting Relations Between Photo-electric Current and Illumination.

Structure of the Atom.

Theory and Use of the Molecular Gage.

Theory of Unimolecular Reaction Velocities.

Absorption and Scattering of X-Rays.

New Method of X-Ray Chemical Analysis.

New Method of X-Ray Crystal Analysis.

Roentgen-Ray Spectra.

High-Frequency Spectrum of Tungsten.

Arrangement of Electrons in Atoms and Molecules.

Chemical Reactions at Low Pressures.

Constitution and Fundamental Properties of Solids and Liquids.

Dissociation of Hydrogen Into Atoms.

Effect of Space Charge and Residual Gases on Thermionic Currents in High Vacuum.

Evaporation, Condensation and Reflection of Gas Molecules.

Fundamental Phenomena in Electron Tubes Having Tungsten Cathodes.

Isomorphism, Isosterism and Covalence.

Mechanism of the Surface Phenomena of Flotation.

Octet Theory of Valence and Its Applications With Special Reference to the Organic Nitrogen Compounds.

Properties of the Electron as Derived From the Chemical Properties of the Elements.

Structure of the Helium Atom.

The Structure of the Hydrogen Molecule and the Hydrogen Ion.

Dr. Whitney is a trustee of the Albany Medical College and of Union College, and a member of the Cor-



W. R. WHITNEY

poration of Massachusetts Institute of Technology. He is a member of the U. S. Naval Consulting Board, National Research Council, American Chemical Society (president in 1910), American Electrochemical Society (president in 1911), American Institute of Mining and Metallurgical Engineers, American Institute of Electrical Engineers, American Association for the Advancement of Science, American Academy of Arts and Sciences, American Physical Society and British Institute of Metals. He received the Willard Gibbs Medal in 1916 and the Chandler Medal in 1920.

PUBLICATIONS

Dr. Whitney's translation of Le Blanc's textbook of electrochemistry is well known. Among the papers which he has personally published, are the following:

1. The Rate of Solution of Solid Substances in Their Own Solutions (with A. A. Noyes). *J. Am. Chem. Soc.*, vol. 19, pp. 930-34 ('97).
2. The Nature of the Change From Violet to Green in Solutions of Chromium Salts. *J. Am. Chem. Soc.*, vol. 21, pp. 1075-84 ('99).
3. The Precipitation of Colloids by Electrolytes (with J. E. Ober). *J. Am. Chem. Soc.*, vol. 23, pp. 842-63 ('01).
4. An Investigation of Ammonio-Silver Compounds in Solution (with A. C. Melcher). *J. Am. Chem. Soc.*, vol. 25, pp. 69-83 ('03).
5. The Corrosion of Iron. *J. Am. Chem. Soc.*, vol. 25, pp. 394-406 ('03).
6. Electrolysis of Water. *J. Phys. Chem.*, vol. 7, pp. 190-93 ('03).
7. The Migration of Colloids (with J. C. Blake). *J. Am. Chem. Soc.*, vol. 26, pp. 1339-87 ('04).
8. Colloids. *Trans.*, Am. Electrochem. Soc., vol. 7, pp. 225-36 ('05).
9. Arcs. *Trans.*, Am. Electrochem. Soc., vol. 7, pp. 291-9 ('05).
10. Suspensions in Dilute Alkaline Solutions (with Alonzo Straw). *J. Am. Chem. Soc.*, vol. 29, pp. 325-29 ('07).
11. Organization of Industrial Research. *J. Am. Chem. Soc.*, vol. 32, pp. 71-8 ('10).
12. Some Chemistry of Light. *J. Am. Chem. Soc.*, vol. 32, pp. 147-59 ('10); Presidential Address, American Chemical Society, Dec. 29, 1909.
13. Alloys. Amer. Foundrymen's Assoc., 1910.
14. Chemistry of Luminous Sources. Johns Hopkins University, 1910; Lectures on Illuminating Engineering, Vol. 2.
15. Research as a Financial Asset. *Electrical World*, vol. 57, p. 828 ('11); *J. Ind. Eng. Chem.*, vol. 3, pp. 429-33 ('11); *Science*, vol. 33, pp. 673-81 ('11); Congress of Technology.
16. Mental Catalysis. *MET. & CHEM. ENG.*, vol. 9, pp. 179-82 (April, 1911). Opening Chemists' Building, New York.
17. Theory of the Mercury Arc Rectifier. *G. E. Rev.*, vol. 14, pp. 619-21 ('11).
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CONFERRING THE MEDAL

Willis R. Whitney, Bachelor of Science and Doctor of Philosophy:

It gives me the greatest pleasure, as the representative of the Affiliated Chemical and Electrochemical Societies of America, to place in your hands this beautiful Perkin Medal, as a token of the appreciation and affection of your fellow chemists.

The Biggest Things in Chemistry

BY W. R. WHITNEY

If I were to try to justify my receiving the Perkin Medal I think I would begin by assuming that now good intentions are being rewarded. As the aim of the award is to promote or stimulate research, I must find the ways by which I can most directly do so, and so I ought to say something about the biggest things in chemistry. No matter how irrelevant some of my remarks may seem, I hope you will believe that they are aimed with that high intent. While it is a great honor, it is also a wonderful opportunity to write something which may be read by 15,000 or more American chemists.

In America patents are granted to individuals for their new disclosures. Such patents are not granted to organizations, to companies, nor even to laboratories. This is really an antique limitation, for discoveries are often the result of combined efforts. And so I look at the Perkin Medal, in my case, as an award directed to me, but belonging to the Research Laboratory to which I belong, it having not yet become customary to award such medals to laboratories. In any case, I heartily thank the various men and organizations which made this medal possible, and the committee of award who have chosen that my name shall stand on that honor list headed by Perkin.

I am not going to tell of the specific researches in which I may have co-operated, nor of the good fellows who have carried them out in our laboratory, though

I should like to do so. One reason is that this is, to a considerable extent, being done all the time, through our laboratory system. We have always followed the plan of individual publication as completely as seemed desirable from the scientific point of view and as rapidly as consistent with fair commercial conditions. Moreover, I, being almost the only man in our laboratory who does not often personally carry through separate researches, have already summarized the work of others until it is overdone.

What I have to say oscillates about a central point. This point I see so well that I am surprised that every one does not see it too, and make more use of it. I am also at a loss to know why so many men go through college keeping their eyes mainly on a ball of some kind or other when the world is so full of greater interest. Perkin's life contains all the data which we need in analyzing scientific research, and shows at once what I will repeat throughout this paper—that our great advances are usually made by men who are trained in their particular line of work and are working diligently just beyond the boundaries of the known.

Perkin was a student of chemistry in one of the best college laboratories in England, under a great teacher (Hofmann), who was so imbued with the chemical research spirit that he tried to keep Perkin from stopping to develop technically his discovery of mauve. He actually left such an impression on this young man's mind that after years of commercial success Perkin returned to pure scientific research and enjoyed it for the rest of his life.

The essentials appear to be: First, the teacher, enthusiastic pioneer, hunting and fishing along that ever-expanding outer rim of knowledge; then the laboratory and equipment, supported by some far-sighted government, individual or organization. And then the school-boy with shining morning face. Don't say it can't be done, and that Perkins, Faradays and Pasteurs are born, not made, for the process is entirely standardized. We in our schools have not realized the proper sequence, because we have used so much of our energy in bringing large numbers of men part of the way only.

On receiving the first Perkin Medal at the time of the Jubilee Celebration Sir William Perkin said that he had all his life insisted on the importance of research and that this medal would accomplish a valuable result if it helped to encourage and stimulate activity in that direction. He then proceeded to tell the interesting story of his own discoveries. Such a story is the strongest force he could have used to support his wish to promote research, and it is true that, although it would have been more agreeable to him if some one else could have told the story, everyone who heard it and the countless chemists who live to read it are glad no one else told it.

EARLY INTEREST IN CHEMISTRY

No greater satisfaction in connection with my own life's work could come to me than to contribute to the encouragement and stimulation of research. If I can help it to an appreciable extent by telling any unpublished portions of my own story I will willingly disregard for a few moments a natural reluctance to talk about myself.

I learned that Prof. Perkin became a chemist through the influence of an Englishman named Hall, with whom he came into contact when under fifteen years of age, and, moreover, an event which increased his desire to become a chemist was seeing an experiment showing

the growth of certain crystals. I have the honor to have started as a chemist in this identical manner, and I will tell a little more about it, because I have always wished I had some way of expressing my gratitude to my particular Mr. Hall.

When I was about fifteen years old an English mill owner and one of the leading citizens of my home town, William C. J. Hall, assisted in establishing a Young Men's Christian Association. He had also long been interested in the microscope and was a scientist such as we seldom find among business men today. He formed a free evening class for about half a dozen boys—all that could work together around the rotating table on which he placed his immense microscope. This was so arranged that specimen, instrument and illuminating system did not have to be disturbed as they passed from one boy to another for observation. He did not merely show his specimens, of which he had thousands, but taught us how to prepare them in all the various ways now more or less common. They were all wonderful to me, and still are.

My mother gave me some money which, combined with that of one of the other boys, purchased a small microtome, and my father gave me \$75 for a microscope. Under Mr. Hall's guidance I bought the instrument, with the understanding that whenever I wanted a better one the old one would be taken back at the original price. I later procured one for \$250 which, throughout thirty-five years, I have used almost daily. One of the first experiments I tried with the microscope was to precipitate metallic silver from silver nitrate solution onto a speck of copper filings. Anyone who has watched these beautiful crystals grow knows that they are surpassingly wonderful. They constituted my first chemistry. It was those little bottles of salts and bugs in alcohol that led someone to call me a chemist, and it apparently determined my future work.

It does not seem now as though anyone else ever enjoyed a tenth of the pleasures my old microscope introduced to me. I find them inseparably interwoven with about everything I know. Even the barren North Pole reminds me of Andrée and Amundsen and microscopic algæ which drifted across the polar circle from the Lena delta. The equally barren Sahara reminds me of Darwin and De Vries and the diatoms which were carried by the wind from central Africa and fell on the deck of the Beagle, hundreds of miles away.

CONCENTRATING ON THE IDEAL

In trying to put the truthful personal and human element into these notes, as previous Perkin medalists have done for the help of would-be research men, I find I cannot lay valid claim to the insurmountable difficulties nor to especially commendable early struggles which have helped so many others. Perhaps even this admission, however, may have its place for the encouragement of some research man. I was early taught that a dollar a day was a fair wage and that frequently was unearned, and I quit worrying about pay so long ago that the date is not important. I once asked the president of a large technical school for a salary increase of \$75 a year and was shown that it could not be done. Perhaps that wise president convinced me that financial rewards are not the main thing. At any rate I believe it.

In mapping milestones not mentioned before I want to express my indebtedness to Prof. A. A. Noyes, who showed me some of the interesting things in the science of chemistry. He let me work with him on some

physicochemical researches, and this work was responsible for my later spending two years with Ostwald in Leipzig and a summer with Friedel in Paris. Work with these men gave me a feeling of surety in chemistry that no mere talk could ever have done. I ought to say that one of our first joint researches, so far as publication was concerned, had the peculiar effect of freeing me forever from the wiles of college football, and if that is a defect make the most of it! Dr. Noyes and I conceived an idea on sodium aluminate solutions on the morning of the day of a Princeton-Harvard game (as I recall it) that we had planned to attend. It looked as though a few days' work on freezing point determinations and electrical conductivities would answer the question. We could not wait, so we gave up the game and stayed in the laboratory. Our experiments were successful. I think that this was the last game I have ever cared about seeing. I mention this as a warning, because this immunity might attack anyone. I find that I still complainingly wonder at the present position of football in American education.

THE BIGGER THINGS

I would prefer now to talk about the biggest things in chemistry, not so that I may be facetious, nor yet to form a companion piece to a talk on the littlest things. Far from it. In fact, so far from it that after having some of my thoughts in preliminary notes for years, with a conviction that they ought to be expressed, I have always deferred it. I feared that I was not just the man to say it.

We are all interested in the detailed and specific advances which constitute our science. We know that it is from these little things that the largest ones grow. We see a certain similarity between the history of Prof. Perkin's mauve, with its subsequent enormous development of the dye, medicine and explosive industries, and the development of the living acorn into the spreading oak tree. But we should sometimes look at the forests from the plains, without obstructions. And we want to know our chemistry, too, in its relation to the general landscape. Some kind of an inner man advises us not to think exclusively of the littlest things, the parts of some whole, but sometimes to give constructive thought to the ultimate objects, to our aims at large, our chief pretensions, our real ambitions, our main direction of motion. Are these consistent with or independent of our temporary and apparently vacillating movements?

I know from experiment (as we usually say) that no two chemists would agree at first as to what constitute the most important things of chemistry. I have found, however, that if we say that the "possibilities" are the biggest things, then today there is some agreement among experts.

TESTED LAWS

Chemistry is one of those branches of human knowledge which has built itself upon methods and instruments by which truth can presumably be determined. It has survived and grown because all its precepts and principles can be retested at any time and anywhere. So long as it remained the mysterious alchemy by which a few devotees, by devious and dubious means, presumed to change baser metals into gold it did not flourish, but when it dealt with the fact that 56 g. of fine iron, when heated with 32 g. of flowers of sulphur, generated extra heat and gave exactly 88 g. of an entirely new substance, then additional steps could

be taken by anyone. Scientific research in chemistry, since the birth of the balance and the thermometer, has been a steady growth of test and observation. It has disclosed a finite number of elementary reagents composing an infinite universe, and it is devoted to their inter-reaction for the benefit of mankind. The rate of this advance in chemistry is in our day almost incredibly great.

THE HISTORY PATH

Mark Twain's little history game has given me a view of our rate of development, and particularly of modern as compared with ancient affairs, that I want to pass along to you. Possibly some of you have thought of the rate of mental development, of material development and of power developments as involving only a fairly uniform change through all time. This is not so at all. But to shorten this story: I started from a certain point in the woods with a measuring tape and marking tools and laid out a winding path 1,000 ft. long. I cut smooth marking places on all trees along the way and on some large rocks. I appropriated 1 ft. length of this path for each year's history since William the Conqueror (the year 1000), and spent the rest of my time properly locating prominent events along the path, down to 1,920 ft.

I was impressed by the 45-ft. length of Queen Elizabeth's reign, near the middle of the way, and such a short distance from Columbus and the discovery of America. Stockings and pins and sugar (except as medicine) came into the path about there. But of interest to us particularly is that all the great chemists began to arrive together near the 1,850-ft. point. This seemed very recent. It meant that most of the superstitions about matter began to disappear only about 250 ft. back, so to speak. You all know the story, but for 75 or 80 per cent of my measured path, and for the interminable portion representing all time prior to 1000 A.D. (which I let wind without construction or destruction back the mile or more which might still have been historically illustrated), there had been no need for more than four supposed elements, earth, air, fire and water. It was not the old facts but the dimensions which impressed me. While a foot is ample space in which to erect monuments to everything we know about any year chosen in the fifteenth century, and a single tree could be signpost for all the cards on events for any century a little earlier, there was great lack of space for descriptive matter beyond the 1,800-ft. point.

All down the line, to within a stone's throw of the end, individual man-power had been the important energy, and then as power it almost disappeared. Within 200 ft. of the end, which stood for the present day, steam had been put to use, and there came in turn the myriads of machines which multiplied a thousand-fold the previous constant and limited muscular power of man. No one can accurately determine the added spread of effort due to this substitution of coal for human strength, and then of machines, one for another.

Within 30 ft. of the end of the path a score of new chemistries had grown into activity, and every single one seems more promising than the original stem: physical, colloidal, subatomic, radio, metabolic, biologic, enzymic, piezo, therapeutic—all growing infants. Thus the time seems almost near when, to quote Carnegie, "the mind, like the body, can be moved from the shade into the sunshine."

This interesting game of Mark Twain's actually

chokes itself off mechanically when one tries to post modern chemical work at one foot per year. New facts now take about that space when posted edgewise in abstract journals, a dozen items per page. What this game, applied to chemistry, had done for me is to show me the almost inconceivably great strides in countless lines which constitute our modern chemistry, and it leaves me with the feeling that no one in the world has ever had such possibilities open to him as the present-day student of chemistry.

CREATIVE CHEMISTS

Perkin was a well-prepared research chemist when he made his discoveries. He was just the kind of man of which we produce too few. Only a very small number of our students get so far in the science as he went under Prof. Hofmann, and nowadays, in order to go so far, one must go much farther, for, as Wendell Phillips said, "to be as good as our fathers were, we must be a good deal better." The process Perkin followed is the same one which has led to most of our discoveries. It is the encouragement of natural inquisitiveness under the best conditions. It is using the newest knowledge and best tools in exacting pieces of work. No short-cut and easy process would have produced dyes from tar. Such efforts could not even find a way to make tar acceptable for road material.

One of the biggest things in chemistry for us today is to learn how to bring about the productive teaching of chemistry. The desirable qualities are illustrated by the life of Wöhler, who prepared the first organic compound when the consensus of opinion (and infinite argument) favored the theory that organic compounds were only producible through a mysterious vital force. Pasteur's work is another case of a trained research chemist, and every American should learn his ways. What such explorers seek are not imaginary points on a drifting field of perpetual ice in an uninhabitable world, but something which may possibly help every individual who lives after them.

We might have similar results developing in chemistry today, but they call for the good teachers and the highly trained observer, with well-backed faith. These two, high training and faith, are an uncommon pair with us. They seldom grow within the same Yankee.

EXPANSION OF INORGANIC DEVELOPMENT WORK

I need not repeat what is known about the many disclosures of inorganic chemistry. How, within the past few years, chemical science has at least doubled the number of available metals, and so raised to the n th power the possible alloys. All these new metals are generally coming into use, as you know.

I am often reminded of metallic calcium in this connection, because it is really still being born, but the process is the old one. It was produced by high-grade electrochemical research, and the discoverer in describing the process said: "We do not know now of any use for this new metal, but when its properties and production are understood it will probably find its place."

It is almost useless to think otherwise. Here is a chemical element the compounds of which are as numerous and whose ores are as rich as those of any element known. The isolation of the metal is not so simple as in the case of zinc, copper, iron or tin, and its properties are different, but, as usual, it is differing properties which determine the new use. It is worth telling in passing that during the war we made this

metallic calcium and found two widely different uses for it. One was as a suitable generator of hydrogen to maintain very high pressure of this gas inside certain deep-sea sound-detecting devices, where the sea water itself was the other reagent. The reaction was slow and well suited for this work. The other use is as a continuously reacting purifier for argon in the tungar rectifier. This latter is now the basis of a considerable manufacturing business. It is interesting, from the chemical research standpoint, because it consists of a bulb made of a special new glass, a tungsten wire spiral, an artificial graphite electrode, a little argon gas and some metallic calcium. Within the spread of my brief experience there was a time when any part of this combination would have been an impossibility from lack of every one of these chemical materials. And so I note such researches as Prof. Lehner's on selenium oxychloride, and I say to myself, "Watch it grow." To add such a liquid to our little category will prove an ever growing utility.

We ask ourselves, Can there be greater fields of new organic chemical research than that which met Perkin as a student? Is not tar the last big raw material? The answer is simple. New fields are greater in number because the territory of chemical knowledge is so greatly broadened and the new tools are so numerous. The results will depend solely on mentality—not tar. Is it not within reason that another as great a field as dyestuffs will be developed directly from carbon itself, for example? The entering gates to organic chemistry, reached by the shortest road, were apparently opened when calcium carbide was first made. Thus, starting with two of our most abundant mineral products, coal and limestone, and adding water alone, we are supplied with the endothermic gas, acetylene. From this point almost anything organic seems possible. When we realize that the manufacture of acetone, alcohol, etc., has been thus made possible from these inorganic raw materials we might as well expect, by the same road, useful food as certainly as medicaments.

I am repeatedly pointing to need in our country for the highest class of chemical preparation. It is not enough to talk of the importance of fuel, of the conservation of coal, of the possible use of benzene or alcohol in our motors. Such have already become problems, and we have a hundred thousand engineers in the country capable of solving them. Some of these men have already carried out the manufacture and use of hexahydrabenzene in motors, for example, but the chemistry itself, as a science, though still infinitely promising, is relatively neglected.

EXPERIMENTS IN AGRICULTURE

Possibly one of the biggest things in chemistry lies in agriculture, but it would be futile for me to treat of its research by the modern truthful but standardized method. It is admitted that we need more and better fertilizers. We now use nearly \$200,000,000 worth annually. It is true that we have recently spent many million dollars on nitrate plants. We also think we need half a million tons of potash annually, and of this we can see how to produce locally only about 10 per cent. We want synthetic ammonia and we can get it, because during the war we were forced to adopt production methods derived from foreign chemical research.

I do not need to go farther with agriculture in order to prove that I am not a real farmer, but I insist on doing so because I want to make clear the thought that possibly our troubles in general with Nature are some-

times due to our personal limitations, not to the limitations of Nature.

It looks to me as though possibly man had developed most of the cultivated fruits of the field along the line of maximum human exertion and immunized them to everything else. I draw this hasty conclusion from a single experiment of my own. Last year I procured some special high-grade seed corn and treated portions of it in widely different ways. In one case the kernels were planted, properly spaced, through holes in large sheets of paper placed on new ground which had had its grass killed by a year's covering with gravel, which was then removed. The paper was to discourage the weeds and make hoeing unnecessary. Other hills were planted without the paper, and still others in which the soil was taken up, softened and replaced. None of these new-type gardens was disturbed during the summer. Less radical experiments, including nothing at all but muscular effort, were tried on other hills in an old type garden.

Knowing how corn had been produced through thousands of years of applied work, the results could have been foreseen. All that grown on new soil, protected by paper from weeds and from evaporating winds, took the whole summer to grow about a foot high. It looked very mature, but didn't bother to produce any ears. That which had been about buried in modern artificial fertilizer, and well hoed, pulled through somehow, and that which had been manured and most energetically hoed did the best and gave a normal corn crop.

The growing of corn and grain is an older process than making wire nails and cannot be so easily improved. It has developed with no fair regard to human labor, and will take more novelty of effort to change it than was employed in freeing manual labor from nail, screw and bolt making, or from the production of artificial indigo or synthetic camphor.

When one reads of the experiments of Loeb on the rate of growth of bryophyllum shoots as influenced by various schemes of cutting leaf from stem, etc., one can hardly doubt that new truth, learned for itself alone, in some such way, may at least rearrange some parts of future agricultural research. Anyone who has annually tried to kill a burdock by any means short of complete eradication, or who has watched the persistency with which a lot of wild chicory will grow to maturity in the almost imaginary crack between a reinforced concrete road bed and the adjoining separate curbstone, will appreciate the thought that some time, somehow, man may successfully direct his researches toward the growth of useful vegetation with reduced, not increased, human labor.

MEDICAL RESEARCH

Many biggest things in chemistry are coming from chemical research in the field of life and health. When I recall the Rockefeller Institute for Medical Research and think of the international character of its men and work I incline to the belief that through such researches in chemistry and allied sciences the countries of our world may be more certainly finally allied than by the system of countless peaceful words coupled with increasing armaments. There I have seen Carrel, French scientist of the purest type, keeping chicken tissues growing on microscope slides for nearly a decade in order that he may carry out those quantitative experiments which lead to exact medical science. In such an institution a class of refined and exhaustive research

work can be done whose results stand as foundation stones on which doctors and surgeons of all lands may build at once. The diplomacy of such institutions leaves no room for international spies. The results, as soon as verified, are published to all quarters of the globe. Jacques Loeb, studying the amphoteric properties of gelatine or the temperature coefficient of the life-reactions of fruit flies, is putting permanent points of observation on the graph of human knowledge where all may see, confirm and use them. The little Japanese Noguchi, a most attractive enthusiast and a co-worker of Dr. Flexner's for nearly twenty years, is now all wrapped up in yellow fever work. He has isolated the germ and prepared the preventive vaccine and the immunizing sera. Thus he adds some of the finishing touches to that story of a fight which has been under way since 1900, when Dr. Lazear knowingly risked and lost his life by letting a certain mosquito bite him.

WONDERS OF THE BRAIN

If we think of the brain as the workshop of the mind, and then look back over the history of the growth of brains, we find that this workshop first appeared as a relatively *very* small portion of the mass of the early animals. All the prodigious vertebrates of the mesozoic period had exceedingly small brains in proportion to their bodies. The brain size in comparison to the size of the animal has always been on the increase. In man and his forerunners this is also well known. But it is significant that even with man there is no continuing brain growth when he is kept from doing or thinking something new. The Egyptian fellaheen, who were kept at unchanging labor for many centuries, possessed the same size brain cavity at the end as at the beginning of that period. But the diameters of the brain cavities of the early man-forms after the chimpanzee (the Trinil, Piltdown and Neanderthal men) stand to man as at present in about the relation of the numbers 12, 13, 14 and 15.

And yet, in this most modern workshop, the energy which is consumed is so small, when compared to the work done by other organs of the body, that it cannot be measured as energy at all. It is easy to measure the work done by the little finger and express it in calories consumed from the food eaten. The most extensive mental exercise is much more economical of energy. In other words, we have not yet taxed the mind's workshop from the energy or work point of view. All this means that, following the direction of natural development, there need be no lack of that brain power or mentality which is needed to handle all that we may wish to know and think.

MENTALITY

The biggest thing of all in research is the mental effect, the projecting of a beam of light into the infinite and the growth of man's appreciation. I can scarcely touch the many connections here. But in delicacy and sensitiveness the mind far transcends the wireless receivers which yet read, half around the world, a message sent by a few watts of energy. And I need say nothing about its possibilities as a power producer or controller. In co-operative work minds multiply, instead of adding together, and growth of mind depends on the experiments or the reactions with things. Whether mind is polarized energy, or merely a long habit, may still be in doubt, but there can be little doubt as to what expands it.

Not very long ago it was safer to conceal new truths

than to disclose them. If a man wished to die by some horribly ingenious method he had but to discover something like the rotundity or mobility of the earth and insist on it. For advocating justification by faith alone he would be burned alive. Dabbling with intangible matters which led only to disputation was gradually displaced by increased attention to immediate surroundings.

Is it too much to say that through research into materials the main advances in physical and mental welfare take place? Where do we meet contradiction if we say that, except for research or experimental study of matter, we stand still or mill about in circles filled with superstitions? Particular attributes of the human mind may well have reached higher altitudes in some previous age, as is usually claimed. In specific lines of human undertaking we can but accept this as true. We have no Homer among our poets, no Cellini nor Angelo nor Da Vinci among our artists. Plato and Aristotle and many others ages ago equaled our present-day logicians. Such are the nuggets of truth which the seeker for values in history is apt to dig up. As architects or sculptors or hewers of stone we may be retrogressing, and in any selected development we may have passed zeniths, but all the time the knowledge of the universe and of each atom of it, from the tiny flower of the crannied wall to the sun which brings it forth and the stars which so immensely exceed this, has been rapidly increasing. The only perpetual motion is the growth of truth. Possibly faith, hope and love are not at a maximum in our age, but they may be, and through all ages there seems to run Tennyson's one "increasing purpose." Only one sure line of continuing increments can be traced. It is not the line of the search for waters of eternal youth. It is not the series of philosopher-stone experiments, though a few of them contributed to the steady growth of our horizon. It is not the line of ascetism, stoicism, religious tolerance or intolerance of any form, nor yet the political systems of the widest variety. They are now useless except as they added to the accumulating mass of truth. Appreciation of environment has always increased.

RELIGION

The natural desire for religious truth has been responsible for most colleges and universities. They served first to encourage learning and prepare religious teachers, but only recently has it become the recognized duty of universities to seek truth by investigation of material things. Goldwin Smith wrote of Oxford in the early days that, "For the real university students the dominant study was that of the school of philosophy, logical and philosophical, with its strange jargon; an immense attempt to extract knowledge from consciousness by syllogistic reasoning instead of gathering it from observation, experience, and research, mocking by its barrenness of fruit the faith of the enthusiastic student. The great instrument of high education was disputation often repeated, and conducted with the most elaborate forms in the tournament of the schools, which might beget readiness of wit and promptness of elocution, but could hardly beget habits of calm investigation or paramount love of truth."

The uptrending curve of recognized facts might be called Nature's appreciation curve, or the growth of mind. While cattle eat, drink and die with no more appreciative attitude toward their surroundings than shown in previous ages, mankind has accumulated, by

experiment, everything that distinguishes him. But certainly the end of this growth is far away and still out of sight. When men can talk so glibly about their closeness to a Creator and yet uniformly show, by destructive warfare, their extreme remoteness, surely the great undertaking, whatever it means, is not nearly complete. We have much to learn.

May it not be possible that the human urge for new truth, the world trend for clearness of vision in material things, will be justified? Can there be a better way of appreciating the wonders of creation than by looking into them, uncovering, understanding and appreciating them?

I should identify all search for scientific truth with the highest religious aim, no matter what the cult. I would point out here that our inactivity and inappreciation in the presence of infinite, undeveloped truth is the most inexcusable type of error and unfaithfulness. It is intense faithlessness, no matter what conception of a Creator we adopt.

There is no better (perhaps no other) way of going forward in the new paths which instinctively attract us than by using new material knowledge. Is it not possible that words of affection, of sympathy and promise of all kinds, helpful, heartfelt and beautiful as they may be, are only the paper money of our transactions, and that behind them there should be gold of service in which to pay the promises?

I do not look at this as crass materialism. We all know that the mere chemical reactions of the brain are not the whole story. A measuring machine repeating automatically all the motions of the scientist would not interest us at all. Appreciation of the infinite is not mechanical, but truth is necessary for appreciation. John Burroughs has said: "Every day is a Sabbath day to me. All pure water is Holy Water, and *this* earth is a celestial abode. It has not entered into the mind of any man to see and feel the wonders and mysteries and the heavenly character of this world." Yet most of what even John Burroughs sees and appreciates is outside of the infinitely beautiful and orderly realms of modern chemistry. When we are first old enough to ask ourselves questions we are so mature that we seem already surrounded by an infinitely complex and interesting environment. A persistent and age-old instinct makes us want to wander

"Into regions yet untrod
And read what is still unread
In the manuscripts of God."

And it has developed that in no other way may we hope to understand and appreciate. Chemists should naturally be the first and greatest appreciators. Research is appreciation.

Efficiency of Electroplating Greatly Increased

Much interest has been aroused by the account given at a joint meeting of the Faraday Society and the Institute of Metals held in Sheffield of a discovery made in the university of that city which will increase the output of electroplating factories by 100 per cent. Frank Mason, the inventor, who is lecturer in electrometallurgy and electrochemistry in the university, discovered by experiment that by a change in the chemical composition of the electrolyte the maximum current of the bath could be increased by over 100 per cent and the process of electroplating performed in less than half the time taken by the existing method.—*The Engineer*, Nov. 26, 1920.

Swedish Electric Pig Iron Furnace

Brief Description of the Constructional Details, Methods of Starting and Operation—Gray Iron, Low in Sulphur, May Be Had by High Power Input—Operating Figures for Long Campaign in 1920—Estimate of Cost

BY JONAS HERLENIUS

Secretary-Treasurer Hamilton & Hansell, Inc.

FOR various reasons the question of electric iron ore reduction has lately been of vital interest, not only in this country but throughout the world. The increased price of coke and consequently pig iron, the higher cost of transportation and the present ample development of cheap hydro-electric power in vast territories where suitable ores and charcoal are available for the production of a higher grade of pig iron, are probably the main reasons why this question has been brought into the limelight. Another fact, which may also have an important bearing on the subject, is that a certain type of furnace for this purpose has been successfully used in Sweden, although very little information regarding operating results and performances is available to anyone desiring to make a study of the situation. It is the object of this article to describe the Swedish electric pig iron furnace and to summarize briefly some of the results from its use as a commercial unit for iron ore reduction.

DEVELOPMENT

In 1909 the first Swedish electric pig iron furnace was installed in Domnarvet, Sweden. It was in operation for about three months, but afterward was shut down for a long period. On the basis of the results obtained, however, a special trial plant was built in 1910 at Trollhättan, Sweden, by "Jernkontoret" (the Swedish Iron and Steel Institute), on a government appropriation in order to develop an electric-furnace type that would satisfactorily replace the ordinary charcoal blast furnace. The trials were conducted with skill and accuracy by expert engineers for nearly two years and the results obtained proved to be very satisfactory, both from a practical and economical standpoint. Several of these furnaces have since been installed in various steel plants in Sweden, so that at the present time a total of twelve units are in operation in that country, ranging in size from 2,200 to 8,000 kva. transformer capacity. In addition, there are also similar furnaces in operation or contracted for in Norway, Italy, Japan and Brazil.

DESCRIPTION OF FURNACE

The furnaces are installed in buildings of brick, concrete or steel construction containing the entire furnace and its surrounding pig beds and provided with spacious charging floors. The furnace proper consists of a wide melting chamber or crucible, above which is a shaft with a bell-charging apparatus at the top. Fig. 1 is a section of a typical modern furnace; the dimensions are special for each installation and have to be calculated for the capacity, the kind of ore, the charcoal or coke available and the grade of pig iron to be produced. The shaft is thus designed in accordance with the general practice for common blast furnaces, except

for a recent tendency to widen out the lower section, making the diameter of the shaft at its junction with the crucible even larger than at the bosh.

The entire brickwork and shell plate of the shaft are suspended independently of the crucible. A steel ring is attached to the shell plate and rests on brackets and cross-girders supported by three or four columns, either a part of the furnace building or preferably independent of it. The bottom of the shaft is an iron ring, which makes a flexible joint with a corresponding watercooled ring serving as a skewback for the bricks in the crucible roof. The shell has an extension of from 6 to 9 ft. above the stockline and carries the charging bell. In this extension openings are made for the gas outlets.

The crucible is cylindrical and is contained in a mild steel shell resting on beams supported by a concrete foundation. The electrodes are inserted through the thin brick roof at an angle of about 65 deg. to the horizontal.

The entire shaft is lined with firebrick and the thickness of the wall is about 18 in. for the upper and middle sections and about 14 in. for the lower. The crucible is also usually lined with firebrick, although lately rammed-in coke or waste electrodes have been used with good success both in the bottom and in the sidewalls. The roof is lined with special shaped firebrick. To prevent it from raising, on account of the gas pressure within the crucible, an outside latticed steel construction suitably braced and connected to the shell plates is provided.

GAS CIRCULATION

The waste gases from the furnace are taken through either one or two openings in the throat. They are carried in gas conduits of sheet iron, with internal water sprinkling, to a large dust catcher, and from there to suitable washers and scrubbers for cleaning and cooling. The gas is drawn from the furnace through these apparatus by an exhaustor having a capacity of 1,700 to 2,800 cu.ft. per minute at 14-in. water gage. This exhaustor is direct connected to a 20- to 30-hp. totally inclosed variable speed motor. It is specially constructed to deal with the gas and has internal water-spraying appliances. A duplicate set is always installed in parallel for emergency, and one of them is periodically shut down for cleaning.

A portion of the gas is returned to the furnace by means of either one of the above-described exhaustors, or in order to assure a constant supply, by a separate rotary blower of the same capacity, but operating under a pressure of about 20-in. water gage. This gas is forced into the free space between the charge and the roof of the crucible, through a number of tuyeres in the wall. They are supplied from a bustle pipe and point upward to blow the gas directly underneath the roof in

order to cool it. There is consequently a certain quantity of gas circulating through the furnace, which is beneficial for the preheating of the charge in the shaft and for facilitating the preliminary reduction of the ores. The volume of this circulating gas is constant and the gas formed during the process is, therefore, available for heating auxiliary boilers or furnaces in the plant. For this purpose it is of particular importance on account of its high B.t.u. value.

ELECTRODES

The electrodes used are almost exclusively made of amorphous carbon and number from four to eight, depending on the capacity of the furnace. They are round, 24 in. in diameter, have nipple joints for continuous

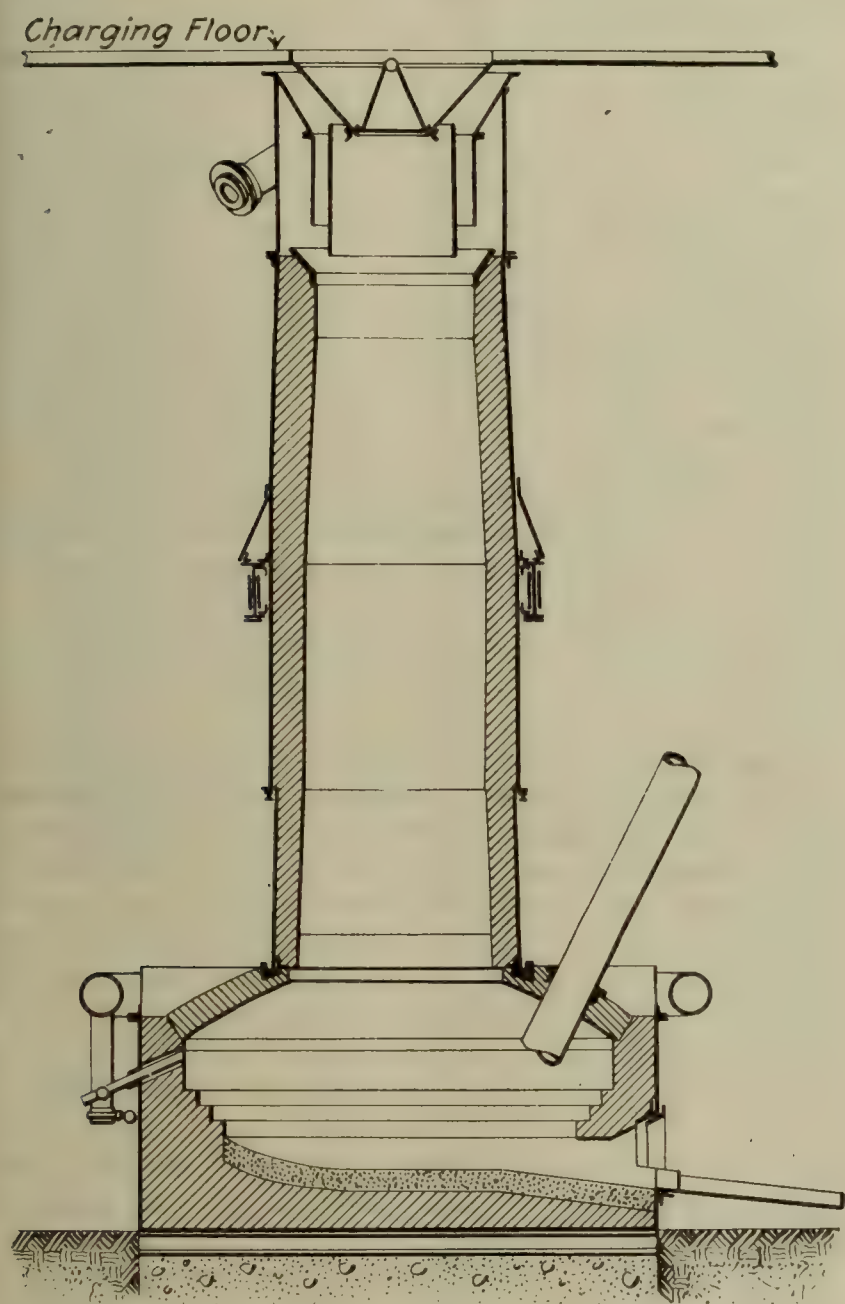


FIG. 1. SECTION OF A TYPICAL SWEDISH ELECTRIC PIG-IRON FURNACE

feed and can be loaded up to about 16,000 amp. Heavy water-cooling boxes and gas glands are placed in the apertures where the electrodes enter the crucible roof and close to them are water-cooled contact clamps of copper directly connected to the busbar work. As the power input is regulated by changing the potential on the transformers, there is no need of electrode adjustment except as they are consumed. The feeding mechanism for that reason is extremely simple and consists only of a screw drive with handwheels. The electrodes are mostly supplied from Sweden or Germany; American makes have been used extensively, the price, however, being at present too high on account of prevailing

rate of exchange and the high freight rates. Graphite electrodes have been used successfully, although no figures on their cost are available in comparison with amorphous carbon. There is a possibility, however, that such electrodes will be necessary on account of their high current conductivity in larger furnaces requiring more power and where consequently a higher amperage must be carried.

COOLING SYSTEM

In addition to the electrode coolers and contact clamps, there are various other parts of this furnace that must be water-cooled. For instance, at the flexible joint between furnace shaft and crucible there is a water-cooled ring. In the shaft brickwork, at the tap hole, tuyeres, etc., there are water pipes and coolers in accordance with standard blast-furnace practice. Furthermore, most furnaces lately installed have a complete water-spraying device for the entire shell of the crucible. In addition water is required for cooling the transformers, exhausters, gas conduits and for cleaning the gas. It is, therefore, of utmost importance that an ample water supply be provided at suitable pressure and that the operation of the system be safeguarded against breakdown. For that reason centrifugal pumps are always installed in duplicate, each having a capacity of about 200 gal. per minute. In addition a tank of about 500 cu.ft. capacity is situated on the charging floor at a higher level than the furnace. This is desirable to provide against any temporary failure of the main supply pipes.

The crucible roof is air-cooled on the outside by means of blast supplied from a small rotary blower connected to a 5-hp. motor.

HANDLING OF SLAG AND IRON

Usually both cinder and iron notches are provided. For very rich charges, however, only the iron notch is used. The iron is run in launders to the pig beds, as shown in Fig. 2, or may be poured in a ladle for transportation to a mixer or bessemer converter. The slag is collected in large pots and the arrangements for tapping or handling iron and slag do not differ from general blast-furnace practice.

ELECTRICAL EQUIPMENT

The operating current for this type of furnace may be either two-phase or three-phase, depending upon the furnace capacity. The average size furnace has about a 3,000 to 4,000 kva. transformer bank, consisting of three single-phase transformers which are delta connected on primary. On secondary six independent phases are induced, each connected to one electrode, making a total number of six. Larger furnaces have two single-phase transformers which are Scott-connected for incoming three-phase, giving a two-phase, four-wire system. On secondary each conductor is then connected to two electrodes, making a total number of eight.

The transformers are installed as close to the furnace as possible in order to use a minimum amount of busbar copper and to avoid excessive current loss by induction. The transformers are specially constructed to withstand the heavy duty imposed upon them. The secondary voltage can be regulated in eight to nine steps, from 55 to 110 volts for charcoal, or from 35 to 70 volts for coke furnaces by means of reduced capacity taps on primary coils. The tap changing is accom-

plished under full load for each phase separately by means of eight-way primary selective break switches, remote operated with handwheels from outside the transformer room.

The transformers and the above-mentioned selector break switches, together with other electrical equipment required, such as main automatic oil-circuit breakers, lightning arresters, power transformers, etc., are all installed in a separate transformer room, which usually is an extension to the main furnace building. The secondary busbar leads are brought over from the transformers to the furnace interlaced and are directly connected to the contact clamps.

In order to cut down the cost of copper and the induction losses installations have also been made where one transformer unit is located directly in front of each pair of electrodes. Rotary fans are then necessary for cooling the transformers. This arrangement, however, is not practical from an electrical standpoint especially with respect to primary interconnections.

All instruments necessary for the electrical control of the operation are mounted on panels conveniently situated on a level with the roof of the crucible. The handwheels and handles for operating the primary switches are mounted on panels that fit into the wall of the transformer room.

The incoming primary current on the different Swedish installations varies from 6,800 to 20,000 volts and in each case is stepped down directly to the operating voltage of the furnace. The number of cycles does not seem to have much bearing on the matter, as there are installations on 25- and 50- as well as on 60-cycle current.

HEAT GENERATION

The heat in the furnace is generated by the passage of current between the electrodes and is proportional

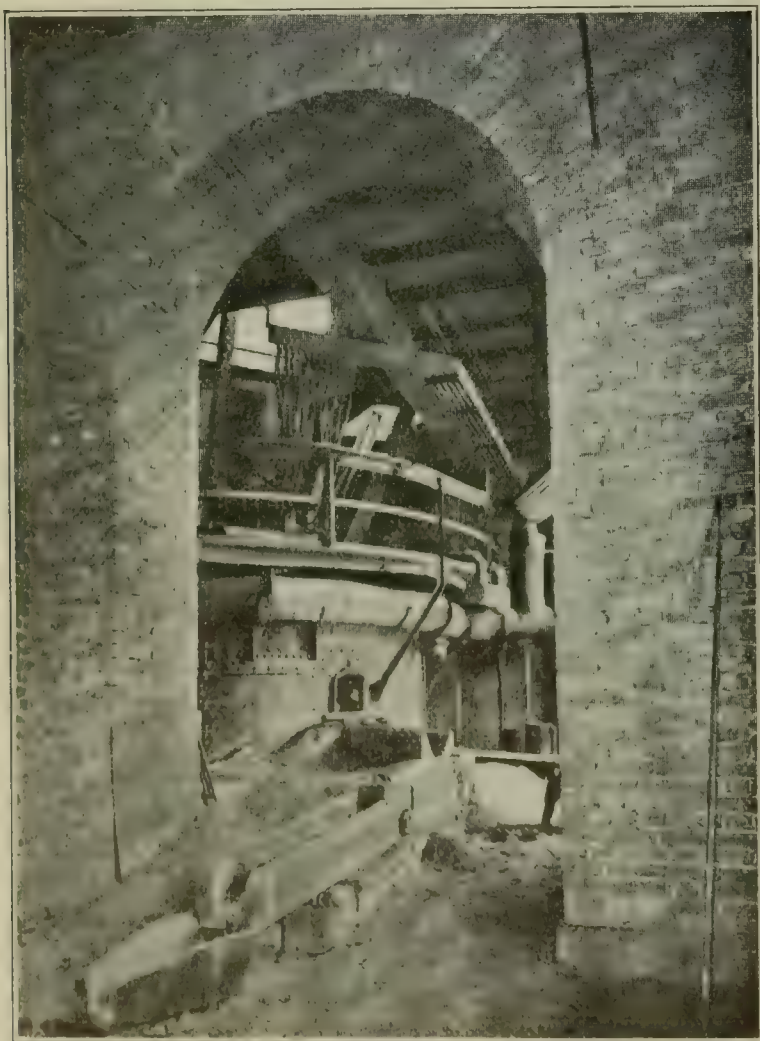


FIG. 2. LOWER PORTION OF FURNACE AND IRON RUNNER

to the voltage between any pair of electrodes. The power input is regulated by changing the potential on the transformers, and the connections are arranged so that the transformers can operate without injury with different phase voltage. This is an important feature, as the power input is usually regulated according to ammeters or wattmeters which are connected to the secondary busbar leads for each electrode. The operator must endeavor to maintain an even power input for each electrode and must change the potential whenever necessary. As the resistance of the charge between the electrodes changes the potential has to be adjusted to maintain the same power input. Occasionally, however, the power at one electrode may have to be increased or decreased to obtain an even melting or sinking of the charge.

CHARGING FLOOR AND HANDLING OF ORE

It is of great importance in the operation of this type of furnace as on all charcoal blast furnaces that the charge of ore, lime and charcoal or coke be properly distributed in fixed quantities. For this reason a specially constructed gas-tight bell is used with double conical rings in which the charge is contained. The bell is discharged by means of a hoist by a double movement whereby the content of each ring is emptied separately. The hoist and winding gear for raising and lowering the bell is operated by a 4- to 5-hp. reversible and totally inclosed electric motor.

On one side of the charging floor are installed a number of ore bins provided with discharge gates, and the bell is charged by hand with a charging bucket. The ore bins should have a total capacity of from 70 to 100 tons per furnace. Fig. 3 is a view of the charging floor.

The ore should be crushed down to 2½ in. maximum size and preferably less. For this purpose crushers are installed on the ground level in a special building. Usually one gyratory crusher, driven by a 60-hp. motor, is sufficient, but for larger installations two or three crushers are employed. The crushed ore drops into a loading chute, then into an automatic skip, which discharges into a receiving hopper on the feed floor. From there the ore is distributed to the various bins by means of a larry-car, which can be spotted automatically.

For smaller furnace installations the skip hoist is usually replaced by an inclined bucket elevator, which unloads onto a belt conveyor with a tripper.

Some installations have also been made where the ore bins are located on the ground, in which case the prepared charge is hoisted up in a bucket to the charging floor and tipped into the bell.

CHARCOAL OR COKE STORAGE

Charcoal or coke should be stored in a special fire-proof building of concrete or steel construction, with walls and roof of corrugated iron, having a capacity of about a year's supply. After screening the fuel is loaded into buckets having a capacity of about 30 cu.ft. and transported to the charging floor of the furnace by means of an aerial tramway.

WORKING STAFF

The operation of the electric pig iron furnace requires the same class of labor as common blast furnaces. For an installation of two furnaces the follow-

ing force is necessary: One superintendent, one assistant superintendent, two chemists, three foremen, one electrician, one crane operator, eight common laborers per shift. In addition there will be required two men per shift for loading charcoal and from three to five men per shift for unloading and crushing the ore.

STARTING OF FURNACE

The furnace should be slowly pre-heated with a coke or wood fire in the crucible for about two to three weeks. After the ash is removed and 2 to 3 tons of coke is shoveled into the crucible through the electrodes holes about twenty charges of coke, ore and lime are filled in and the electrodes inserted. Carbon blocks are placed directly underneath each electrode to insure a good contact. The entire shaft is filled with charges of mixed ore, lime, coke and finally charcoal with slowly increasing ore content. The current is then switched on, but the gas circulation is not started until about two days after.

OPERATING DATA

Swedish ores are usually very rich in iron and consist of magnetites and black hematites in the form of lump ore or concentrate, either crude, briquetted or sintered. The various ores available are mixed with suitable fluxes, such as bessemer slag and lime, to obtain the desired slag. In general the charges will contain anywhere from 50 up to 60 per cent of iron. Fine concentrates can be used dry only and to a limited amount, the maximum being about 30 per cent. The reason for this is that they have a tendency to pack in the shaft and stop the circulation of gas, not only on account of their fine character but mainly because they easily flux and seem to attach themselves to the refractories. This may cause scaffolding with subsequent caving of the charge, serious disturbances in the furnace operation very difficult to overcome whenever they appear. (Increasing the gas pressure as a corrective would not be feasible, as the thin brick roof of the crucible would then give way.) The lime should be crushed to the size of a large walnut and usually does not have to be burned. In furnaces operating with coke, however, burning seems to be of some advantage.

Charcoal should preferably be of pine, in lump form and fist size. The fine material after screening can be used only with difficulty and to a very limited extent. Charcoal made of refuse from sawmills is not very suitable, as it contains mostly flat pieces that stop the gas circulation.

A typical analysis of Swedish charcoal is as follows:

H ₂ O.....	13.21	Ash.....	2.18
Gas.....	11.72	C.....	72.89

and the average weight is 40 lb. per hectoliter.

The consumption of charcoal is, of course, dependent on the ores and the operation of the furnace, but in general will amount to only 35 to 45 per cent of the requirement in a common blast furnace. It may be of interest to know that during 1918 the average consumption of charcoal in all Swedish blast furnaces was 56.6 hl. per ton, whereas in the electric pig iron furnaces it amounted only to 24.8 hl.

OPERATION ON COKE

In regard to the operation on coke very little data are available, although furnaces are now running in Norway using a mixture of coke and charcoal as re-

ducing agent. Trials made in Trollhättan led to the conclusion that the operation on coke was not satisfactory. This, however, was due to the fact that the furnace and equipment were not suitable for the purpose. Trials made in Tinfos and Hardanger, in Norway, showed that the dimensions of the shaft as well as the crucible had to be changed materially. Coke has a higher current conductivity than charcoal and furthermore tends to graphitize, for which reason the potential must be lower, and suitable taps on the transformers arranged accordingly. It may, therefore, be assumed that a properly designed coke furnace, with equipment provided for the purpose contemplated, may be a success. An interesting report on the results obtained with coke in furnace installations in Norway has been written by George Stig and appeared on page 29, July 7, 1920, issue of CHEMICAL & METALLURGICAL ENGINEERING.

It has been proved that the pig iron produced from these furnaces is of a higher grade than the iron from common blast furnaces. The reason is probably that



FIG. 3. VIEW OF CHARGING FLOOR

electric pig iron is more thoroughly deoxidized and, therefore, requires less content in Si and Mn to be suitable for the open-hearth process.

The iron and slag from electric pig iron furnaces are always tapped at a lower temperature than from common blast furnaces. This is contrary to what would be expected when using electricity for heating, but is due to the large capacity of the crucible. Directly underneath the electrodes the heat is, of course, intense, but in the center and bottom of the crucible and between the electrodes are fields where heat must be supplied by conduction. The cold gas and the effective cooling of the roof are also features that greatly contribute toward lowering the temperature so that the average will be comparatively low.

With an ample power input, however, the temperature can be considerably increased so that no trouble has been experienced, at least in later installations, in producing a pig iron high in carbon and silicon and with a gray fracture.

The operation of these furnaces is very simple and requires less labor than common blast furnaces, as long as no variations in the charge are made. Any alterations, however, in the amount of ore and coke must be carried out carefully, as the furnace will react very suddenly if the changes are made too violently and disturb the equilibrium in the crucible. It must also be borne in mind that the means to re-establish

normal conditions are very limited for this type of furnace. Usually the only remedy is to throw ore or coal into the crucible through openings in the roof, as a change in the charge would not have any effect until a long time after.

PRODUCTION OF GRAY IRON

On account of the intense heat of the arcs from the electrodes a certain amount of calcium carbide is formed, which evidently has a deoxidizing effect on the iron. This carbide slag will also eliminate some of the sulphur, although not to the extent that would be expected. As a matter of fact, the desulphurizing in these furnaces in usual practice is less than in the ordinary blast furnace, which, of course, is due to the lower temperature. However, with high-powered furnaces lately installed, sulphur has been successfully eliminated by an ample power input producing an iron of gray fracture and high silicon. It is, therefore, obvious that the introduction of carbon and silicon and the elimination of sulphur is a matter of using coke, power and time in the furnace, but can always be accomplished. High-sulphur ores, however, should be roasted not only to save power, but to avoid the large charge of lime that otherwise would be necessary and that would make the slag too basic and sluggish.

Most furnaces operate with a slag of about 1.4 to 1.5 silicate degree (a sesquisilicate), which is satisfactory, especially when the bottom is made of crushed coke. Preferably, however, the silicate degree should be lower and down to 1.0 (a singulo-silicate), in order to avoid bad corrosion from a more acid slag.

FURNACE GAS

The temperature of the gas extracted from the furnace is, of course, dependent upon the pressure obtained from the blower. On late installations, the temperature is about 400 to 550 deg. F. The dust contained in the gas was investigated in Trollhättan and found to be 4.63 g. per cu.m. gas (of 0 deg. C.) in the down-comers from the furnace shaft. To show the efficiency of the cleaning system, it may be of interest to know that after the washer and scrubber the content was reduced to 0.88 g. and in the bustle pipe to 0.62 g.

An average analysis of the gas from this furnace shows results as follows:

	Volumes Per Cent		Volumes Per Cent
CO ₂	23.49	CH ₄	1.52
CO.....	63.15	N.....	1.49
H.....	10.35		

The weight of 1 cu.ft. of dry gas was 0.081 lb. and the heat value 2,297 cal. per cu.m., which is equal to 258 B.t.u. per cu.ft. dry gas.

The gas circulation has been greatly improved lately by the installation of positive blowers that deliver a constant volume of gas. This was the key to the solution of a variety of difficulties, especially with respect to uniformity in operation.

REPAIRS AND RENEWALS

Late figures on electrode consumption are rather high, probably due to their war quality. Previous to the war it required from 11 to 15 lb. per ton of pig produced and the greater part of this consumption is due to the carbon dioxide of the gas being reduced by the incandescent carbon to CO.

In regard to the life of refractories, the weakest point

in the furnace is the crucible roof, parts of which must be renewed as they burn out during the course of operation. For a large furnace installation of five units during 1917, the total production of pig iron was 29,255 tons and the total quantity of brick used was 416 tons. For 1918 corresponding figures were 25,791 tons with 391 tons of brick and for 1919, 22,350 tons, consuming 380 tons of refractories.

A complete relining of the crucible roof can be accomplished in about 5 days, using a force of sixteen men, and a complete relining of the entire furnace will take about one month.

An installation of one furnace will utilize about 76 to 77 per cent of the power, whereas for several furnaces the load factor will increase and approximate 80 per cent. The power factor is, of course, dependent on the number of cycles, but will average about 90 per cent for 25-cycle current. The efficiency of the furnace is about 70 to 75 per cent, based on the experience with the Trollhättan installation.

ACTUAL RESULTS

The results obtained from the operation of these furnaces are naturally greatly influenced by local conditions at the various plants, as for instance the number of furnaces installed, the capacity and the power behind each unit, the kind of ore used and the character of the pig iron produced.

In the following table some actual results during the first seven months of 1920 are given from the operation of a large plant of several units, having a transformer capacity each of 3,000 to 4,000 kva.

	Furnace 3	Furnace 5
Total amount of ore used, tons.....	5,733.20	6,310.41
Total amount of lime used, tons.....	568.74	742.80
Total amount of ore and lime used, tons...	6,301.94	7,053.21
Total amount of charcoal, lb.....	2,957,440	3,112,640
Total amount of current, kw.-hr.....	9,576,200	9,001,700
Operating time, hr. and min.....	3,736 5	2,989 35
Idle time, hr. and min.....	167 45	97 25
Total time, hr. and min.....	3,903 50	3,087
Produced pig iron:		
Open-hearth, tons.....	365,670	3,483.275
Bessemer.....	3,307,585	.....
Total, tons.....	3,673.255	3,483.275
Relative figures:		
Electrodes, lb. per ton pig.....	17.6	19.3
Charcoal, hl. per ton pig.....	20.1	22.3
Electric current, kw.-hr. per ton pig.....	2,605	2,580
Average load in kw.....	2,565	3,020
Pig iron per day in tons.....	22.5	27.1
Per cent pig of ore charged.....	64.2	55.25
Per cent pig of total charge.....	58.3	49.40
Lime in per cent of ore.....	9.95	11.75
Idle time in per cent of operating time....	4.47	3.23

"Ton" means metric ton of 1,000 kg., equal to 2,205 lb. (approximately 1 long ton).

COST OF INSTALLATION

The total present cost in the United States of a complete electric pig iron plant with one furnace of 4,000-kva. transformer capacity is estimated at about \$150,000.

New York, N. Y.

Fire Destroys the Wilmington Leather Co.'s Plant

The plant of the Federal Leather Co., at Wilmington, Del., was practically destroyed by fire which started in some unknown way in one of the older buildings and quickly spread throughout the entire works. Eleven buildings and valuable stock of both raw materials and finished leather products were destroyed before the fire was got under control.

Steel Castings of High Strength and Toughness—I

A Chapter From a Forthcoming Book Giving Data on the Improvement to Be Expected After Properly Heat-Treating Steel Castings, With Illustrative Tests on Strong, Tough Castings Which Have Replaced Forgings on Gun Mounts

By FEDERICO GIOLITTI
Bessemer Medalist

IT IS useful to illustrate the great variety of results obtainable on various types of steel castings by applying the processes which have previously been studied in theoretical outline,* especially in connection with the differences existing between the effects of homogeneity quenchings and of mere homogeneity annealings. In order not to multiply the examples unduly, some of the more characteristic and, so to speak, typical instances will be chosen.

NORMALIZED MILD STEEL CASTINGS

A soft steel casting containing carbon 0.23 per cent, manganese 0.66 per cent, silicon 0.21 per cent, phosphorus 0.05 per cent, and sulphur 0.03 per cent was reheated at 850 to 900 deg. C. and allowed to cool very slowly, requiring about thirty-six hours to reach room temperature.

It showed the microstructure reproduced in Fig. 1 and physical properties shown in Table I determined by pulling a tensile test-piece 12 mm. diameter and 40 mm. long between reference points.

A prismatic test-piece 20 mm. square tested under static flexure broke at an angle of 130 deg. with a coarsely crystalline fracture reproduced in Fig. 4.

The same steel reheated during twelve hours at 800 to 850 deg. C. and left to cool, requiring ten hours to reach atmospheric temperature, showed the microstructure reproduced in Fig. 2 and somewhat better physical properties (Table I).

The tension test revealed a "mixed" structure containing part crystalline and part fibrous texture, as shown in Fig. 4. The static bending piece bent into a U shape.

Finally, another casting of the same steel—after undergoing the first treatment above mentioned—was reheated at 800 deg. C. during twenty minutes, quenched in boiling water, and finally drawn during one hour at 650 deg. C. Its properties, especially the ductility, as shown in Table I, are still better.

The microstructure of the steel thus treated is reproduced in Fig. 3. The fracture of the broken test-piece reproduced in Fig. 4 was entirely fibrous.

TABLE I. PHYSICAL PROPERTIES OF HEAT-TREATED 0.23 C STEEL

Heat-Treatment	Tensile Strength	Elastic Limit	Elongation	Reduction in Area
Reheated to 875 deg. C., cooled in 36 hr.	61,600	34,300	13	....
Reheated 12 hr. to 825 deg. C., cooled in 10 hr.	68,000	41,000	17	13.9
Complex (see text)	73,600	47,000	17.5	24.8

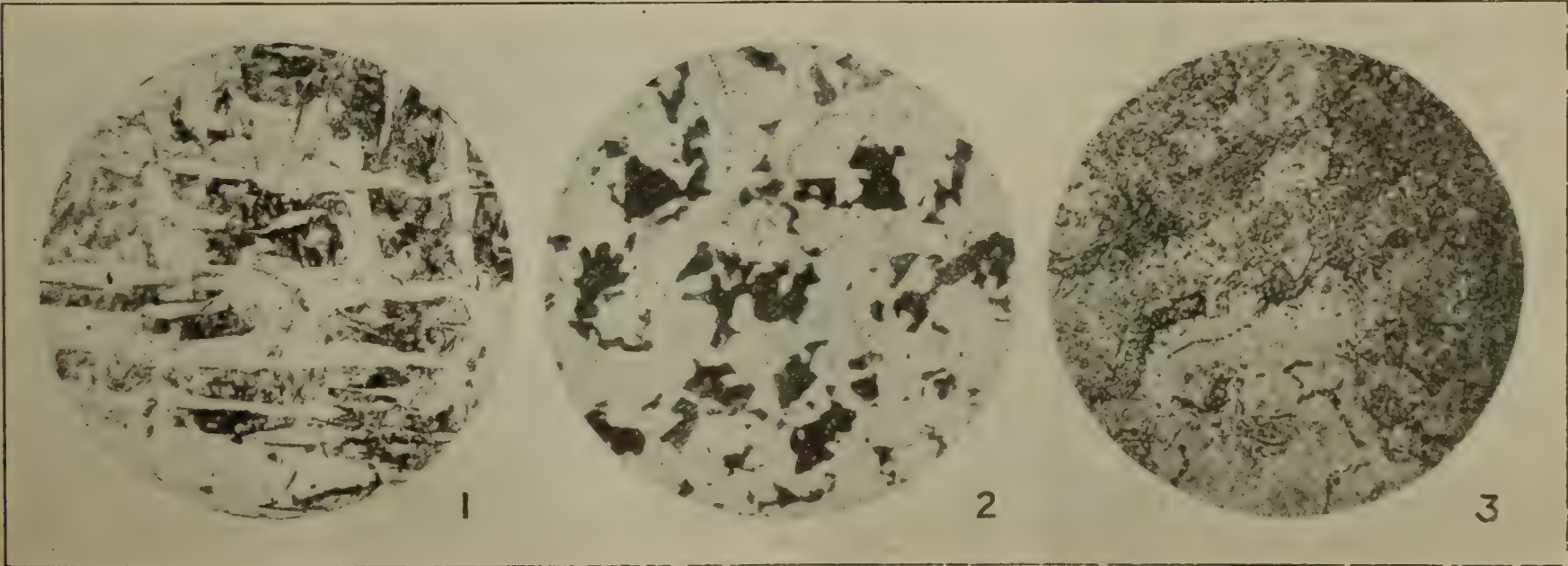
The prismatic flexure test bent into a U, similar to the previous one.

EFFECT OF INSUFFICIENT ANNEALING

Another mild carbon-steel may be cited, made by the acid process and having the following composition:

	Per Cent
Carbon.....	0.25
Manganese.....	0.85
Silicon.....	0.15
Sulphur.....	0.02
Phosphorus.....	0.03

It was cast in ingots 15¾ in. (400 mm.) square. Fig. 7 shows the structure of this steel as cast. Rectangular bars 3½ x 5½ x 11¾ in. (80 x 150 x 300 mm.) were taken from the lower half of those ingots and subjected to the heat-treatments indicated in the first column of Table II. In the next four columns of the same table



FIGS. 1 TO 3
Structure of 0.23 C. steel casting after various heat-treatments.

*"Heat Treatment of Soft and Medium Steels," Press of McGraw-Hill Book Co.

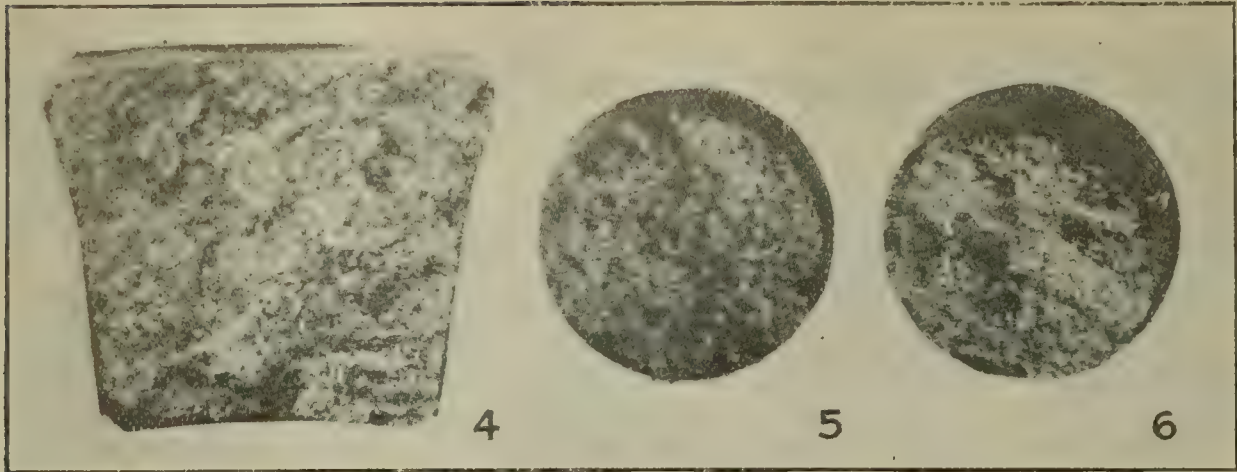


Fig. 4. Fracture in static bending after very slow cooling.

Fig. 5. Tensile fracture after normalizing

Fig. 6. Tensile fracture after complex heat-treatment.

are noted the principal tests on tension pieces 13.8 mm. in diameter by 100 mm. long taken from the bar after being subjected to the heat-treatments indicated in the first column.

Heat-Treatment	Physical Properties				Structure (Enlarged 100 Dia.)
	Tensile Strength, Lb. per Sq. In.	Elastic Limit, Lb. per Sq. In.	Elongation, per Cent	Reduction in Area, per Cent	
Annealed at 940° C. during 45 min. followed by slow cooling in the furnace.....	79,600	42,700	17.5	18	Fig. 8
Annealed at 850° C. during 45 min. followed by slow cooling in the furnace.....	76,800	44,200	14	13	Fig. 9
Heated and cooled as No. 1 followed by a drawing at 700° C. during one hour and subsequent slow cooling in the furnace.....	73,200	39,800	21.5	27	Fig. 10
Heated and cooled as No. 2, followed by a drawing at 700° C. during one hour and subsequent slow cooling in the furnace.....	74,500	42,700	26	35	Fig. 11

The tabulated data particularly exhibit what has been said relative to new heterogeneities induced by recrystallization of ferrite from a system of austenite crystals in which the greatest part of the original chemical heterogeneities has been undisturbed by insufficient annealing. Inherited non-uniformities are especially evident in the large variations in ductility due to ferrite accumulations accentuated by the drawing operations. To be convinced on this point, compare structure and the figures for elongation and the reduction of area of the first and second test-pieces with the third and fourth.

LIMITED EFFECT ON VERY SOFT CASTINGS

In order to confirm the relatively limited effects which homogeneity heat-treatments produce upon the physical properties of very low-carbon cast steels which,

by the way, never present the real phenomena of ingotism, I may add in Table III some comparative data between the effects produced upon the physical properties of one of those steels by a pair of homogeneity quenches of considerable energy. The steel examined was of following composition:

	Per Cent
Carbon.....	0.09
Silicon.....	0.028
Manganese.....	0.47
Sulphur.....	0.01
Phosphorus.....	0.02

TABLE III. NORMALIZATION OF 0.09 PER CENT CARBON STEEL

Heat-Treatment	Physical Properties			
	Tensile Strength, Lb. per Sq. In.	Elastic Limit, Lb. per Sq. In.	Elongation, per Cent	Reduction of Area, per Cent
Heated at 850° C. for 3 hr., followed immediately by quenching in water and then drawn at 650° for 2 hr.....	50,500	30,000	31.8	55.8
Heated for 14 hr. at 1100° C. followed immediately by quenching in water. Re-heated at 850° C. for 3 hr., followed immediately by quenching in water. Finally, drawn at 650° C. for 2 hr....	54,500	33,700	33	60.2

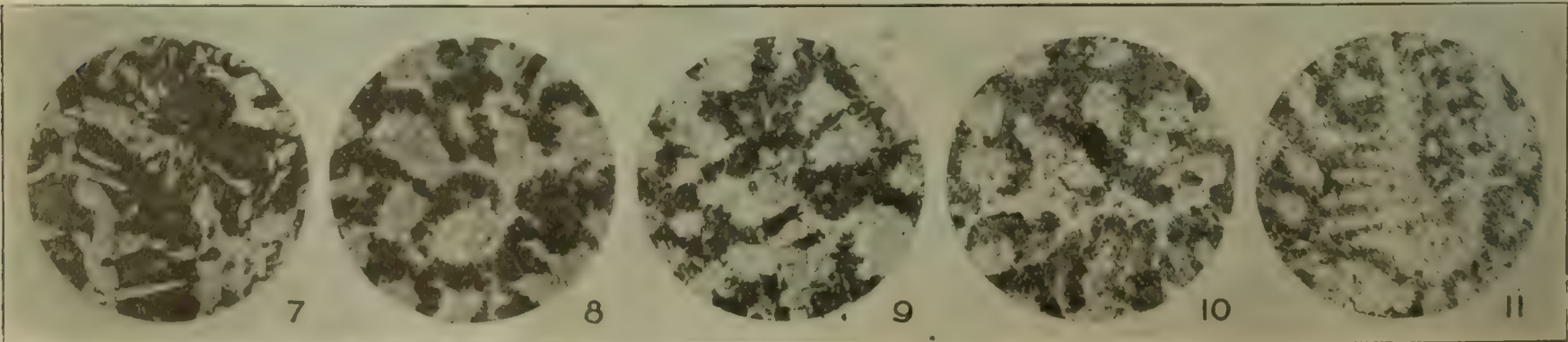
HOW INGOTISM EXHIBITS ITSELF

When steel is cast in quite large masses, either in ingots or in formed castings, the phenomena of ingotism always appear with a great deal higher intensity than when it is cast in smaller sections. This is due to the well-known fact that the slowness of cooling during the solidification range enhances the phenomena of intercrystalline liquation and segregation. Ingotism also shows a greater intensity when massive castings contain large quantities of emulsified inclusions. Evidently the steel then feels the effects of even a mild homogeneity heat-treatment a great deal more than it would were it cast in smaller masses.

As an example of this fact, take the case of an acid open-hearth steel having the following composition:

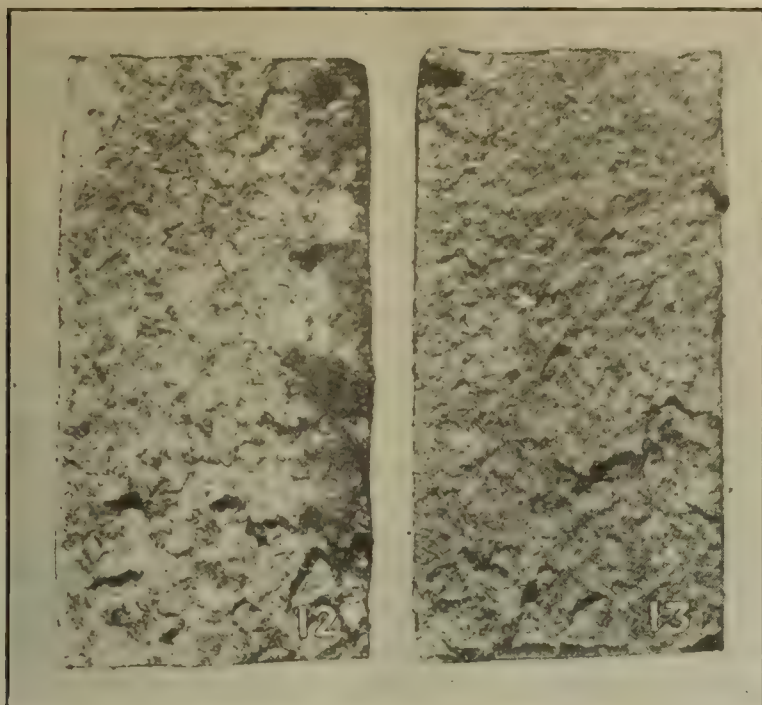
	Per Cent
Carbon.....	0.47
Manganese.....	0.63
Silicon.....	0.27
Sulphur.....	0.029
Phosphorus.....	0.03

Rough castings weighing more than ten tons each for 381 mm. gun cradles were made with this steel. One of these castings was heated for twelve hours at 750



FIGS. 7 TO 11

Structure of 0.25 C acid steel ingot after various heat-treatments. × 100. Etched with alcoholic solution of picric acid.



FIGS. 12 AND 13

Impact fractures of massive 0.47 C steel casting after different heat-treatments.

deg. C. Tension test-piece (cylindrical bars 13.8 x 100 mm.) and Charpy impact samples (30 x 30 x 160 mm., with a cylindrical notch 4 mm. in diameter) were then cut from the body of this casting.

The results of these first physical tests are contained in Table IV. The pulled test-piece was stretched throughout all its length, and the fracture of the impact bar revealed a coarsely crystalline structure, Fig. 12. These properties correspond well to the microstructure and are indicative of strong ingotism partly due to the presence of a large proportion of inclusions.¹

The same casting was reheated for seven hours at 850 deg. C. and then left to cool in the air, so that its temperature dropped to 400 deg. C. in about three hours. The effect of the heat-treatment upon the structure consisted of a remarkable dissemination of the massive ferrite. Equally remarkable are the effects upon the physical properties, as shown in the table.

The tension test-piece did not show the least stretching along its length which produces the characteristic dappled surface, and the impact fracture exhibited a

¹An extended contribution on the effect of oxidized inclusions in steel will be published shortly in CHEMICAL & METALLURGICAL ENGINEERING.



FIG. 14. TESTS ON RAW 0.21 C STEEL CASTING

finely crystalline and partly fibrous structure shown in Fig. 13.

These data well indicate the mechanical characteristics by which ingotism appearing in thick masses of cast steel exhibits itself, especially when the metal contains large quantities of emulsified inclusions. In fact we must conclude that the "normal" properties of this steel are still altered or disguised even after the long heating at 750 deg. C.; denoting by the term "normal" properties the average resulting from the superposition

TABLE IV. HEAT-TREATMENT OF MASSIVE CASTINGS CONTAINING 0.47 PER CENT CARBON

Heat-Treatment	Tensile Strength	Elongation	Charpy Impact, Kg.-M. per Sq.Cm.
Heated for 12 hr. at 750 deg. C.	76,200	19.0	1 2
As above, then reheated 7 hr. at 850 deg. C. and air-cooled.	88,000	24.0	3 61

of the specific properties of its individual normal structural constituents. Were this not the case, there can be no doubt that the effect of the second heating at 850 deg. C., followed by slow cooling, should have changed the physical properties of steel, in an *opposite*



FIG. 15. TESTS ON 0.21 C CASTING AFTER NORMALIZING AT 850 DEG. C.

direction to those which in reality it has produced. The above examples confirm the idea that the average properties as usually determined on steel affected by ingotism are most probably due to the distribution and the continuity of the structural constituents rather than to the specific properties of the constituents themselves.

TESTS ON SPECIAL STEELS

We should now sum up the conclusions we have reached regarding the results obtainable by various homogeneity heat-treatments when applied to castings for machine parts when manufactured of the types of steels more frequently used for such purposes.

In order to give examples which conform to normal industrial conditions, I shall select steels of the average purity usually attained in steel foundry operation. This observation holds not only for "structural" or (improperly called "metallic") impurities such as sulphur, phosphorus, copper, etc., but also for the "foreign" or "non-metallic" impurities, especially the solid inclusions.

Results will be given for the usual physical tests—i. e., tensile, static bending, and impact upon a nicked

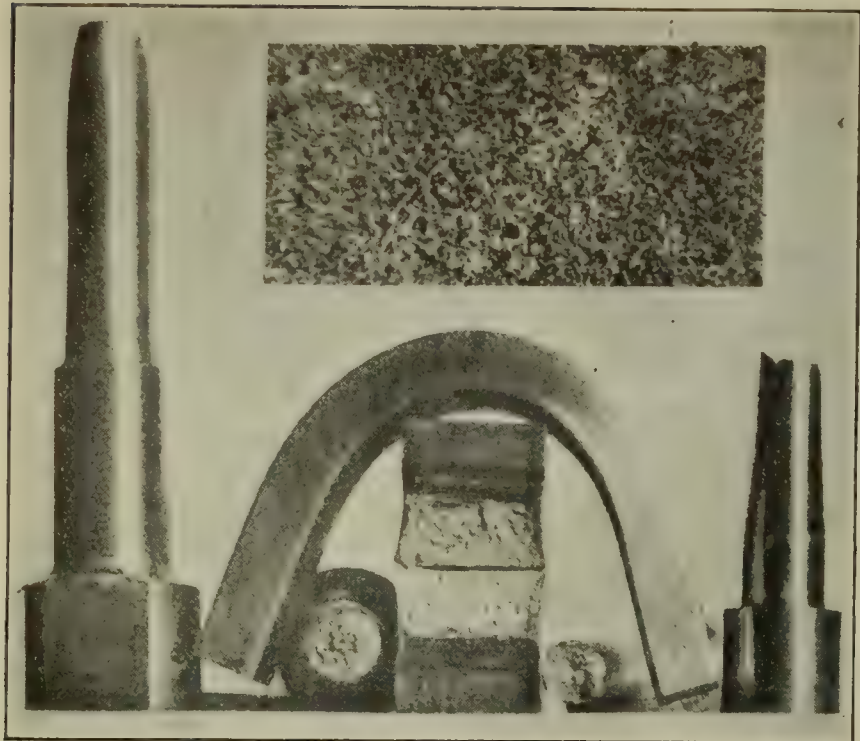


FIG. 16. TESTS ON 0.21 C CASTING AFTER AIR-QUENCHING

bar. In addition to these it will be useful to add the results of a impact tension test, made by the well known method using Charpy's pendulum striking a fixture holding a cylindrical test-pipe 10 mm. in diameter by 50 mm. long between the conical heads. The breaking work will be indicated in kilogram-meters, and refers to the initial cross-sectional area of the test-piece. All the static tensile tests referred to in the following paragraphs of this chapter were made upon cylindrical test-pieces 13.8 mm. in diameter by 50 mm. between reference points. Static bending tests were made upon rectangular prismatic bars 9.5 x 20 x 160 mm. The test-pieces were placed horizontally upon one of its 20-mm. faces, upon two parallel hard steel rolls 70 mm. in diameter, spaced 140 mm. apart on centers, and free to turn around their axes. The test-piece was forced to bend by pressure imposed upon the upper face by means of a 40-mm. steel cylinder whose axis was placed parallel to the end supports and so arranged that it could move up and down a vertical plane passing midway between. Pressure was maintained until the two ends of the test-piece were bent enough to slip between the two supporting cylinders, so that at the end of the test the piece was bent like a U with almost parallel legs.

The examples to be mentioned in the following para-

graphs are especially interesting when the physical properties obtainable by means of simple homogeneity reheatings are compared to those resulting from homogeneity quenchings.

EFFECT OF CARBON

Starting with ordinary carbon steels for making castings, data relative to two steels containing 0.21 per cent and 0.34 per cent carbon are gathered in Tables V and VI. Merely for comparison, data obtained from forged test-pieces of the same steels have been added. Working was done at about 1,000 deg. C., bringing a square bar 100 x 100 mm. down to 35 x 35 mm. Pieces for the various physical tests were always cut from the forged bars in a *longitudinal* direction—that is to say, with their long axis parallel to the direction along which the steel had been extended by forging.

In the figures reproducing the appearances of the tension and bending tests the two tension tests shown on the left are those broken under a gradual pull, while the two at the right are those broken under longitudinal impact. The slow bend test is shown above in the center, while below is the fracture of the piece broken by the Charpy impact pendulum. These figures are reduced to about half natural size. Microstructure

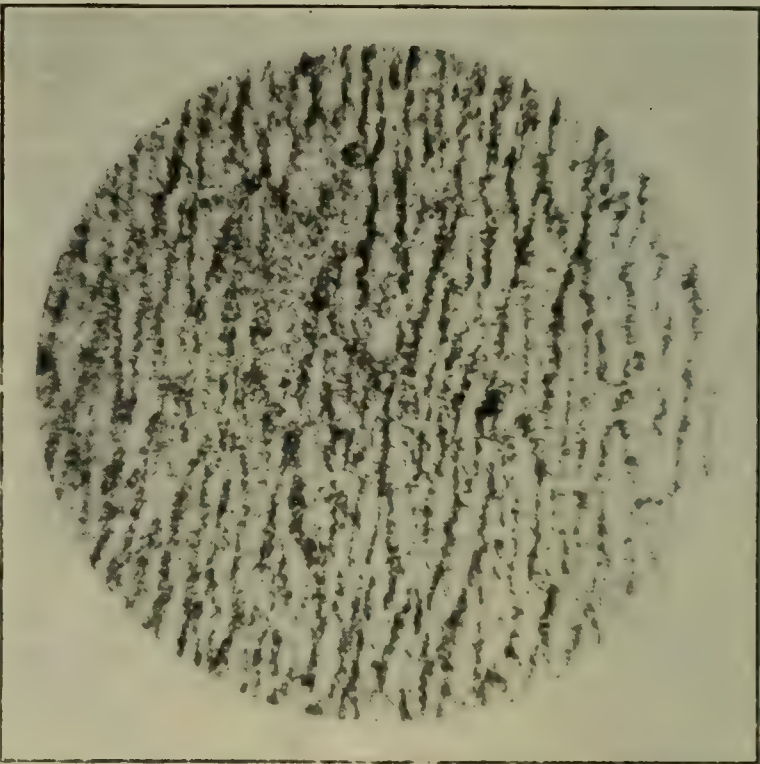


FIG. 17. MICROSTRUCTURE OF FORGED 0.21 C BAR. NORMALIZED. X 80. ETCHED WITH HNO₃ IN AMYL ALCOHOL

TABLE V. STEEL "A," CONTAINING 0.21 PER CENT CARBON

Treatment	Static Tensile Test				Impact Tensile Test		Charpy Impact Kg.-M. per Sq.-Cm.	Static Flexure	Micro- structure and Tests
	Tensile Strength Lb. per Sq. In.	Elastic Limit, Lb. per Sq. In.	Elonga- tion per Cent	Reduction of Area, per Cent	Tensile Strength Kg.-M.	Elongation per Cent			
Raw casting.....	75,700	42,700	25	33.5	121	32	4.62	Good	Fig. 14
Casting heated at 850° C. for 3 hr. and cooled slowly.....	77,700	53,000	27	42	124.5	33	8.13	Good	Fig. 15
Casting heated at 850° C. quenched in air and drawn at 550° C.....	79,600	55,800	28	45	128	31	9.89	Good	Fig. 16
Forged bar, reheated like casting No. 2 for 3 hr. at 850° C. and cooled slowly.....	80,600	55,800	32	60	112.8	29	17.12	Good	Fig. 17

TABLE VI. STEEL "B," CONTAINING 0.34 PER CENT CARBON

Treatment	Static Tensile Test				Impact Tensile Test		Charpy Impact Kg.-M. per Sq.-Cm.	Static Flexure	Micro- structure and Tests
	Tensile Strength Lb. per Sq. In.	Elastic Limit, Lb. per Sq. In.	Elonga- tion per Cent	Reduction of Area, per Cent	Tensile Strength Kg.-M.	Elongation per Cent			
Raw casting.....	86,800	51,200	18	21	29.5	7	1.7	Good	Fig. 18
Casting heated at 850° C. for 3 hr. and cooled slowly.....	85,500	54,800	25	33.5	83.3	18	6.15	Good	Fig. 19
Casting heated at 850° C. quenched in air and drawn at 550° C.....	90,600	63,300	24	40.5	135	27	7.41	Good	Fig. 20
Forged bar, reheated like casting No. 2 for 3 hr. at 850° C. and cooled slowly.....	88,900	59,000	30	53	132	34	11.75	Good	Fig. 21

is at an enlargement of 60 diameters, after etching with nitric acid in amyl alcohol.

Two steels, which will be indicated with the letter A and B respectively, had the following chemical composition:

	A	B
	Per Cent	Per Cent
Carbon.....	0.21	0.34
Manganese.....	0.94	0.96
Silicon.....	0.19	0.19
Sulphur.....	0.03	0.02
Phosphorus.....	0.07	0.06
Copper.....	Traces	Traces
Arsenic.....	Traces	Traces

Evidently they can be considered as differing only in carbon, inasmuch as the variations in all the other elements are within analytical accuracy.

It is easy to see that all the numerical data contained in the two tables, as well as all the structures reproduced in the fourteen corresponding figures, find a clear

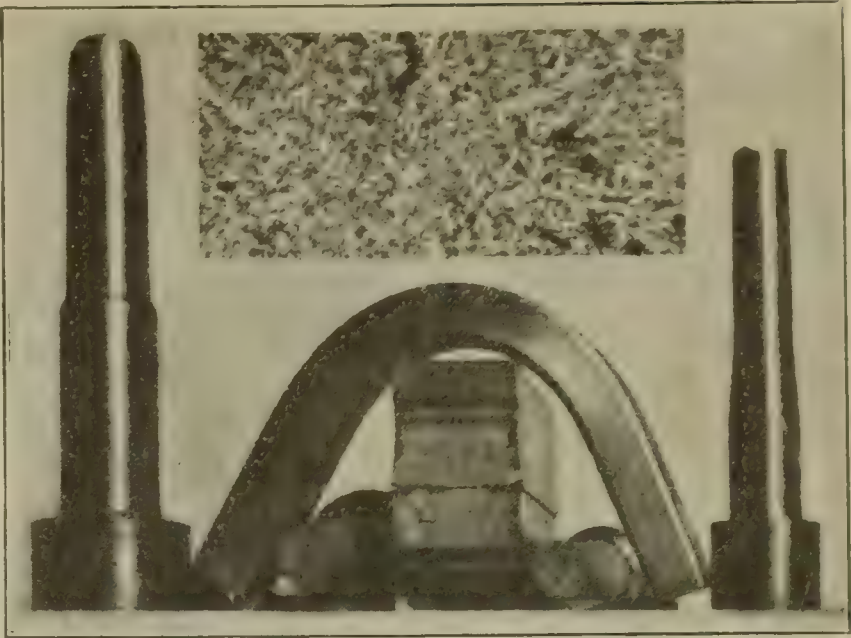


FIG. 19. TESTS ON 0.34 C CASTING AFTER NORMALIZING AT 850 DEG. C.

previously, the present results were obtained by subjecting a casting of intricate form to various heat-treatments. For this reason the following data will give an idea of the results which can be readily obtained in the practical application of homogeneity heat-treatments.

Steel used for these experiments was made in the acid open hearth and had the following composition:

	Per Cent
Carbon.....	0.26
Manganese.....	0.90
Silicon.....	0.18
Sulphur.....	0.02
Phosphorus.....	0.04
Nickel.....	1.76

Twenty-three pieces like that detailed in Fig. 22 were cast from the same heat. Pieces for physical tests were taken from the thicker part of the wall of the partly square partly cylindrical bore shown in section in the lower right part of the drawing. The whole casting had previously been subjected to a given heat-treatment.

For information and as a datum, I might add that a bar taken from an ingot of the same heat, after being forged and reheated at about 850 deg. C., gave the following results in tension when using a cylindrical

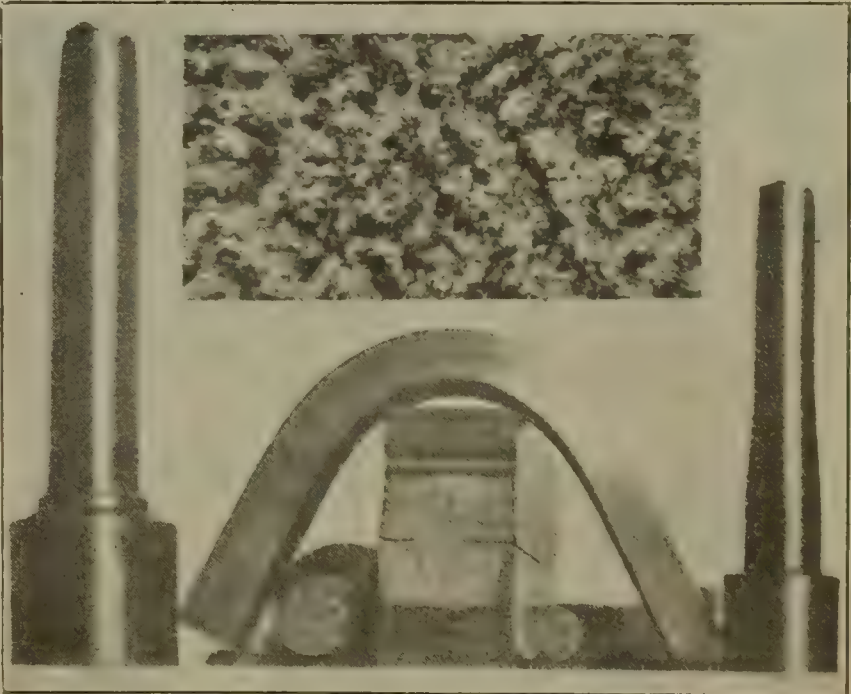


FIG. 20. TESTS ON 0.34 C CASTING AFTER AIR-QUENCHING

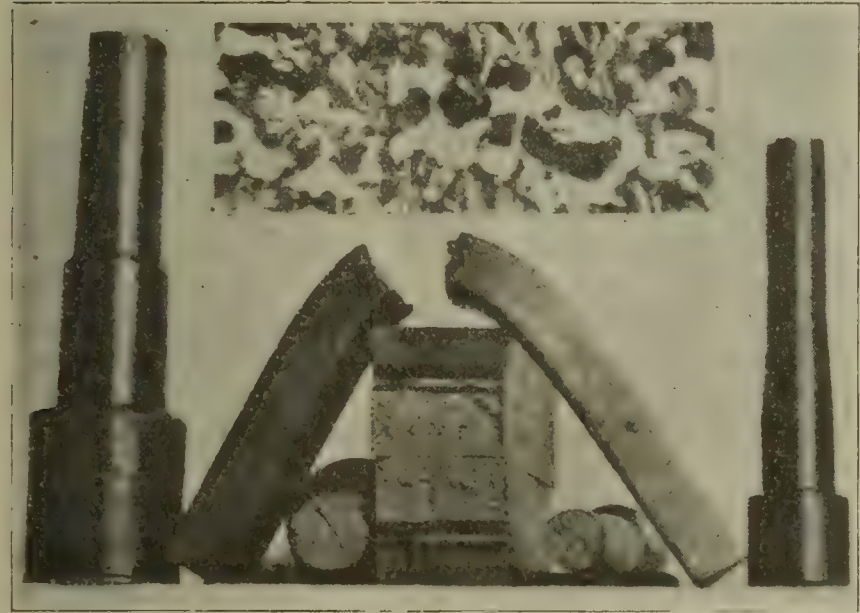


FIG. 18. TESTS ON RAW 0.34 C STEEL CASTING

interpretation in the considerations developed in the preceding chapters.

The general fact may again be pointed out from the two examples that the differences between the effects produced by annealing and those produced by quenching are less remarkable the lower the carbon content, all other conditions being equal. For confirmation, compare the data contained in the tables and the corresponding half-tones.

Comparing the microstructure and the physical properties of the cast sample No. 3 (rapidly cooled in air and drawn) with those of the same steel when forged and annealed (No. 4) gives a concrete example of what has been said regarding the possible errors resulting whenever it is thought that the average homogeneity of all components in a steel can be judged on the basis of a microscopical examination which, in reality, reveals only the distribution of the carbon. In the present case, for instance, the results of the physical tests reveal a greater persistency of the original chemical heterogeneities in tests 3 of both steels than in tests 4, while the microstructure of tests 3 actually appears much more uniform than that of tests 4.

TESTS ON COMPLEX NICKEL-STEEL CASTING

Information will now be given for a nickel steel more responsive to homogeneity heat-treatments. Contrary to the experiments upon simple test-pieces described

TABLE VII. TESTS ON NORMALIZED CASTING OF MILD NICKEL STEEL

Treatment	Static Tensile Test				Impact Tensile Test		Resiliency, Kg.-M. per Sq.Cm. (Charpy test-piece)	Test Piece of Static Flexion
	Tensile Strength Lb. per Sq.In.	Elastic Limit, Lb. per Sq.In.	Elongation, per Cent	Reduction of Area, per Cent	Tensile Strength, Kg.-M.	Elongation, per Cent		
Heated at 800° C. for 4 hr., followed by rapid cooling in air, completely cooled in 1 hr.	96,000	56,000	15	14	106	12	5.1	Good
Heating and cooling as No. 1, then drawn 1 hr. at 700° C., followed by cooling in 6 hr.	86,800	52,500	21	22.5	117	27	7.5	Good
Heated at 800° C. for 4 hr., followed by a slow cooling in the furnace, requiring 18 hr.	92,200	52,000	28.5	39.8	145	35	8.22	Good
Reheating and cooling as in No. 3, then drawn at 700° C. for 1 hr., followed by slow cooling (6 hr.)	91,700	52,600	33	52.8	142	33	33	Good

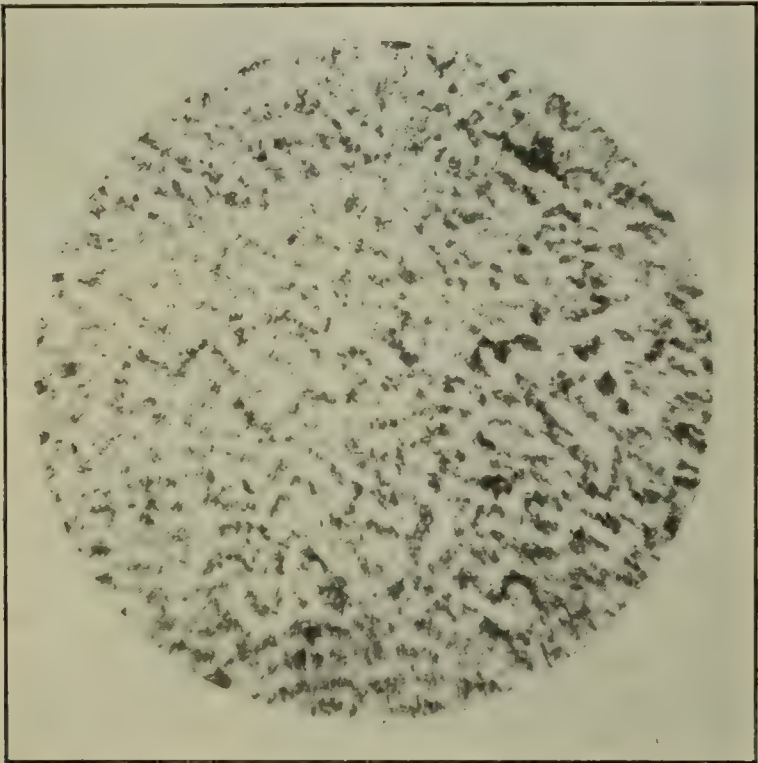


FIG. 21. MICROSTRUCTURE OF FORGED 0.34 C BAR. NORMALIZED. X 80. ETCHED WITH HNO₃ IN AMYL ALCOHOL.

test-bar 20 mm. in diameter and 200 mm. long between reference points:

Tensile strength.....99,500 lb. per sq.in.
Elongation.....17 per cent.

The results of the physical tests made on castings subjected to various indicated heat-treatments are gathered together in Table VII. The numerical data contained in this table do not need explanation and find easy interpretation in the body of considerations developed in the previous part of the book. However, it is useful to point out that these data, especially when compared with those just given, clearly substantiate a phenomenon known to be related to the relative frequency of the centers of ferrite crystallization. Special steels of this type are characterized by centers of secondary crystallization closely packed together. It

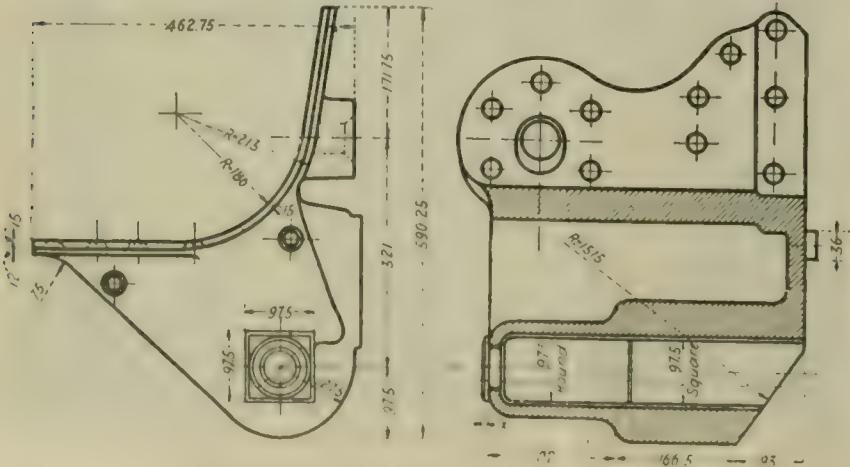


FIG. 22. DETAILS OF NICKEL STEEL TEST CASTING

is therefore a great deal less dangerous to cool such special steels through the transformation range slowly, after a given homogeneity heat-treatment, than it is to do the same thing with an ordinary carbon steel. From this special point of view it is especially interesting to compare the differences between No. 2 and No. 3 of Table VII with the corresponding values contained in Tables V and VI.

(Part II will be published in a subsequent issue.)

Reparation of War Damages in the Pas-de-Calais District

The Pas-de-Calais district was one of the principal sufferers from the war. The amount of damage done, exclusive of the heavy losses to the mines, estimated on a basis of values in 1914, reached 325,000,000 fr., apportioned approximately as follows: Damages to real estate, 138,000,000; for tools and appliances damaged or removed, 122,000,000; for the destruction and requisitioning of raw materials, 54,000,000; and for the destruction or requisition of manufactured articles, 11,000,000.

As the greater number of the establishments damaged were completely destroyed, large sums will be necessary for the reconstruction of this department. Already the amount for clearing away alone has reached over 8,000,000 fr., and advances of all kinds accorded to industrial companies for war damages exceed 200,000,000 fr. Of this, 120,000,000 has been allotted in money for urgent reparations, the reconstruction of buildings, transportation, administration expenses and the direct purchase of machinery, raw materials, etc. Of 1,551 industrial companies damaged, 400 have been set going again and 16 per cent of the labor employed before the war is now re-employed again.

Most of the reconstruction work already done has been in those industries connected with the manufacture and use of construction materials. Although much affected by the lack of coal, the brick and tile factories and the limekilns and quarries are producing to their utmost. The products of these industries are being used as rapidly as possible in the rebuilding of the 66,000 houses totally destroyed and valued at 1,320,000,000 fr., and the 29,000 houses partly destroyed, valued at 290,000,000 fr.

French Beet and Sugar Output

The official forecast for the French production of sugar beets for the 1920-21 period, as recently published in the *Review* of the American Chamber of Commerce in France, is placed at 1,919,538 tons of beets, as compared with 1,130,907 tons for the previous year, or an increase of 69.7 per cent. Refined sugar production is estimated to be 244,260 tons, as compared with 143,328 tons in 1919-20. This represents an increase of 70.4 per cent.

The Rise and Development of the Electrolytic Alkali and Chlorine Industry in Europe—II

An Outline of the Electrolytic Cells Employed in the Electrolytic Alkali and Chlorine Industry of the United Kingdom, Germany, Austria, France, Italy, Switzerland, Russia and Belgium*

By JOHN B. C. KERSHAW, F. I. C.

Electrolytic Alkali and Chlorine Industry in Germany

AS STATED in Part I of this article, the first successful electrolytic alkali works was that started in the year 1890 at Griesheim, near Frankfort, in Germany, the cell used being a diaphragm type of cell patented by the Elektron Co. According to Lunge, the experimental work which led up to the design of the Elektron cell was initiated by three German electrical engineering firms in 1884, a common fund being raised for this research work. The success which crowned the effort gave the Germans a distinct lead for many years in this new branch of the chemical industry.

The original Elektron works, at Griesheim, started with only 200 hp., but in 1892 it was doubled in size. At this period the writer was studying chemistry at Bonn University, and while there he heard with great surprise that success had been achieved at Griesheim in the manufacture of alkali by electrolytic methods, for at this date no one connected with the older LeBlanc alkali industry believed in the practicability of the electrolytic processes.

The Griesheim works having proved the value of the cell and process, a larger works was planned at Bitterfeld, in Saxony, where extensive lignite deposits are

companies have not always been satisfactory, the orders for plant and machinery which have been placed with German firms and the demand for German chemists and managers to take charge of these works in France, Russia, Austria and other European countries have no doubt amply compensated for the cost of the original research work carried out between 1884 and 1888 by the Allgemeine and other German electrical engineering companies. According to the writer's own figures, there were in 1907 already nine works in operation using the Elektron cell and process, the aggregate power utilized in these being 18,800 hp. Allmand, in 1912, estimated the aggregate capacity of the Elektron works at 33,000 hp., and stated that the Elektron or Griesheim cell was the most important of its type in use in Europe at that date. Its success is ascribed chiefly to its simplicity of design and low costs for repairs and maintenance, since its current and energy efficiency are comparatively low. (See accompanying Table.)

THE GRIESHEIM ELEKTRON CELL

The following description of the Griesheim cell is based largely upon that given by Allmand in the works already referred to.

The cell (Fig. 9) consists of a rectangular iron vessel, steam-jacketed, and covered externally with some non-heat-conducting material. This outer vessel contains a series of inclosed porous cement boxes about 1 cm. thick, which contain the carbon or magnetite anodes, and themselves act as diaphragms.

The advantage of magnetite as anode material for electrolytic alkali cells is that the chlorine gas is obtained free from CO₂; and it is claimed also that magnetite electrodes have a life of two years, even under the unfavorable conditions obtaining in the Griesheim cell. The magnetite anodes are of cylindrical shape, and are cemented to the lids of the anode boxes.

The chloride of sodium or potassium used in these cells is introduced into the anode chamber in the solid state, by a pipe reaching almost to the bottom of the cell, and is used in the pure form. The walls of the outer vessel act as cathodes, and in addition pieces of sheet-iron are suspended between each couple of anode cells.

The anodes and cathodes in each set of cells are connected in parallel and a current of 2,200-2,500 amp. is employed. The working temperature is high (90 deg. C.) and the concentration of caustic soda obtained in the cathode chamber is low, owing to the low current density employed and to the action of the current upon the sodium hydrate as it is formed. The solution in the anode boxes is kept saturated with NaCl (or KCl) and the caustic alkali solution is drawn off intermit-

COMPARATIVE EFFICIENCIES OF THE LEADING TYPES OF ELECTROLYTIC ALKALI AND CHLORINE CELLS
(Allmand & Kershaw's figures)*

Type of Cell	Cathode Efficiency	Energy Efficiency	Emf. in Volts	Conc. of Caustic Liquor	Kw.-Hr. per Kg. NaOH
Finlay.....	98	75	3.0	2N	2.0
Billiter-Siemens.....	92	68	3.1	3N	2.3
Vorce.....	97	62	3.6	?	2.5
Billiter-Leykam.....	95	59	3.7	3 to 4N	2.6
Allen-Moore.....	91	59	3.5	2½N	2.6
Whiting.....	92	53	4.0	5N	2.9
Hargreaves-Bird.....	85	..	3.7	3N	..†
Nelson.....	86	53	3.8	3N	2.9
Castner (rocking-cell)...	92	50	4.2	5N	3.1
Kellner (C anodes).....	95	49	4.5	5 to 6N	3.1
Bell-jar (Aussig).....	85	49	4.0	2N	3.1
Griesheim (carbon).....	70-80	45-51	3.6	1 to 2N	3.0 to 3.4
Wilderman.....	97	45	5.0	5 to 6N	3.4
Kellner (Pt. anodes).....	97	45	5.0	5 to 6N	3.4
Townsend.....	94	45	4.8	4N	3.4
Griesheim (magnetite)...	70 to 80	40 to 46	4.0	1 to 2N	3.3 to 3.8
Outhenin, Chalandre....	66	41	3.7	2N	3.7
Theoretical figures....	100	100	2.3	..	1.54

* Copyrighted by the author.

† This cell produces Na₂CO₃ not NaOH.

found, and this plant commenced work with 2,000 hp. in 1894, and was doubled in size in 1895.

The developments of the Elektron cell and process in Europe since that year have been remarkably rapid and have proved the value of being first in the field, for although the financial results of the subsidiary

*For Part I see CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, No. 2, Jan. 12, 1921, p. 77.

tently from the outer compartment of the cell. The emf. used varies from 3.6 to 4 volts. This low voltage is due to the fact that only a comparatively low current density can be employed and that the conductivity is increased by heat. When producing a liquor in the cathode chamber containing 80 g. NaOH per liter, in

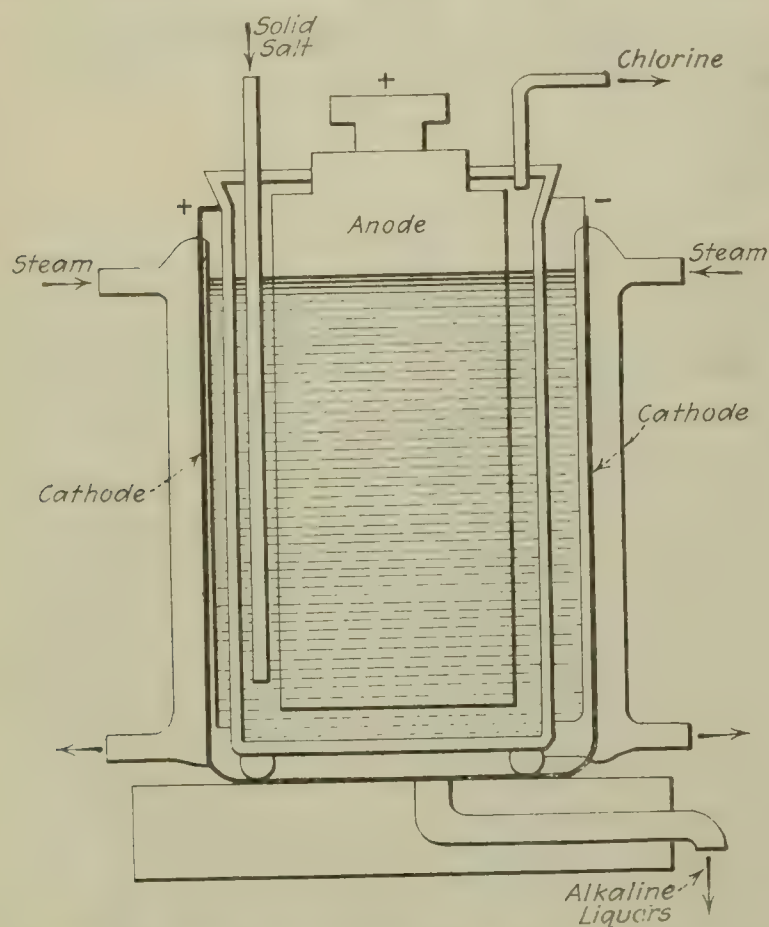


FIG. 9. THE GRIESHEIM OR ELEKTRON CELL

fact, the current efficiency of the cell is only 70 per cent. This can be raised to 80 per cent if liquor of only one-half of this strength is produced. The high temperature of the anode chamber causes the production of chlorates, which can be separated by crystallization when potassium chloride is being electrolyzed, since the potassium salt is not a very soluble product, but the sodium chlorate cannot be separated in this manner and is therefore lost.

The electrochemical works at Bitterfeld is operated entirely with electric power, derived from the very extensive beds of lignite which occur in the vicinity. The site of this works was chosen by the promoters because it was believed that the cheapness of the power would more than counterbalance the distance of the



FIG. 10. EXTERIOR VIEW OF THE ELEKTROCHEMISCHE WERKE AT BITTERFELD

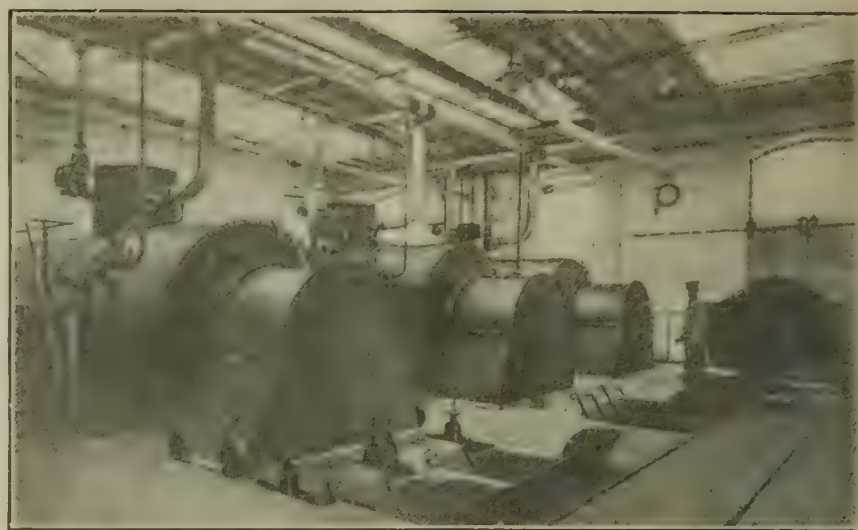


FIG. 11. GENERAL VIEW OF BOILERS FOR BURNING LIGNITE IN GERMANY, WITH STEP-GRATES BELOW FLOOR LEVEL

works from the usual markets for the manufactured goods. Very few details of the power plant have been allowed to appear in print.

Air-dried lignite is finally burned under tubular boilers with step-grates. Fig. 11 shows a general view of the charging floor of the boilers. The grate is sunk below the floor level, and the lignite is tipped directly into the charging hoppers from the tip wagons, in which it is brought into the boiler house. A sliding door, divided into three sections, regulates the admission of the fuel to the grate of each furnace. The

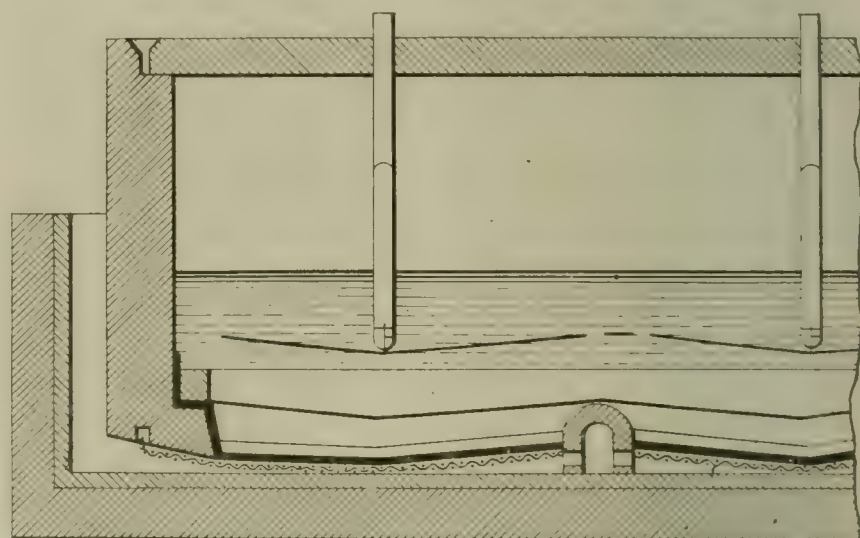


FIG. 12. THE BILLITER-SIEMENS CELL

angle of the step-grate can be altered from the ground level. The whole of the lower part of the grate is inclosed and the admission of air is regulated by levers which open or close the doors in front of the under-furnace space. The air required for combustion is drawn through a system of pre-heating stoves. As the use of the step-grate causes a very gradual evolution of the gaseous matter of the fuel, little or no smoke is produced and a secondary air supply, though provided for, is seldom required.

Trials carried out with this equipment have shown efficiencies ranging from 67 to 69.71 per cent. When using a fuel having a low heating-value, from 2.66 to 3.01 lb. of water were evaporated per lb. of fuel, the rate of burning varying from 3.1 to 4.1 lb. per sq.ft. of heating surface.

THE BILLITER-SIEMENS CELL

This cell was patented in 1907 by an Austrian chemist, Dr. J. Billiter. The patent rights for Europe then passed into the hands of Siemens & Halske of Berlin.

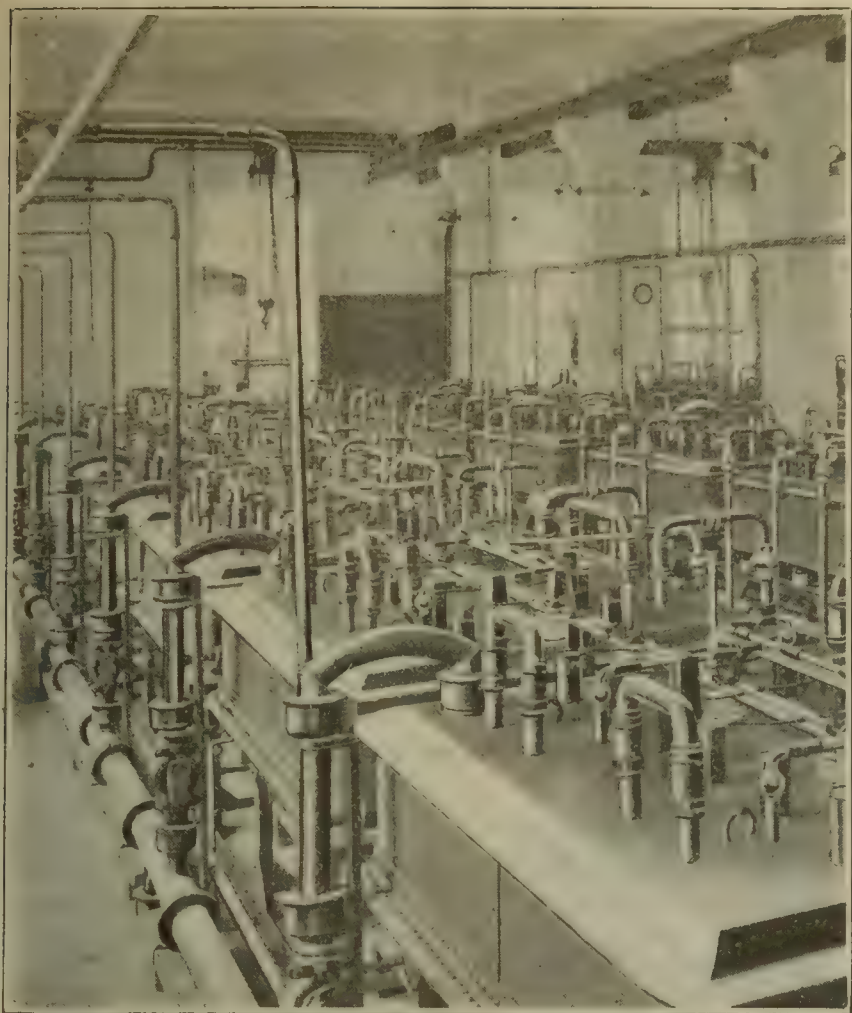


FIG. 13. BILLITER-SIEMENS CELLS AT SPIRO & SOHNE PAPER WORKS, BOHEMIA

and the cell is now known as the Billiter-Siemens cell. Before the war it was in operation in two works in Germany, two in Austria and one in the United States.

The cell is of the submerged diaphragm type (see Fig. 12), but the diaphragm is placed horizontally and not vertically, and it lies practically on the bottom of the cell, resting upon the iron gauze which forms the cathode of the cell. Above the diaphragm are placed inverted boxes or bell-jars, constructed of cement or slate, cemented at their lower edges to the diaphragm and containing large horizontal graphite anodes. The anode chambers are provided with pipes for feeding in the fresh brine solution, for leading away the chlorine gas liberated and for heating the electrolyte. The diaphragm of the cell is formed of asbestos-cloth, covered on its upper surface with a mixture of asbestos wool and fine barium sulphate, which prevents convection and diffusion losses and yet possesses a low electrical resistance. This horizontal layer of fine but well-graded inert material is the novel feature of the Billiter diaphragm. The cathode net, with the diaphragm resting upon it, is bent slightly upward in order to permit the escape of the hydrogen formed on its under surface. Several of these anode boxes or bells are contained in the outer vessel, which may be square or oblong in shape.

At Aschersleben long, narrow troughs are employed, with granite side-walls and iron bottoms, which thus serve to make electrical contact with the cathode net resting upon them. There are ten cells, each designed to utilize a current of 2,000 to 2,500 amp. and to yield a caustic potash liquor containing 18 to 23 per cent, with an expenditure of 1,000 kw. The chlorine obtained from the cell is remarkably pure, and the current efficiency is as high as 95 per cent, with an emf. of only 3.66 volts per cell.

Another form of the Billiter-Siemens cell had

been introduced before the war at the sulphite paper-pulp works of Spiro & Söhne, at Krummau, in Bohemia. The cells are very much reduced in size from the earlier trough type. They are constructed of boiler-plate, with a thick cement lining along the four inner sides, in order to confine the current to the bottom of the cell. This bottom, as before, is in contact with the iron-gauze cathode upon which the diaphragm rests. Each cell contains twelve graphite anodes, connected in parallel, the cells themselves being connected in series. Each cell takes 500 amp. and the total power used in the thirty-two cells installed is 65 kw. The chlorine produced at this plant is absorbed by milk of lime and is used in the form of calcium hypochlorite solution for bleaching purposes. The caustic soda liquor produced is sold in the liquid form, as facilities for concentrating it and obtaining the solid product are lacking.

The only other type of electrolytic alkali cell in use in Germany before the war was the Solvay mercury cell,¹ at the works of the Deutsche Solvay Co., at Osternienberg. This works was started in 1896 and utilized 1,500 hp. for the manufacture of caustic potash and bleaching powder.

MANUFACTURE OF HYPOCHLORITE OF SODA IN GERMANY

As regards the manufacture of hypochlorite of soda by electrolytic methods in Germany, only two forms of cell have been used extensively—namely, the Haas & Oettel cell and the Kellner cell.

Electrolytic methods of producing bleaching solutions have been widely adopted in Continental Europe. Before the war many hundreds of these installations were to be found scattered all over the Continent, wherever cheap electric power was available. More recently the tendency in Germany has been to produce the chlorine in the ordinary type of electrolytic alkali cell and to absorb this chlorine in milk-of-lime before using the calcium hypochlorite as the bleaching agent. Siemens & Halske have convinced themselves, by actual trials, that this plan is the more efficient and economical. The high price of platinum has of course operated to prevent the further adoption of the Kellner electrolyzer, but the Haas & Oettel type is stated to be still employed in Germany, where sodium hypochlorite solutions are required for bleaching fine cotton or linen goods.

Electrolytic Alkali and Chlorine Industry in Austria

In Austria four types of cell have been employed for the electrolysis of brine solutions—namely, the Aussig bell type of gravity cell, the Billiter-Leykam cell, the Billiter-Siemens cell and the Kellner mercury cell.

THE AUSSIG GRAVITY CELL

In the Aussig gravity cell no diaphragm is employed to separate the anode and cathode compartments of the cell, but the greater density of the caustic soda formed at the face of the cathode is relied upon to effect its separation from the unaltered brine solution in the remainder of the cell. Fig. 14 shows a sectional elevation of the Aussig bell cell; *a* representing the anode, *c-c* the two sections of the ring-shaped cathode and *d* the bell which surrounds the anode and serves to collect the cathode gas. The successful operation of a cell of this type depends chiefly upon very careful control, not only of the specific gravity and of the rate

¹See CHEM. & MET., vol. 24, p. 79, where this cell is described.

of flow of the brine solution but also of the current density and of the relative positions of the electrodes to each other and to the lower edge of the bell.

The failure to study all the conditions required to obtain success with gravity process led to the failure of this type of cell at St. Helens in the years 1896-1900; but at the works of the Oest. Verein f. Chem. Produktion, situated at Aussig, the open bell cell has been in successful operation since 1899, and a current efficiency of between 85 and 90 per cent is said to be obtainable with it. The strength of the solution of caustic soda obtained runs from 100 to 150 g. per liter Na_2O .

The costs for maintenance and repairs are of course very low and the absence of a diaphragm reduces the emf. required to work the process to $4\frac{1}{2}$ volts. On the other hand, a low current density must be employed, and the bell can be constructed only of small dimensions, so that a large number of bells are required to produce a large output.

THE BILLITER-SIEMENS AND BILLITER-LEYKAM CELLS

The Billiter-Siemens diaphragm cell, which has been already illustrated and described,² was operated before the war at Bruckl, in Bosnia, by the Bosnische Elektrizitäts Gesellschaft, with sixty-four 2,500 amp. units, similar in type to those installed at Aschersleben.

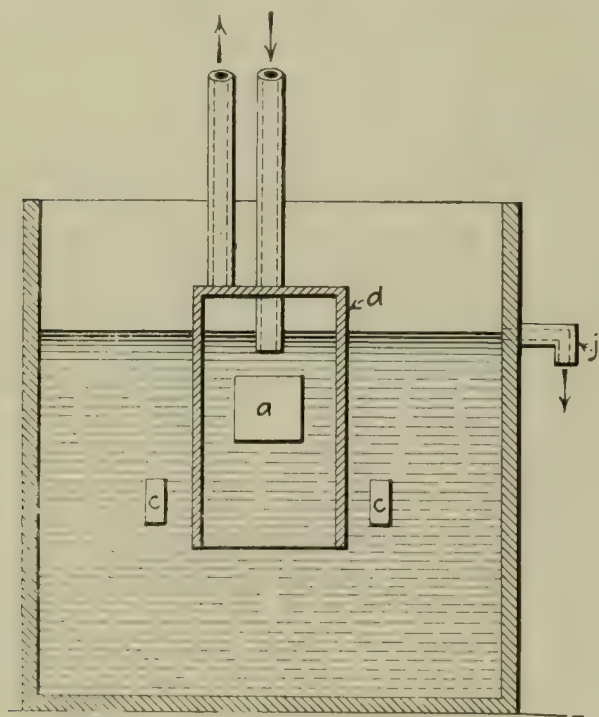


FIG. 14. THE AUSSIG CELL

Dr. Billiter, however, in 1910, designed and patented another cell which dispenses with the diaphragm of his earlier type and is known as the Billiter-Leykam cell. According to Allmand, this was one of the most efficient cells that had been operated technically before the war. The cell is shown in Fig. 15 and is seen to be a modification of the Aussig bell type of gravity cell.

The chief feature of the cell is the design and arrangement of the cathodes underneath the bell-jar. These cathodes are constructed of T-iron, inclosed in woven asbestos bags or tubes, and are sufficiently inclined to allow the hydrogen to pass away readily by the opening marked 16 in the diagram; while the caustic liquor descends to the bottom of the cell, and passes away by the channel marked 4.

According to Allmand, it is unnecessary to purify the brine at all with this type of cell; and the asbestos sheath of the cathodes is woven as coarse as is consistent with its purpose of collecting and leading away

from the anode bell or hood the hydrogen gas formed underneath it at the cathodes. In this way all disturbance of the liquor within the bell by the escaping hydrogen bubbles is avoided.

The Austrian rights of this cell were purchased in 1911 by the firm of paper manufacturers, Leykam Josefthal Gesellschaft, and an installation of fifty-six 1,200-amp. units was started at its factory, at Gratwein, near Gratz, in 1912. Allmand visited this plant, which utilized 500 hp. in 1912, and has published a detailed description of it in a paper read before the Faraday Society in November of the same year. The current efficiency is about 92 per cent, and the emf.

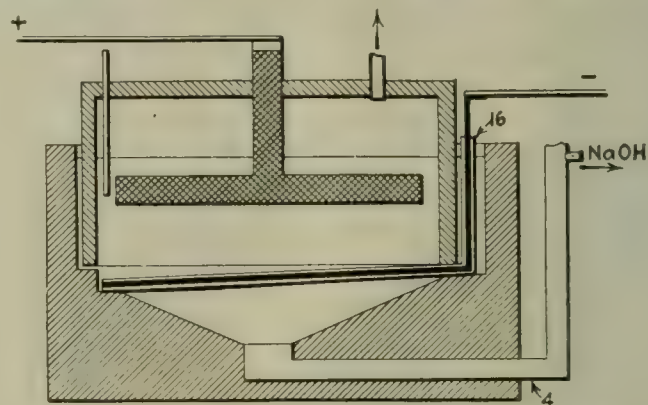


FIG. 15. THE BILLITER-LEYKAM CELL

required at 65 to 70 deg. C. is $3\frac{1}{2}$ volts. The cathode liquors contain on an average 12 to 13 per cent NaOH; but by decreasing the rate of flow of the brine, 16 per cent NaOH can readily be obtained.

THE KELLNER MERCURY CELL

The Kellner type of mercury cell has been worked by the Consort. für Electrochem. Industrien at Golling, in Austria, and at Jaice, in Bosnia, since 1900; but again there is no information available as to what has happened to these works during the war period.

The first-named works was only a small one of 200 hp., but at Jaice, in Bosnia, there was a large hydro-electric installation capable of producing over 10,000 hp.

The Kellner mercury cell at both of these works differed from that used at Weston Point in that compressed air was employed to circulate the mercury. The cell was a large but shallow vessel, constructed of cement, and was divided into three compartments by transverse partitions, dipping into the layer of mercury on the floor of the cell.

The center compartment formed the anode division, and contained a number of cement hoods carrying the anodes. The two end compartments of the cell were the cathode compartments, and in these the decomposition of the sodium amalgam occurred with the aid of iron, exactly as in the original Castner-Kellner cell.

The cathode compartments were, however, provided with outside troughs in which the mercury collected, and by means of a pump this mercury was forced to travel backward and forward from the anode to the cathode compartment of the cell. The circulation is reported by Allmand to be very efficient, and to permit the use of a high current density with the cell (15 to 20 amp. per sq.dm.); but no other data concerning the operation of Kellner cell or of the works at Jaice are available for publication.

(The third and last part of the article, dealing with the Electrolytic Alkali and Chlorine Industry in France, Italy, Switzerland, Russia and Belgium, will be published in a subsequent issue.)

²See p. 120

A Comparison of Various Methods of Water Purification

An Impartial Discussion on the Respective Merits and Disadvantages of Methods of Water-Softening by Filtration Through Zeolites, by Chemical Precipitation and by Rectification With Boiler Compounds

By WILLIAM MACKLIN TAYLOR

IN THE face of the claims and counterclaims set up by the manufacturers of the various processes of water purification, the layman and the chemist who have not specialized on this subject frequently experience difficulty in deciding which process is best adapted to their needs. The purpose of this article is to outline the strong and the weak points of these processes, drawing conclusions which will enable the uninitiated to decide more intelligently which process will solve his problem most successfully.

The term "water purification" is susceptible of two entirely different meanings. Water may be purified from a sanitary viewpoint and still remain as impure as before from an industrial standpoint, and *vice versa*. This article will deal exclusively with the purification of water for industrial uses.

Broadly speaking, the purification of water for industrial purposes may be divided into five classifications, which are as follows:

Distillation.

Removal of suspended matter by filtration.

Water-softening by filtration through zeolites.

Water-softening by precipitation.

Rectification by the use of boiler compound.

This article will deal principally with the last three methods mentioned and will touch on the first two very lightly.

DISTILLATION

Wherever a water of highest purity is an imperative requirement, distillation is the only method whereby it can be produced. The cost of its production is so high, however, that its commercial use is very limited, as compared with the other methods of purification. Where the entire absence of all impurities (dissolved and suspended) is not an absolute requirement, it is frequently possible, by the use of one or more of the other methods of purification, to obtain a water which will satisfactorily meet the requirements, and thereby effect a marked economy.

FILTRATION

Generally speaking, when a filter has removed all of the suspended matter which a water carries, it has fulfilled its mission. The processes of filtration are too well known to justify taking the time to describe them in detail here.

There are cases where filters which would hardly fall into the third classification are used for other purposes than the removal of suspended matter. The most notable of these are the filters whose beds are composed of marble chips, whose purpose is the removal of free acid from acid waters, and the filters whose beds are composed of various forms of charcoal, whose purpose is the removal of organic coloring matter.

The water in the clouds is as pure as any natural

water can be; but in passing through the air, as it falls in the form of rain, it commences to absorb impurities. As it travels over or through the earth before being used, it absorbs other impurities. The most troublesome of these are the salts of calcium and magnesium; and there is no natural supply of water known which is entirely free from them.

In cleansing operations as carried on in laundries and textile mills, the calcium and magnesium present in the water destroy soap, necessitating the use of larger quantities than would otherwise be necessary, thereby increasing the costs of operation. They form an insoluble curd-like precipitate with the soap, which adheres very tenaciously to the fibers of cloth or yarn and which causes trouble in various ways. In the laundry it causes a dirty yellowish gray appearance on the finished work, and later the organic acid to which the calcium and magnesium are united decomposes, giving off an unpleasant odor. In the textile mill it causes unevenness and breakage of the yarns in weaving, increasing the amount of "seconds." In the dye-house it forms lakes with the dyestuffs, causing streaked and uneven dyeing. In the preparation of certain chemicals, dyes, extracts, etc., the presence of calcium or magnesium salts causes precipitates, or lowers the quality of the finished product in other ways. In the boiler room the presence of calcium and magnesium in the water is a sure forerunner of boiler scale, which, if allowed to accumulate in the boiler, causes an enormous loss of heat and thereby a proportional excess consumption of coal. By acting as a heat insulator on the wrong side of the boiler shell, it allows the metal to become overheated, shortening its life and increasing the repair bill.

Hence, from the standpoint of nearly every industrial user of water, the salts of calcium and magnesium are trouble-makers and their elimination is desirable. Since it is these salts that make water hard, their elimination renders the water soft.

There are two well-known processes by which these salts may be more or less completely removed from the water. They are: Water-softening by filtration through a zeolite filter, and water-softening by precipitation.

ZEOLITE FILTERS

There are several kinds of zeolites in use today; some are of natural origin, some are produced by the fusion of several components, and others are produced by a precipitation process. All, however, work upon the same principle, taking advantage of the same chemical law of mass action, the details of operation alone being different. It is not my purpose here to state any preference for one over another, for all do good work and efficient work in the fields to which they are adapted.

In general, the zeolite water-softener is a pressure

filter, whose bed consists of granules of a zeolite. This zeolite is usually a hydrated silicate of aluminum carrying a large amount of loosely-bound and chemically active sodium. By the law of mass action, when water containing salts of calcium and magnesium is passed through this bed of zeolite, the sodium is exchanged for the calcium and magnesium, and the water in the effluent contains only very small amounts of the substances. If we use "R" as the symbol of the acid radicals to which the calcium and magnesium are joined, and "Z" as the symbol of the zeolite, the reaction which takes place might be written as follows:



This reaction, while very efficient from a commercial standpoint, does not proceed to theoretical completion, for a very small amount of calcium and magnesium remains in the filtered water, this amount usually ranging from 0.3 to 1.4 grains per gal., calculated to calcium carbonate. Water carrying less than the latter figure is usually referred to by manufacturers of zeolite water-softeners as water of zero hardness, although this term is really misleading.

In the author's library of water analyses, compiled during many years of work as a chemical engineer specializing on water purification, there appear many analyses of waters treated by the zeolite process. Some of these are accompanied by analysis of the same water before treatment. Probably the most representative of these is a sample of the city supply of Des Moines, Ia., taken July 3, 1917, and completed July 7, 1917. It runs as follows:

Dissolved Substance	Raw Water	Treated Water
Sodium chloride.....	0.58	0.88
Calcium carbonate.....	9.50	0.25
Magnesium carbonate.....	5.29	0.21
Magnesium sulphate.....	0.42	
Sodium carbonate.....		17.44
Sodium sulphate.....	8.52	8.59
Iron and aluminum oxides.....	0.40	0.14
Silica.....	1.14	1.24
Total.....	25.85	28.75
Hardness, calculated to calcium carbonate.....	16.15	6.50
Alkalinity, calculated to calcium carbonate.....	15.77	16.94

It is obvious that the time soon comes when all of the available sodium in the zeolite has been given up in exchange for the calcium and magnesium, and an exchange can no longer take place. When this time comes, it is not necessary to replace the zeolite with new material, for it can be regenerated or restored by reversing the law of mass action, for this law operates equally well in the reverse direction. This is accomplished by soaking the filter bed in a strong solution of brine made of common salt. The calcium and magnesium which had been absorbed by the zeolite are exchanged for the sodium of the sodium chloride, forming calcium and magnesium chlorides, and the sodium is absorbed by the zeolite. After having been steeped for a sufficient length of time—which differs with the products of different manufacturers—the brine is drawn off, the free salt remaining is rinsed out till the water runs sweet, and the zeolite is again in its highly effective state.

Water which has been passed through a zeolite water-softener exhibits the following properties:

It contains a smaller amount of calcium and magnesium salts than does the water treated in any other way except distillation.

It contains a slightly higher amount of dissolved solids than the raw water.

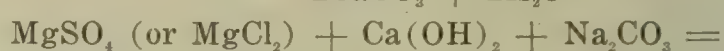
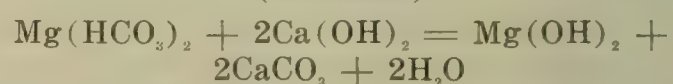
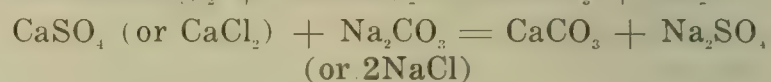
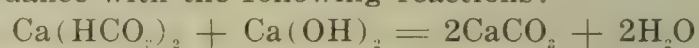
The alkalinity to methyl orange is slightly higher

and (except in case of an improperly-processed zeolite) no caustic alkalinity is added to the water. It makes a very satisfactory potable water and possesses a quite acceptable taste.

The greatest fields for the zeolite water-softener are in places where water is used for cleansing, as in laundries, textile mills, hotels and homes; or where the presence of the calcium and magnesium salts in the water cause trouble, as in the preparation of certain chemicals, extracts, dyes, etc.

PRECIPITATION WATER-SOFTENERS

The forms of precipitation water-softeners are many, but the principle upon which they operate is the same in all: The removal of calcium and magnesium salts by precipitation and filtration. The calcium is precipitated as the carbonate, the magnesium as the hydroxide. With few exceptions, the reagents used are hydrated lime and soda ash, and the precipitations are effected in accordance with the following reactions:



Some precipitation water-softeners have been sold which use caustic soda alone as the precipitant, but these had a very limited field, and never attained a very wide distribution. Other precipitation water-softeners at present on the market make use of barium carbonate as a precipitant in place of soda ash. These are valuable where the water contains large amounts of sulphates; but these constitute a special case, and cannot be considered at length here.

Precipitation water-softeners may be divided into two major classes: the intermittent and the continuous systems.

The continuous type of lime-soda ash water-softener (which enjoys a very much wider distribution than the intermittent type) consists usually of a large sedimentation tank provided with reagent tanks in which the weighed amount of chemicals to be used in treating the water is stirred up with a sufficient amount of water to permit of ready flow; and an apportioning device which allows the reagents to flow into the raw water in proportion to the raw-water flow. The water usually flows into a downtake, where it is thoroughly mixed with the chemicals and where the precipitation takes place. It then rises slowly in the sedimentation tank proper until it reaches the top, where it overflows through a filter, and is then ready for use. The sedimentation tank is built sufficiently large to allow such a slow upward movement of the water as not to interfere with the downward movement of the precipitates formed, as they settle in the form of a sludge, to the bottom, where they are drawn off through a valve as often as may be necessary. The standard practice is to allow four hours' time for the water to pass through this tank—i. e., the sedimentation tank is built sufficiently large to accommodate an amount of water equal to four times the rated hourly capacity.

The intermittent type of lime-soda ash water-softener consists of two or more large tanks from which the water is drawn alternately. As soon as one of the tanks is empty, it is refilled with the raw water, the necessary

amount of reagents is dumped in, and after a short period of agitation the precipitate is allowed to settle to the bottom. While this precipitate is settling, the water is being used from the other tank or tanks and by the time the supply of softened water in the other tanks is exhausted, the precipitate in the first tank is completely settled, and the water in this tank, now softened, is ready for use.

Water from the lime-soda ash water-softener exhibits the following properties:

It contains a smaller total amount of dissolved salts than the raw water.

Its alkalinity to methyl orange is usually less (except in cases of a raw water carrying a very small carbonate content), but it exhibits a small amount of "caustic alkalinity" (alkalinity to phenolphthalein). This is usually sufficient to give it a rather unpleasant, soapy taste, rendering it unfit for potable use.

It is impossible to carry the elimination of calcium and magnesium salts to the degree attained in the zeolite water-softener, the lowest practicable limit being a little over 1.6 grains per gal. of hardness, expressed in terms of calcium carbonate. In practice, the hardness of the treated water will usually run considerably above this figure, the average probably being in the neighborhood of from 3.5 to 4.0 grains per gal. The analyses which follow are those of raw and treated water from the city supply of Cedar Rapids, Ia., and are representative of the best results to be obtained from the lime-soda ash water-softener:

Dissolved Substance	Raw Water	Treated Water
Sodium chloride.....	1.46	1.46
Calcium carbonate.....	7.45	2.15
Magnesium carbonate.....	3.07	0.84
Magnesium sulphate.....	1.74	.....
Sodium carbonate.....	.....	2.33
Sodium sulphate.....	8.05	10.22
Iron and aluminum oxides.....	0.11	0.12
Silica.....	0.71	0.79
Total.....	22.59	17.81
Hardness expressed as calcium carbonate.....	12.55	3.15
Alkalinity expressed as calcium carbonate.....	11.10	5.25

The greatest fields available for the lime-soda ash water-softener are in the treatment of water which is evaporated for steam and of water which is used for the production of raw-water ice.

BOILER COMPOUNDS

During the past two decades the use of boiler compounds has fallen into disrepute, due to two causes. Of these probably the more important has been the existence of manufacturers of unscientific formulæ—the charlatans and mountebanks of the water-purification field. The substances used in the manufacture of these compounds are legion, and they include such irrational and worthless components as sawdust, potato peelings, ground straw, malt, spent tanbark, etc. As a warning against these, I would advise every purchaser of boiler-compound to shun any compound which is claimed to give satisfactory results on every water. It is the same proposition to try to treat every human ailment with the same medicine as to treat every water with the same compound.

The other cause for the disrepute into which the use of boiler compound has fallen is the propaganda distributed by the manufacturers of water-softeners. The unscrupulous manufacturers referred to in the previous paragraph gave good grounds for this propaganda, but it was not directed solely against these. Many manufacturers of boiler compounds approach the problem of the prevention of boiler scale in a thoroughly scientific

manner, maintaining well-appointed laboratories where the work is carried on by experienced chemical engineers and where the problem of the proper treatment of water is worked out with intelligence and skill.

In considering the various methods of water-purification, it is these latter boiler compounds to which I shall refer.

Exactly what takes place in a boiler under the combined effects of heat and pressure we shall never know. We can only judge from results as seen from the outside and from interior inspection after the heat and pressure have been removed.

It has been learned that the presence of certain salts in the water causes scale and the addition of certain chemicals will prevent this, causing substances which would otherwise form the scale to settle to the bottom of the boiler in the form of mud, to be disposed of in the blow-off. Certain other dissolved salts have been found to induce foaming and priming. The addition of other chemicals has been found to exert a counteracting force. The number of chemicals used in the boiler-compound field are many. A few of those used for the prevention of scale by a precipitating action are: soda ash, caustic soda, sodium silicate, tri-sodium phosphate, hydrated lime, barium hydrate, barium carbonate, barium chloride. Other chemicals which prevent the adhesion of scale by causing it to form in granules or in some other way preventing its fastening itself upon the metal are: certain mineral oils, graphite and certain tannin extracts. Some of those which have a tendency to counteract foaming are barium hydrate, barium carbonate, barium chloride, hydrated lime and certain vegetable oils.

To neutralize corrosion from free acid or from the sulphates of iron and aluminum, any alkaline salt may be used, soda ash probably being the most frequently employed. Electrolytic corrosion may frequently be overcome by the use of metallic zinc.

In general, the only field for the use of boiler compounds is in the treatment of boiler-feed waters.

GENERAL DISCUSSION

The value of any of these systems of water-purification depends entirely upon two considerations: 1. The nature and amount of dissolved matter present in the raw water. 2. The purpose for which the water is to be used.

There are supplies of water which cannot be satisfactorily treated for any industrial use by any method with which the author is familiar; as for instance, samples of water from parts of North Dakota and Wyoming which he has analyzed and which contain magnesium sulphate in excess of 1,200 grains per gal. Some supplies can be successfully treated by one method where another method would fail utterly. It is the purpose of this article to help the engineer decide which method will give best results on his supply of water, for his purpose.

ADVANTAGES OF ZEOLITE TYPE OF WATER-SOFTENER

Let us consider first the zeolite type of water-softener. Its outstanding advantages are the following:

1. It produces a water which contains a smaller amount of calcium and magnesium salts than can be obtained by any other method except distillation.
2. It requires less expert attention than the lime-soda ash water-softener.
3. No chemicals are fed into the water, hence there

is no changing of amounts of chemicals to take care of fluctuations in the hardness of the water.

4. The only reagent used is common salt, and this is less subject to fluctuation in supply and price than is soda ash.

5. Because no sedimentation tank is required, the zeolite water softener requires less space than the precipitation water softener.

DISADVANTAGES OF ZEOLITE TYPE

Its outstanding disadvantages are as follows:

1. The amount of sodium salts present in the water is increased and (due to the fact that sodium, a monad, has an atomic weight greater than half that of either calcium or magnesium, both of which are diads) the total amount of dissolved matter is increased rather than diminished. If used for boiler-feed water, this would increase the tendency to foaming and priming.

2. The cost of operation, exclusive of the cost of labor, is greater than with the precipitation water-softener.

3. The capacity fluctuates with the fluctuation in the amounts of calcium and magnesium salts present in the water.

4. Disintegration of the zeolite by attrition and solution, although it may be very slight, increases the upkeep or depreciation of the installation.

5. Many waters that could be easily handled by the lime-soda ash water-softener cannot be handled by this system. Large amounts of calcium or magnesium salts or large amounts of sodium salts render its use either inefficient or impossible. A zeolite softener cannot satisfactorily handle any water containing a larger amount of iron than the average. The presence of minute quantities of manganese will in a short time render a zeolite softener incapable of softening water. If the raw water carries an appreciable amount of suspended matter, it must be filtered before passing it through the zeolite machine.

It is not my intention to weigh these advantages against the disadvantages for specific applications, but rather to point out a few general considerations governing their operation.

TYPE OF LAUNDRIES, TEXTILE MILLS, ETC.

In laundries and textile mills, where the presence of calcium and magnesium salts causes the destruction of soap, and the curds formed by the interaction taking place between soap and these salts cause a lowering of the quality of the work turned out, for the average water the zeolite system is the logical system to use. In the preparation of chemicals, dyes, extracts, etc., where calcium or magnesium causes precipitates or lowers the quality in other ways, the zeolite system is the better system, provided only that the presence of increased quantities of sodium salts does not affect the quality. This rule holds good only for waters whose hardness is not greatly in excess of the average. For a water whose hardness ranges above about 40 grains per gal., the advisability of installing a zeolite softener presents a special problem which would have to be decided separately for each separate case. The reason for this lies principally in the fact that the raw water used to rinse out the salt used for restoring or regenerating a zeolite must be used in such quantities that with such a hard water the tendency is to reduce the capacity of the softener beyond the economical point.

Where a water contains a large amount of sodium salts, there is a tendency for the law of mass action to act in both ways during the passage of the water through the filter bed. It is as if the upper layers of the zeolite removed the calcium and magnesium, and then the water with the addition of the sodium which replaced the calcium and magnesium, being so high in sodium salts, partially restored the zeolite in the lower layers, just as the brine does. The amount of sodium salts which would cause trouble varies in different cases, and it would be difficult to formulate any rules which would hold good in all cases. The presence, however, of more than 40 grains per gal. of sodium salts or of more than 50 grains per gal. of dissolved solids is sufficient to cause the water to be viewed with suspicion.

Where a water carries a higher amount of iron than usual, or even a minute quantity of manganese (this latter is comparatively rare), or where the water contains any free acid, it is necessary to pre-treat the water before passing it through the zeolite machine. Iron or manganese dissolved in the water is absorbed by the zeolite, and in time forms a coating over the granules which interferes with the contact between the water and the zeolite; and without this contact, the exchange of the sodium for the calcium and magnesium is impossible. Free acid present in the water causes the zeolite to disintegrate more rapidly than is the case with the normal, slightly alkaline water. In addition to this, the acid water which does not carry a comparatively high amount of dissolved iron is indeed a rarity. Acid waters, however, are rarely met with outside of districts where mining is carried on or where steel mills are located.

WATER SHOULD BE ANALYZED BEFORE DECISION IS MADE

This may be a good place to state that it is a wise move on the part of a prospective purchaser of not only the zeolite but of any type of water-purification apparatus to have an analysis made of his water by some responsible laboratory. If the proposed installation is a large one, the prospective purchaser can well afford to protect his interests by obtaining the opinion of a reputable consulting chemical engineer; for it will frequently mean the prevention of costly trouble in the end, compared with which the consulting chemical engineer's fee would be a mere trifle.

In many cases zeolite water-softeners have been installed in private homes, in apartment buildings and in hotels and have given complete satisfaction, water treated in a zeolite machine having a pleasing flavor, and the removal of the hardness makes the water much pleasanter to use for bathing or for any cleansing operation, besides leaving the skin in better condition. Some claims have been put forth to the effect that boiled foods will cook more quickly in softened water than in the raw water, but I question it.

ADVANTAGES OF PRECIPITATION WATER-SOFTENER

Now let us turn to the precipitation water-softener. Its prominent advantages are:

1. Lower cost of operation. Ignoring the question of labor (for the grade of labor used to operate the softener varies so widely with different owners of water softeners that a just comparison is impossible), with rare exceptions, the lime-soda ash water-softener can be operated at less cost per thousand gallons of water treated than is the case with the zeolite softener.

2. Capacity remains the same, regardless of fluctuation in the hardness of the water. The fluctuations are taken care of by increasing or decreasing the proportion of chemicals to the amount of water treated.

3. The treated water carries a smaller amount of dissolved solids than the raw water and there is not as great an amount of sodium salts added to the water as with the zeolite softener. This lessens the tendency to foaming and priming, when the water is used for boiler feed.

4. There is no depreciation on account of attrition of mineral, as with the zeolite water-softener. Given equal care, the life of a precipitation water-softener should exceed that of the 100 per cent performance of the zeolite filter bed.

5. The limits of hardness or amount of sodium salts present in water which can be treated are considerably higher than with the zeolite water-softener.

6. If the water contains an appreciable amount of suspended matter, it is not necessary that it be filtered before being treated.

7. Waters containing free acid or high amounts of iron or manganese can be as effectively treated as if these substances were not present.

DISADVANTAGES OF PRECIPITATION WATER-SOFTENER

The notable disadvantages of the precipitation water-softener are:

1. Where space is an item, the precipitation water-softener requires a much larger space than does the zeolite softener.

2. It is an impossibility to produce as soft a water as can be produced in the zeolite softener.

3. Its operation is more complicated than that of the zeolite softener; hence it requires greater intelligence on the part of the operator to make the changes in the treatment necessitated by fluctuations in the hardness of the raw water.

4. The soda ash used fluctuates in price, and is frequently difficult to obtain at any price.

5. It is difficult to obtain a water through a lime-soda ash water-softener that will be suitable for human consumption.

The water obtained by treatment through the precipitation water-softener is pre-eminently a water suitable for boiler feed or for the manufacture of raw-water ice. Prior to the commercialization of the zeolite water-softener, the precipitation system secured a wide distribution among laundries, textile mills, etc. But for ordinary waters, the zeolite water-softener soon demonstrated its superiority in these fields. In laundries and textile mills every grain per gallon of hardness left in the water represents the destruction of soap and the formation of the sticky curd caused thereby, and the fact that a softer water can be obtained with the zeolite water-softener enabled it to appropriate these fields almost exclusively to itself in territories whose water supply was not impossible of treatment by this method.

In boiler feed, however, it is not necessary that the water be softened down to the last grain per gallon in order to prevent boiler scale. The presence of a small amount of caustic alkalinity (alkalinity to phenolphthalein) in the water is not only sufficient to prevent the formation of new scale by the treated water, but it will also, in most cases, help soften and remove scale that had already formed. It is necessary, however, to watch the performance of the precipitation water-

softener quite carefully to see that the water is treated properly, and that the treated water conforms to the standards of tests for such a treated water. Any fluctuation in the amount of proportions of the dissolved solids calls for a corresponding change in the amount or proportions of the chemicals fed to the water. The standard practice calls for hardness slightly less than the alkalinity to methyl orange, and for the alkalinity to phenolphthalein to be slightly greater than half that to methyl orange. The hardness may reach 5 to 6 grains per gal. in the treated water without causing scale to form.

Laundries, textile mills and other users of water whose supply is of such a nature that the zeolite water-softener cannot handle it properly may frequently obtain very satisfactory results by the use of the precipitation water-softener. As a matter of fact, one distinction between the performance of the two types of water-softeners is the fact that the zeolite machine's efficiency (within reasonable limits) increases in reverse proportion to the hardness of the water, while that of the precipitation type of machine (within reasonable limits) increases in direct ratio to the hardness of the water.

In the manufacture of ice, the smaller the amount of dissolved solids present in the water the better is the water for freezing and the less will be the necessity for core-pulling. Water treated in the precipitation water-softener contains a smaller amount of dissolved solids than does the raw water, hence the value of the precipitation water-softener in this industry. Water treated by a zeolite water-softener will contain a larger amount of dissolved solids than does the raw water, hence the zeolite machine is of no value here. This is one case where there can be no argument as to the relative values of the two types of water treatment.

There remains now the question of the relative value of water treated by boiler compounds to that treated by water-softeners. As indicated above, the only field where boiler compounds come into competition with water-softeners is in the treatment of water for use in boilers to make steam.

ADVANTAGES OF BOILER COMPOUNDS

The principal advantages of boiler compounds are:

1. No expensive apparatus is necessary for the treatment of the water.

2. It is much simpler and easier to handle than is treatment through water-softeners.

3. More accurate proportioning of chemicals is possible.

4. A greater variety of chemicals may be used, effecting better results with many waters than could be obtained by the use of a water-softener.

5. There is no loss of water due to disposal of sludge, backwashing filters, etc.

DISADVANTAGES IN THE USE OF BOILER COMPOUNDS

The more prominent disadvantages in the use of boiler compounds are:

1. Difficulty in obtaining uniform treatment of all the water used.

2. The amount of mud collecting in the boiler is increased, rendering more frequent blowing-down necessary.

3. Actual cost per thousand gallons treated is usually greater than is the case with softened water. This is to some extent offset by interest on investment in a softener, depreciation, repairs, etc.

The salesmen for water-softeners are prone to consider boiler compounds as more or less of a joke, an unscientific way of treating water—making a water-softener out of the boiler. And, as has been intimated before, there are frequently good grounds for this attitude.

The scientific boiler compound of today, however, is really an efficient method of treating boiler-feed water, and in many cases a more scientific method than by treating the water through a water-softener, for there are frequently cases where conditions are met with which cannot be effectively handled with a merely softened water. Among these are the conditions which cause foaming and priming. The use of a water-softener will not prevent these troublesome conditions; water treated in a zeolite water-softener has an increased tendency to cause foaming; and in a water exhibiting a tendency to foaming great care must be taken in treating it with a precipitation water-softener, for the slightest over-treatment increases this tendency. On the other hand, an intelligently prescribed boiler compound will introduce chemicals into the boiler which have an active anti-foaming effect, and will actually prevent foaming.

Pound for pound, boiler compounds cost considerably more than the chemicals used for treating in a precipitation water-softener, but under the influence of heat and pressure the chemicals used carry the reactions which take place nearer to completion and a smaller amount of chemicals can be used to secure a similar effect.

Boiler compounds will have a palliative effect on waters which cannot be satisfactorily treated in either the zeolite or the precipitation water-softener.

On account of the fact that the precipitation takes place inside the boiler, it is necessary to keep closer watch on the blow-off and to prevent accumulations of mud on the flues and other heating surfaces of the boiler, for such accumulations would allow overheating of the coated surfaces which would render repairs necessary.

PRECAUTIONS TO PREVENT CORROSION

Corrosion is usually met with in cases of acid waters. This may be as easily remedied by the use of boiler compound as by treatment in the precipitation water-softener. Soda ash is frequently the neutralizing agent employed, although in many cases where the acid present is sulphuric acid, barium carbonate or hydrate is used. This eliminates the danger of foaming which the formation of an excess of sodium sulphate would cause.

Corrosion from electrolysis is a matter of occasional occurrence in stationary boilers. In marine boilers it is nearly always present. It has been found that the use of metallic zinc will overcome corrosion by electrolysis. When metallic zinc is present in the boiler, the zinc, being electro-positive to the steel of the boiler shell, acts as the anode and is corroded in place of the steel. This fact is made use of by one manufacturer of boiler compounds by using finely pulverized metallic zinc mixed in the compound.

METHODS TO INSURE TREATMENT OF ALL THE WATER

In order for boiler compounds to do their work effectively, it is necessary that all of the water shall be treated. This is frequently difficult of attainment. Some manufacturers make their compound in the form

of a liquid and snuff it in through the injector at stated intervals. Others manufacture their compounds in the form of bricks or of balls, and feed it through some device whereby a small stream of the water is diverted through a section of pipe containing the solid compound, dissolving a small portion and then returning to the main stream of the feed-water inlet. This requires a nice adjustment of the stream which passes over the solid compound, so that it shall dissolve enough, but not too much, but it is probably the most satisfactory method of feeding the compound.

In the small installation, the boiler compound has an immense advantage over the precipitation water-softener, for the original cost of the water-softener is greater in proportion to the rated capacity in a small installation than in a large one. In addition to this the precipitation water-softener does not work so satisfactorily on small amounts of water—say from 100 to 250 gal. per hr.—as it does on larger amounts—from about 500 gal. per hr. up.

LOCAL CONDITIONS DECIDE METHOD TO BE USED IN THE CASE OF LARGE INSTALLATIONS

On larger installations, the question of the superiority of one or the other method of treatment depends upon local conditions. Under average conditions, boiler compound will produce better results with water-tube boilers. The author has, just this morning, inspected the turbinizing of a large water-tube boiler at the plant of a large chemical manufacturing concern. This boiler was in excellent condition, there being slightly less than $\frac{3}{8}$ in. of scale in the tubes, and about $\frac{1}{2}$ in. on the plates. The chief engineer of the plant told me that this was the first time in over a year that this boiler had been turbinized, that they had been operated twenty-four hours per day and had been run on an overload averaging at least 25 per cent, and that during the peak of the day's run the overload frequently reached 100 per cent. The water used in these boilers is Lake Michigan water, which carries 7.6 grains per gal. (slightly over 1 lb. per 1,000 gal.) incrusting salts; and it was treated solely with boiler compound. The reason that boiler compounds will produce better results with a water-tube boiler than will the precipitation water-softener is the fact that foaming preventives can be incorporated into the compound, whereas they cannot in the softener, and a very slight over-treatment of the water in a precipitation softener will cause water to be carried over with the steam from a water-tube boiler, especially at times when the boiler is carrying an overload.

For locomotive boilers the same consideration will obtain as with the water-tube boilers, for they are more subject to trouble from foaming and priming than even the stationary water-tube boilers.

BEST METHOD FOR FIRE-TUBE TYPE OF BOILER

On the fire-tube type of boiler, where there is not so great danger of foaming and priming, for average waters (those running over 8 grains per gal. of incrusting salts) the precipitation softener exhibits its best results; and it is usually superior to boiler compounds on the larger installations where it is possible to give it the proper attention. Accurate statistics are not available, but this will probably cover over 50 per cent of the stationary boiler horsepower in this country. For waters which run unusually high in incrusting salts (60 grains per gal. and over) or which run high in sodium

salts, boiler compounds will usually prove superior, as also is the case with waters whose incrusting salts run much lower than the average (less than 8 grains per gal.).

GENERAL SUMMARY

For laundries, textile mills, dyeing plants, manufacturing of chemicals, extracts, etc., the quality of whose products is lowered by the presence of calcium or magnesium salts, the zeolite water-softener is preferable if the raw water is such that the zeolite water-softener can handle it and if the presence of sodium salts in the water has no injurious effect.

If the water for the above industries cannot be handled by a zeolite water-softener, treatment by the precipitation water-softener will usually prove economical and valuable.

For the manufacture of raw-water ice, the precipitation water-softener is the only satisfactory method of treating.

In larger installations, with an average hard water, which shows no tendency to foaming or priming, for fire-tube boilers, the precipitation water-softener produces the best results.

In smaller installations, or with a low hardness, or an extremely high hardness, for fire-tube boilers, properly prescribed compounds are preferable.

For water-tube boilers of any size and for locomotives boiler compounds usually show best results.

Where high amounts of sodium salts predispose the water to foaming and priming, boiler compounds give best results.

In cases of electrolytic corrosion, the use of a zinc-bearing boiler compound will frequently correct the trouble.

From the above conclusions it is apparent that each type of water purification has a fairly well-defined field in which it is unquestionably *best*. The fields, however, where either of two different methods of treatment would give good results are quite frequently met with, and in these cases individual considerations would decide which of the two methods would be better. If the proposed installation be large enough to justify such action, it would be to the best interests of the user of water to obtain the impartial advice of some reputable consulting engineer.

Hammond Industrial Laboratories,
Hammond, Ind.

The Calcium Requirement of Man

Prof. H. C. Sherman of Columbia University has reported in the *Journal of Biological Chemistry* (vol. 44, pp. 21-7, 1920) a series of figures on the calcium content of various diets, and found that in 227 supposedly typical American diets, while only one was deficient in protein, 37 were deficient in calcium. If all diets furnishing less than 3,000 calories had been increased to that level—i. e., to furnish 3,000 calories—none would have been deficient in protein, but 7 per cent would still be deficient in calcium. Prof. Sherman, who is acting head of the department of chemistry and is one of the leading authorities on food chemistry, emphasizes the importance of increasing the intake of calcium by adding calcium carbonate or phosphate to the diet, or, better still, by increasing the intake of milk and other foods which are rich in lime. Milk has the advantage of increasing the high-grade proteins and of providing the fat-soluble vitamins.

Legal Notes

BY WELLINGTON GUSTIN

Device Having "U. S." as Most Prominent Feature Not Registrable

The Court of Appeals of the District of Columbia has affirmed the decision of the Commissioner of Patents denying to the United States Rubber Co. registration as a trade-mark for shoes the letters "U. S.," written on a disk, with other less conspicuous wording around the border.

The Patent Office had said that the meaning of "U. S." was too clearly established to permit of registration of any mark having that as the most prominent feature. This was agreed to, the decision being based upon section 5 of the trade-mark act, which denies registration to any mark which "consists of or comprises the flag or coat of arms or other insignia of the United States or any simulation thereof, or of any state or municipality or of any foreign nation."

Negligence in Handling of Acids—Care Required to Prevent Injuries to Others

Negligence in the handling of acid is the question presented in the recent decision of the Supreme Court of Rhode Island in the matter of McHugh against Williams & Payton. The latter were manufacturers, using acid in connection with their business. They had a carboy of sulphuric acid stored on the third floor of the building which they occupied. The acid commenced to leak and a quantity went through the floor, falling upon McHugh, who was working for another manufacturing company on the second floor. Because of the severe burns received McHugh brought an action for negligence to recover damages sustained on account of the negligent handling of acid by the defendants. From a judgment against the company an appeal was had and the Supreme Court has reversed the judgment, granting a new trial to the company.

In the court's opinion it appears that, under the Rhode Island workmen's compensation act, had the employee made claim against his employer for compensation and had been paid such compensation he would be barred from bringing an action for negligence against the third party who was responsible for the injury. But this defense was not available in this case.

It was contended for the injured employee that it was the duty of the defendants to use reasonable precaution in placing these acids and in the care of them so that they might not leak upon persons on the floor beneath. The question was presented: What was the duty of the manufacturing company with respect to the care of handling the acid? The court said that its duty was to handle this acid so that it would not injure innocent parties in any other section of the building; and to accomplish this its duty was to use what would be called ordinary care and diligence for the safety of others.

ORDINARY CARE DEFINED

Ordinary care was stated to be such care as a person of ordinary prudence exercises under the circumstances of the danger to be apprehended. The greater the danger

the higher the degree of care required to constitute ordinary care, the absence of which is negligence. It is a question of degree only. The kind of care is precisely the same. (52 Atlantic, 1090.)

The trial court held for the employee that, for injuries from a latent defect which cannot be discovered, the defendant is never liable, but that defendant was bound to make such an investigation of the flasks of acid as would lead it absolutely to know that all of them were sound and that there was no crack in them that would permit leakage. But the Supreme Court held this view was erroneous, that the defendants were required to use only ordinary care and diligence in making an investigation as to the condition of the soundness of the flasks, and not make such a particular investigation of them as would lead them absolutely to know that they were sound.

The case was reversed on this erroneous ruling of the lower court. To require the defendants to make such investigation of the flasks as absolutely to know their condition would require them to exercise the highest degree of care under the circumstances, or to be insurers of the condition of the flasks, and this degree of care is not required in the case herein, but only ordinary care under the circumstances and conditions.

Secret Processes and Letters Patent—Nature of the Rights Therein Distinguished

The nature of a patent right for a secret process or invention and one's property right to discoveries undisclosed to the public are considered in a novel case in the New York Supreme Court. A judgment creditor sought to force his debtor to answer questions that would reveal the nature of his claimed invention. Under the New York law a debtor may be examined "concerning his property," and therefore the court said that if the subject matter of the debtor's ideas or claimed invention constituted property rights then the debtor must answer the questions propounded to him.

It appears that the debtor had constructed some models of his ideas but he had not obtained a patent thereon; neither had he made an application for patent, nor has he made his ideas public. In deciding the matter Justice Cropsey gave a clear statement of the law.

It was said that an inventor may assign or transfer his rights to his invention, before making application for a patent, but even where that is done the application for the patent must be signed by the inventor. (94 U. S., 225).

NATURE OF A PATENT

The federal Constitution has conferred upon Congress the power to secure, for a limited time, "to authors and inventors exclusive right to their respective writings and discoveries"; and under this clause Congress has laid down the rules and regulations for granting of letters patent. To obtain a patent the inventor must make application to the Commissioner of Patents, and file with him a description, "in such full, clear, concise and exact terms as to enable any person skilled in the art or science to which it appertains . . . to make, construct, compound and use the same." A patent grants for the term of seventeen years the exclusive right "to make, use and vend the invention or discovery." This exclusive right is a legal monopoly, entirely the creature of statute. At common law there is no exclusive privilege. (9 Supreme Ct., 168.)

The inventor always had at common law, as he now has under the statute, the right to preserve the secret

of his inventive genius, and to enjoy the fruits of every legitimate utilization thereof, said the court; but upon permitting his secret to become known, his exclusive rights terminated and his secret became public property. His exclusive right to his invention depended upon his success in guarding his secret.

Now, while a patent confers the right of monopoly and the resulting benefits, it grants to the inventor no right in the conception of his mind, in the secret of his invention that he did not possess before.

TWOFOLD PURPOSE OF PATENT STATUTE

A twofold purpose was said to be accomplished by the statute authorizing the issuance of letters patent. First, it secures to the public forever, after the expiration of the patent, the benefits flowing from the inventor's genius, and, second, it rewards the inventor by giving him, for a limited period, the exclusive privilege of making, using and vending his product. The inventor is rewarded, not for making the discovery, but for disclosing his secret to the public. The disclosure by the inventor is the consideration for the grant of a monopoly by the Government. (30 Cyc., 816.)

In another case, Federal Judge Sanborn said:

"A patent is a contract by which the Government secures to the patentee the exclusive right to vend and use his invention for a few years, in consideration of the fact that he has perfected and described it, and has granted its use to the public forever after." (106 Fed., 693.)

A SECRET PROCESS IS NOT PROPERTY

Therefore, the right possessed under a patent consists in the exclusive privilege or monopoly of making, using and vending the physical product of his invention, and not in the secret hidden in the inventor's mind. When the inventor has made application for patent and has described his invention in "full, clear, concise and exact terms," he has made the required disclosure to the public and is entitled to a patent. This right to patent has been held to be a property right. But before the application is made the right is merely a common-law right to enjoy the fruits of his invention so long as he may be able to keep it secret. Upon discovery being made, the secret inures to the benefit of the public. Therefore, said the court, this right lacks the primary and essentials characteristic of property, which is the capability of being exclusively owned, possessed and used. And before application is made for a patent, the inventor has no property right in the invention which can be subjected to the payment of his debts. But when a patent has been issued, the inventor can be compelled to make an assignment of his property right for the benefit of his creditors.

RIGHT OF INVENTOR TO GUARD AND PRESERVE HIS SECRET IS WELL ESTABLISHED

But it does not follow that an inventor can be compelled to file an application for a patent. The right of the inventor to guard and preserve his secret is as well established as is his right to secure from the Government a monopoly by disclosing his secret, and the inviolability of the common-law right of the inventor to preserve his secret is guarded by federal statute.

Therefore the court held, in the instant case, that the right of an inventor, before he has disclosed his secret, is not property in the general sense requiring the judgment debtor to answer questions revealing the nature of his undisclosed invention.

Motion Pictures in Physical Testing Laboratory

By H. J. FRENCH, MET. E.

In studying the properties of boiler plate at various elevated temperatures, including those reached in boiler operation, crude oil distillation, etc., it became desirable to determine the effect of variations in rate of stress application. The factor considered of greatest interest, the limit of proportionality in tension, is generally determined at room temperatures from measurements of elongation under successive increases in load. This procedure, which probably requires the simplest form of apparatus, has likewise been used at elevated

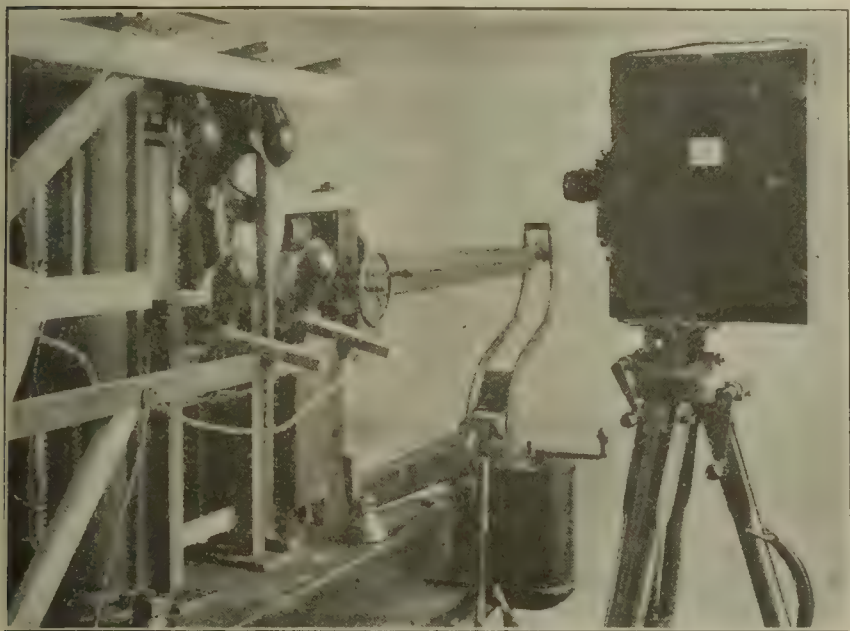


FIG. 1. COMPLETELY ASSEMBLED APPARATUS

temperatures,¹ but is not sufficiently flexible to allow much variation in rate of application of stress or measurement of strain under continuous loading without materially affecting the accuracy of the results obtained. It is here that the motion picture camera finds its application, makes possible the elimination of a complicated mechanism and permits a permanent photographic record of stress and strain to be obtained under continuously increasing load applied at very different rates. Thus its purpose becomes the rapidly repeated and simultaneous photographing of a number of indicators which are always in motion.

Fig. 1 shows the completely assembled apparatus, in-

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¹"Tensile Properties of Boiler Plate at Elevated Temperatures," *Mining and Metallurgy*, No. 158, Section 15, February, 1920. *CHEM. & MET. ENG.*, vol. 22, p. 392 (March 3, 1920).

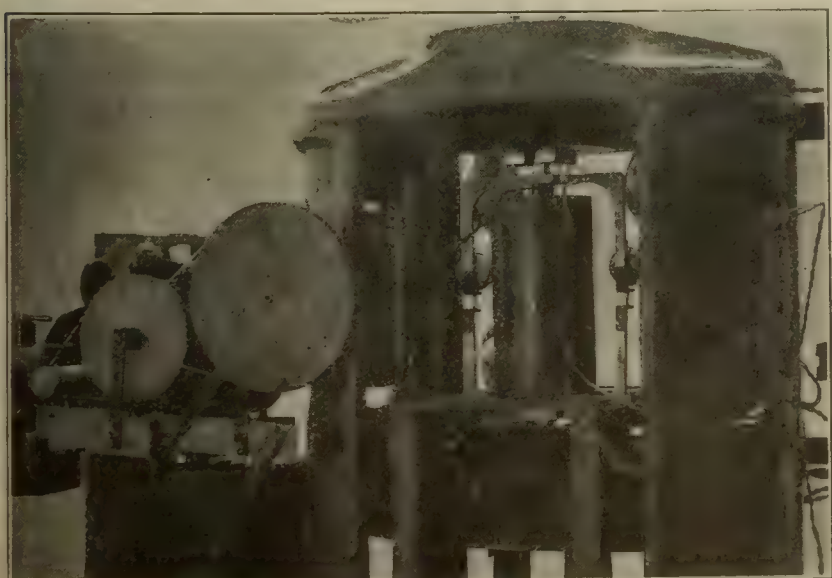


FIG. 2. SHOWING BELTS AND PULLEYS OPERATING LOAD-INDICATING DISK

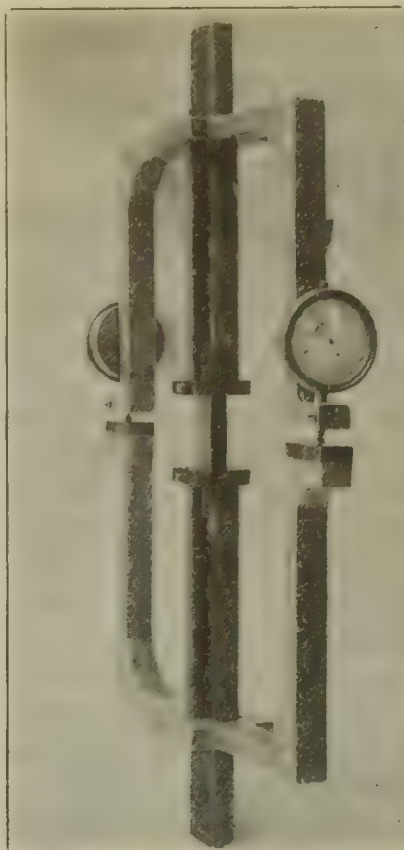


FIG. 3. DEFORMATION-MEASURING DIALS

cluding camera, used in determination of the limit of proportionality at room and various elevated temperatures. The load-indicating disk is driven by belts and pulleys, as shown in Fig. 2, from the screw operating the rider on the beam of the testing machine, while the two compensating dials measuring deformation are mounted on frames, shown in Fig. 3, which in turn are attached to the test specimen by two yokes. The dials are turned, however, to face in one direction. This arrangement is used to bring these three instruments into nearly one plane and as close together as possible in order that the largest images possible may be obtained on the film, an enlargement of which is shown in part in Fig. 4. The testing machine and camera are operated independently at any reasonable speeds, so that a wide variation in rate of loading and number of photographs of the dials may be obtained.

The test specimen is placed in a tubular electric-resistance furnace and may be loaded at various tempera-

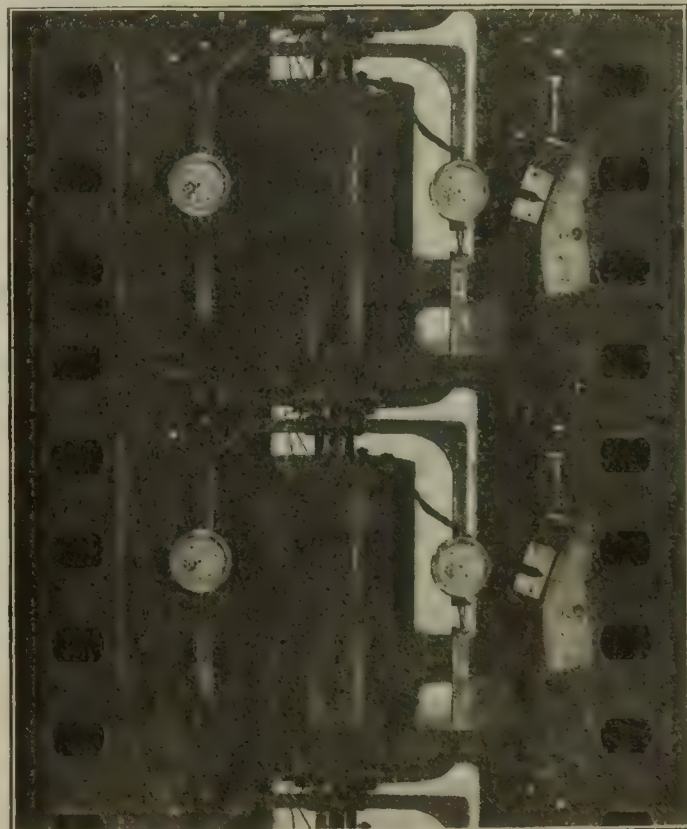


FIG. 4. SECTION OF FILM, ENLARGED

tures. After completion of the test the film is developed and then projected by means of a simple device which allows as much time as desired for obtaining individual readings from any one exposure. From readings so obtained a stress-strain diagram is plotted in the usual manner and the limit of proportionality is obtained. In this case, however, the strain is half the algebraic sum of the deformations recorded by the two compensating dials.

By this method the effect of rate loading on the tensile properties of firebox boiler plate has been studied.

Synopsis of Recent Chemical & Metallurgical Literature

Illuminating and Heating Gas From Wood Distillation.—The industry of manufacturing illuminating and heating gas from wood distillation has made rapid progress in Switzerland during the last few years. The disadvantages of wood gas (presence of great quantities of acetic acid, which is harmful to the life of the pipings, and of carbon dioxide) have been greatly reduced by the use of an improvement in wood distillation which consists in passing the gas through incandescent charcoal. The consumption of charcoal is from 1 to 3 kg. per 100 kg. of wood or 3 to 6 kg. per 100 cu.m. of gas. Tests have shown that by this improvement the following results are obtained as compared with those for a simple distillation of the wood:

The amount of gas produced from a given quantity of wood is nearly doubled.

The carbon dioxide content is reduced 25 per cent.

The calorific value of the gas is reduced 22 per cent.

The heavy hydrocarbon content is reduced about 66 per cent.

The methane content is reduced 50 per cent.

The hydrogen content is increased 80 per cent.

The tar content is decreased 50 per cent.

The acetic acid content is reduced to a practically negligible quantity. The apparatus and pipings are not deteriorated by these small quantities of acetic acid.

The gas produced is much lighter.

The water content of the tar is greatly reduced, thus improving its selling price.—From *Journal für Gasbeleuchtung*. See *Génie Civil*, Nov. 27, 1920, pp. 439-440.

Brass-Casting Practice.—An important research on "The Influence of Gases on High-Grade Brass" was presented before the fall meeting of the British Institute of Metals by T. G. BAMFORD and W. E. BALLARD. Their theoretical studies were supplemented by pouring experiments in a brass foundry and their conclusions were verified in this manner.

It was judged impossible to discover the exact amount of gas present in solid brass by heating it in a vacuum, because the total amount of contained gas would not be evolved and at the same time a considerable amount of zinc would be volatilized. Specially prepared brass was therefore heated at a uniform rate in a tight tube containing a pure gas and the absorption at different temperatures inferred from the change in pressure. Comparing the curve thus plotted with a blank run with no metal, it was found that CO_2 was apparently not absorbed by brass, CO was absorbed to a slight extent, and H_2 showed a fairly large and regular absorption. Sulphur dioxide was absorbed in large quantities between 300 and 1,020 deg. C., at which temperature absorption ceases and an evolution of gas commences, becoming more rapid up to 1,100 deg. C. A marked chemical reaction takes place, producing heavy scale, accompanied by sulphidation, dezincification and the formation of blowholes. No results were possible with methane due to complex reactions accompanied by carbon deposition.

Experiments were then devised and executed to

measure the rate of reaction between SO_2 and brass, and the results were interpreted to mean that under the small partial pressure of SO_2 existing in any furnace atmosphere this gas could not be absorbed by brass at a correct pouring temperature, but would be actually eliminated from the metal.

This implies that the metal must be hot enough to remain fluid in the mold for a few minutes after pouring, and is one reason why brass cannot be poured at too low a temperature.

Experiments to measure the solubility of H_2 in brass were then undertaken, despite the apparent difficulty. Hydrogen-free brass was finally prepared by melting the metal in an atmosphere of CO_2 , bubbling this gas through the metal for about half an hour, pouring and cooling the metal in a carbon dioxide atmosphere. An ingenious experimental apparatus was then devised for bringing the brass to the desired temperature in a neutral atmosphere, replacing this with an atmosphere

TABLE I. 70:30 BRASS (71.10 PER CENT COPPER)

Temperature, Deg. C.	Solubility, Mg. per 100 g.
870	11.0
820	6.9
725	6.7
540	2.5
30	nil
850	3.3
750	2.7
30	nil

of hydrogen without involving heavy zinc losses, and the measurement of the weight of the hydrogen absorbed. The notable and important feature of these experiments is that the solubility determinations were made without subjecting the brass to any pressures differing largely from that of one atmosphere. The results are shown in Table I.

Several different investigators agree that H_2 is soluble in Cu at 600 deg. C., with a solubility rapidly increasing with temperature, reaching 0.3 mg. in 100 g. at 920 deg.

TABLE II. BRUNNER MOND ZINC (CAST IN CO_2)

Temperature, Deg. C.	Solubility, Mg. per 100 g.
750	1.3
600	3.5
300	4.8

C. Little information is available on H_2 and Zn, however, so experiments tabulated in Table II were performed.

Evidently 70:30 brass can absorb much more H_2 than can either of its constituents.

Having determined the fact that hydrogen was absorbed in large quantities, it was important to discover how it could be extracted from the metal. This was done by heating weighed samples of brass in a stream of dry carbon dioxide to oxidize any hydrogen in the sample and then collecting and weighing the water formed in the reaction.

It would appear from the results that a large proportion of the hydrogen retained in the brass is easily removed by heating at 600 deg. C. or above. The major portion of the hydrogen absorbed during heating is usually retained on cooling.

Brass can evidently either adsorb large quantities on its surface, or large quantities can actually pass into the metal.

In the former case, clearly, such adsorbed gas could

not be responsible for internal unsoundness, and in the latter case, since the H_2 could diffuse through the metal, it could hardly develop sufficient internal pressure to be responsible for blowholes. Such an argument does not apply in the case of SO_2 , which in connection with an unsuitable pouring temperature might be responsible for unsoundness.

Investigation was therefore carried out on the relationship existing between the casting and pouring temperatures and the qualities of brass casting. Billets were cast in a brass foundry, observing the temperatures of casting and examining the condition of the billets at the end. Furthermore, a special furnace was designed and built with the object of obtaining a positive answer to the question as to whether any particular furnace gas would have a deleterious effect upon the quality of brass castings, provided the metal was poured at the correct temperature.

These practical experiments verified the following theoretical conclusions completely:

1. In ordinary foundry practice, using a coke-fired natural-draft wind furnace, it is impossible to impair seriously the mechanical properties of the casting by overheating.

2. Cooling the metal to within 40 deg. C. of the liquidus will certainly ruin the mechanical properties of high-grade brass which has been melted in ordinary furnace atmospheres, and will probably render the casting porous.

3. In casting tubes a higher temperature is needed than when casting solid ingots, and it is not advisable to cast 70:29:1 tubes below 1,150 deg. C.

4. Exceptionally prolonged periods of heating of the metal in the furnace do not impair the mechanical properties of the resulting casting, but of course are to be deplored for commercial reasons, on account of the consequential high zinc losses.

5. The furnace treatment is not a deciding factor in influencing the quality of the casting, but the pouring temperature is the notable factor.

6. Unsoundness is usually confined to the upper portion of a casting.

Carbide in Quenched and Tempered Steels.—In the thirty-eighth report of the Japanese Iron and Steel Institute SEIZO SAITO determines by means of magnetic and X-ray analysis that it is immaterial whether one says that cementite or carbon is dissolved in iron to form austenite, since both these phrases refer to the same atomic configuration. If free carbon does dissolve in iron when the mass is heated above the transformation it is reprecipitated as cementite. When tempering a quenched steel at about 300 deg. C. cementite is first set free, but owing to the extreme fineness of the particles the greater part readily decomposes. (Eutectoid steel first separates cementite on tempering at 130, and precipitation is complete at 360 deg.) Honda had previously found that the amount of precipitated cementite reaches an asymptotic value at about 400 deg. C.; further heating to 700 not appreciably increasing its quantity; the amount is less than the value before quenching, possibly by a value equal to that which decomposes when extremely finely divided. Coagulated cementite forming a comparatively large grain (pearlite) or massive cementite in hypereutectoid steels does not decompose below A_1 to any extent, but in the latter case free cementite does partly decompose above A_c .

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Ammonia-Soda Process.—In the usual ammonia-soda process the mother liquor obtained by filtering out the sodium bicarbonate contains small proportions of sodium and ammonium bicarbonates and large proportions of sodium and ammonium chlorides. This liquor is treated with lime in the ammonia stills for the recovery of ammonia. Nearly one-half of the original sodium chloride is lost in the calcium chloride brine, so that the process cannot be worked commercially except at places where salt can be very cheaply obtained. According to a modification proposed by TORANOSKE NISHIGAWA of Tokyo, Japan, more sodium chloride is added to the filtrate after the separation of sodium bicarbonate and ammonium chloride is precipitated by cooling to below 5 deg. C. Prior to cooling, sufficient ammonia is added to the liquor to convert the small proportion of bicarbonates into normal carbonates. This ammonia is prepared synthetically from the gas from the scrubbers and carbonators, which is almost pure nitrogen. Either the cyanamide or the Haber process may be used. After filtering off ammonium chloride, the mother liquor (containing ammonium carbonate, sodium chloride and some ammonium chloride) is returned to the absorbers to form ammoniacal brine. (1,359,097; Nov. 16, 1920.)

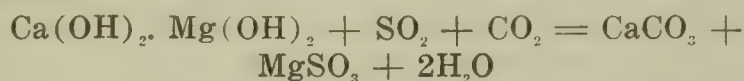
Phosphoric Acid.—FRANK S. WASHBURN of Rye, N. Y., has improved the process for the production of phosphoric acid from phosphate rock described in his earlier patents—1,047,864, Dec. 17, 1912, and 1,100,639, June 14, 1914. An electric furnace is charged with a mixture of phosphate rock and silica and the necessary amount of carbon is fed in from a hopper in the top of the furnace. Further quantities of phosphate and silica are fed from a bin to a rotary kiln and then pass through a hearth furnace before entering the electric furnace through a side opening. The hot gases and vapors from the electric furnace pass through the hearth furnace and kiln in the opposite direction and thus serve to preheat the charge so that maximum thermal efficiency is obtained. (1,359,211; assigned to the American Cyanamid Co.; Nov. 16, 1920.)

Anhydrous Magnesium Chloride.—Needle crystals of magnesium chloride are partly dehydrated by the use of large volumes of heated air until the melting point of the salt is raised above 250 deg. C. The material is then placed in a retort and a current of dry HCl is passed through while the temperature is slowly raised from 150 to 650 deg. C. The product is 98 to 99 per cent $MgCl_2$. (1,359,652; EDGAR A. ASHCROFT of London, England; Nov. 23, 1920.)

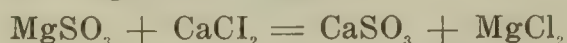
Magnesium.—Metallic magnesium is prepared from anhydrous magnesium chloride, made according to the process described in U.S.P. 1,359,652, by the use of a twin cell electrolytic apparatus. In the primary cell the anodes are of graphite, the cathode is a molten magnesium:lead alloy and the electrolyte consists of fused

anhydrous magnesium chloride. Magnesium:lead alloy from the primary cell forms the anode of the secondary cell and the metallic magnesium which collects at the iron cathodes floats on the surface of the fused MgCl_2 electrolyte and is removed periodically. A current efficiency of 90 to 95 per cent is claimed. The primary cell voltage varies from 4 to 6 volts; that of the secondary cell from 1 to 2.5 volts. The current density is such that the surplus energy maintains the contents of the cells in fusion—that is, at about 750 deg. C. When magnesium alloys are made, only the primary cell is used. The chlorine gas evolved at the primary cell is absorbed in a water emulsion of lightly calcined magnesite, forming magnesium chlorate and magnesium chloride in the molecular proportions of 1:5. The chloride is crystallized, dehydrated and used as electrolyte. The chlorate may be used as such or it may be converted into potassium chlorate and magnesium chloride. (1,359,653 and 1,359,654; EDGAR A. ASHCROFT of London, England; Nov. 23, 1920.)

Magnesium Chloride.—Slaked dolomitic lime is treated simultaneously or successively with an amount of CO_2 equivalent to the calcium in the lime and an amount of SO_2 equivalent to the magnesium content of the lime:



Calcium chloride is then added to convert the magnesium sulphite into magnesium chloride:



The precipitated carbonate and sulphite of calcium are removed by filtration. (1,359,782; EDWIN O. BARSTOW of Midland, Mich., assignor to the Dow Chemical Co.; Nov. 23, 1920.)

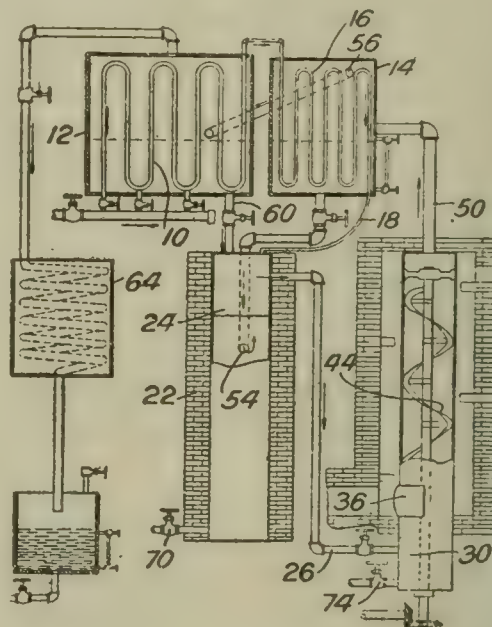
British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Recovering Tin and Zinc From Scrap.—Zinc chloride, palmitin and tin are recovered from the scruff from tinning pots. The scruff is crushed to pieces about $\frac{1}{4}$ in. in diameter, agitated in a tank with about one-fifth as much water below 60 deg. F. until the zinc-chloride solution obtained has a specific gravity of 1.3, when it is drawn off and filtered in a filter press. The remaining sludge in the tank contains palmitine, which term includes palmitin and palmitic acid, tin, tin oxide and a small proportion of chloride of zinc and is ground with water to a paste and screened to remove the heavier particles of tin. "Tin soap," which consists of tin oxide and palmitine, and a proportion of the lighter particles of tin are also separated in the screening operation and are then agitated in a vessel when the tin sinks and the supernatant palmitine and tin oxide are filtered to remove water, treated with sufficient hydrochloric acid to dissolve any zinc and tin oxychlorides, filtered, dried and distilled. The distillate contains a mixture of palmitin and oil. (Br. Pat. 151,374. G. H. CLEGG, Cardiff; Dec. 8, 1920.)

Cracking Hydrocarbons.—In decomposing heavy hydrocarbon oils to yield lighter oils by heating them under pressure, the free carbon which is formed is continuously removed. The oil is heated in a furnace-heated vertical still 30, containing a rotary scraper 44 and is kept normally full of oil. Vapors and oil from the still pass up a pipe 50 to a separating chamber 14, from which the oil passes by a pipe 54 to an insulated

vessel 22 in which the oil rises slowly upward and passes through a screen 24. The suspended carbon deposits in the vessel or is retained by the screen. The oil returns to the still by a pipe 26. The vapors may be passed from the chamber 14 by a pipe 56 to a chamber 12 in which the temperature is controlled by passing the oil supply through a greater or less length of the coil 10. The heavy oils condensed in chamber 12 are passed by a pipe 60 into the vessel 22 and the vapors pass to a condenser 64. The oil supply may be pre-



heated by passage through the coil 10 and a coil 16 in chamber 14 and is admitted to the vessel 22 by a pipe 18. The bases of the vessel 22 and the still 30 are fitted with blow-off cocks 70, 74 to remove deposited carbon. The circulation of the oil among the still 30, the separator 14, and the carbon-removing vessel 22 may be assisted by a pump. The pressure within the circuit is maintained between 60 and 120 lb. per sq.in., and the temperature between 370 and 450 deg. C. (Br. Pat. 151,925; not yet accepted; R. D. GEORGE, Boulder, Col.; Dec. 15, 1920.)

Washing Crystals.—Crystals deposited from a solution containing more than one salt are freed from mother liquor in a centrifugal machine, the process being completed by treating the crystals immediately the bulk of the mother liquor has been removed with water in a state of fine subdivision, either as spray or wet steam, so that no dry air can enter the mass until all the mother liquid has been removed. The crystals are preferably taken from the evaporator and treated at the temperature of their formation, the steam being introduced at a temperature suitable to bring about this result. A centrifugal machine which can discharge the crystals without stopping is preferably used. The process is described in connection with freeing crystals of sodium carbonate from a liquid containing common salt. (Br. Pat. 152,041, J. T. WINDRAM, Johannesburg, S. A.; Dec. 15, 1920.)

Dyes.—The products obtained by treating the sodium or ammonium salts of nitrated diphenylamine compounds with an alkaline cyanide in aqueous solution dye wool brown to purple shades. The diphenylamine compounds should yield water-soluble alkaline salts; the examples provided being hexanitrodiphenylamine, tetranitrothiooxydiphenylamine, 2:4-dinitrodiphenylamine-*p*-sulphonic acid and 2:4-dinitrodiphenylamine-*m*-sulphonic acid. (Br. Pat. 151,868, BRITISH DYESTUFFS CORPORATION and J. TURNER, London, and L. G. BADIÉ, Huddersfield; Dec. 15, 1920.)

Current Events

in the Chemical and Metallurgical Industries

Fixed Nitrogen Corporation Bill Passes Senate

By a vote of 34 to 29, the bill providing for the creation of the United States Fixed Nitrogen Corporation was passed by the Senate Jan. 14 after it had been extensively amended. The chief responsibilities were vested in the President and the handling of the business end of the organization was lodged in the Secretary of the Treasury. Originally the bill provided for vesting most of the responsibility in the Secretary of War, who also was to be in complete charge of operations.

While the passage of the bill by the Senate is regarded as a victory for those favoring it, there is much doubt whether it will be passed by the House. If the bill can be brought to a vote there, it probably will pass, but under the rules it will be difficult to bring it before the House without having the consent of the majority leaders, and it is doubtful if that can be obtained.

The debate on the bill was particularly acrimonious. Senators Wadsworth, Lenroot, Poindexter and others were accused of filibustering against the measure. Although this charge was denied, it is evident that the opponents of the bill left little unsaid in regard to it. For that matter, however, the proponents of the bill occupied much time with their arguments.

The opposition to the administration of the corporation by the War Department was led by Senator Wadsworth, of New York, chairman of the Committee on Military Affairs. In that connection he said: "I think the Secretary of War should not be burdened with more civil jurisdiction. We have piled him with it in recent years. This bill, as drafted, would make him the responsible head for the carrying on of a great commercial business, the manufacture and sale of fertilizer. Military men are suggested as officers of this commercial corporation. Army officers are not trained business men. Soldiers ought not be assigned to work of this character.

"This enterprise should be put under the Treasury Department and business men. The Treasury Department is the business end of the Government."

The desires of Senator Wadsworth in that connection were adopted finally without objection.

An important amendment embodied in the bill just before it was passed provided that:

"The corporation shall be conducted under the supervision and control of a board of directors consisting of not less than five nor more than seven members, to be appointed by the President, by and with the advice and consent of the Senate."

The provision authorizing appointment of army officers as directors was stricken out. The bill was also amended by denying condemnation power to the corporation.

During the discussion of the bill Senator Smoot charged that the principal purpose behind it was not national defense or the manufacture of fertilizer, but the harnessing of a water power at Government expense for the use of the industries and the utilities in the territory tributary to Muscle Shoals.

Sheffield Scientific School Lecture Course for Graduate Students

The following program of lectures at Sheffield Scientific School, Yale University, by well-known leaders in the chemical world, has been arranged so as to give the graduate students of organic chemistry a broader vision of its application in the industries and the inspiration, which comes by contact with such men, to seek further the truths revealed by research:

1. Prof. R. H. McKee, professor of chemical engineering, Columbia University, New York City.

2. Prof. E. V. McCollum, professor in department of chemical hygiene, Johns Hopkins University, Baltimore, Md.

3. Prof. H. N. Holmes, chairman of department of chemistry, Oberlin College, Oberlin, Ohio.

4. Dr. David Wesson, technical director, Southern Cotton Oil Co., Savannah, Ga.

5. Dr. M. L. Crossley, research director, Calco Chemical Co., Bound Brook, N. J.

6. Dr. P. A. Levene, chemist, Rockefeller Institute for Medical Research, New York City.

The first speaker, Prof. McKee, will deliver two lectures as follows: Jan. 20 at 8:15 p.m., on "Tendencies in Chemical Engineering Education"; Jan. 21 at 9 a.m., on "Plant Problems Falling to a Chemical Engineer."

Stamford Chemical Society Elects Officers

The officers elected to take charge of the affairs of the Stamford, Conn., Chemical Society are: President, G. C. Givens; vice-president, S. D. Shipley; secretary, F. B. Wilson; treasurer, R. H. Stevens; director, E. H. Smith.

At the next regular meeting on Jan. 24, Dr. Allen Rogers of Pratt Institute will give an illustrated lecture on "The Utilization of the Shark."

Fellowships Open at Urbana

Sixteen research graduate assistants are maintained by the Engineering Experiment Station, University of Illinois, some of which are now open, each of which carries a stipend of \$600 plus fees. Appointments are for two years, and require not more than half the time at the problem assigned, the remainder being available for graduate study. Further information may be had from Dean C. R. Richards, Urbana, Ill.

Meeting of the Syracuse Section of the A.C.S.

The Syracuse Section of the American Chemical Society held a very interesting meeting on Jan. 7. Dr. C. G. Derick of the National Aniline & Chemical Co., Buffalo, delivered a talk on "Methods of Attacking a Research Problem."

Western Canada Pulp & Paper Co. Enlarges

The Western Canada Pulp & Paper Co., which recently took over the Rainy River Co.'s plant at Port Mellon, B. C., has reconstructed and enlarged the plant and is adding new machinery. The enlarged plant will have a capacity of forty tons of pulp per day.

Metric System Bill Introduced

A bill providing for the compulsory use of the metric system as the single standard of weights and measures in the United States has been introduced in the Senate by Senator Frelinghuysen, of New Jersey. The bill was introduced at the request of advocates of the metric system. Senator Frelinghuysen explains that the introduction of the bill by him does not necessarily carry with it any support on his part for the measure, but he sees no reason why the measure should not be introduced so that members of Congress might acquaint themselves with its purport.

Ten years after the passage of this bill the weights and measures of the metric system would be the single standard for the sale of goods and for computing transportation charges and wages. In order to accustom the public to the new system, all goods in package form which are required to be marked in terms of weight or measure must use the metric system beginning two years after the passage of the bill. From the second to the tenth year the customary units may be retained in addition to the metric, if desired. After four years, weighing and measuring devices shall be manufactured in accordance with the metric system.

Certain exceptions are noted in section 12 as follows:

Sec. 12. That nothing in this act shall be understood or construed as applying to—

(1) Any contract made before the date at which the provisions of this act take effect;

(2) The construction or use in the arts, manufacture or industry of any specification or drawing, tool, machine or other appliance or implement designed, constructed or graduated in any desired system;

(3) Goods, wares or merchandise intended for sale in any foreign country, but if such goods, wares or merchandise are eventually sold for domestic use or consumption then this clause shall not exempt them from the application of any of the provisions of this act.

New Jersey Chemical Society Holds Its January, 1921, Meeting

At the regular monthly meeting of the New Jersey Chemical Society held in Newark, Monday evening, Jan. 10, further growth of the society was manifested by the election of thirty-one new members, thereby bringing the total membership to 576.

Dr. M. C. Whittaker, vice-president of the U. S. Industrial Alcohol Co., gave a very instructive address on "Chemical Organization and Management." He said that three factors—the plant, the process and organization—had to be considered in dealing with this problem, and that the organization factor was the most important. The necessity of a one-man power supplemented by disciplined and dependable co-ordinating units whose work accrues to the employer's benefit, to the successful development of an organization, was strongly emphasized.

Of the various problems pertaining to the smooth functioning of the units the following heads were considered: Misfits in Organization, Intelligence vs. Brawn, Doers vs. Excusers, Materialists vs. Dreamers. Emphasis was laid upon the need of studying the individual man so as to place him in a position where he could utilize his natural ability in the most efficient manner.

Various types of organizations were described and discussed. Among these were dry rot, which required a surgical operation as a remedy; young organizations, characterized by what Dr. Whittaker called "the administrative double pass," where everybody passes his respon-

sibility on to some one else; the all bosses, with no one to do the work; and the lop-sided organization, where there exist petty jealousies and a lack of proper balance between the technical and practical sides of the work.

Dr. Whittaker said that a true test of a successfully operating organization was when all the units were functioning smoothly, and the individuals were all working in harmony and in such a way that the man at the head could devote his energy to the problems of development instead of spending most of his time keeping the machinery going.

C. O. Chan, B. S., of the China Commercial Co., Ltd., gave a short résumé of the economic and political conditions existing in China. He said that due to lack of transportation and banking facilities large-scale production was impossible. Although there was a great deal of money in China, it was so distributed and disorganized as to prohibit its use in large amounts which are necessary for the development of industry by modern business methods. The political situation was characterized as a mixture of ancient Chinese traditions and a copy of European and American customs.

Three fundamental political tendencies have gradually been developed since the beginning of the Chinese Republic. They are the vigorous reform tendency represented by Dr. Yat-sen, Dr. Wu Ting-fang and the common people; the progressive tendency led by the scholar Liang Chao Chu advocating moderate reform, and the reactionary tendency represented by the Monarchist party. Besides these, there are two other groups representing powerful interests and privileges, the military, or Pei Yang, group and the Communication, or Chiao-tung, group.

The Monarchist party has become insignificant and is on the decline; the leader of the Progressive party, although exerting great influence by his pen, lacks strong executive ability and consequently the party has never been able to stand on its own feet and is dependent upon whatever other party is in power. The result is that the Military and Communication groups control the situation in northern China, where they are the strongest, and the common people in the southern provinces, where they predominate.

Both the economic and the political situations were depicted so as to give the American manufacturer an idea of the problems which confront him in doing business with the Orient. China, with its 400,000,000 population, represents a tremendous potential buying power and is a great market for manufactured chemicals. In turn she is rich in raw materials such as vegetable oils, camphor, coal, copper, gold, iron ore, antimony and tungsten. Mr. Chan expressed the hope that the United States might grasp this great opportunity to develop a chemical trade which would be of such immense benefit to both parties.

C.W.S. Service School Opens

The Service School of the Chemical Warfare Service at Edgewood Arsenal opened on Jan. 10. The purpose of the school is to develop officers for the command of Chemical Warfare Service troops in the field and to act on the staff of division, corps and army commanders.

In addition to instructing these officers in the specific military problems arising in connection with the use of gas, the men will be schooled in the fundamental chemical problems involved and the chemical properties of the various gases.

The Crocker-McElwain Plan to Help Employees

The Crocker-McElwain Co. and the Chemical Manufacturing Paper Co. have recently announced a plan for the relief of the hazard of unemployment so far as their employees of more than five years service are concerned. Their idea is to place any employee of more than five years service on the salary list. At such times as the mills may be closed the employee will receive salary, and in turn he obligates himself to do other work about the mill than his ordinary position would call for. The nature of this work is to be agreed upon by the employee and his immediate superior. When the mill is operating the workman will receive either salary or the regular wage scale, depending on which amounts to the larger sum per week. This contract may be terminated by either party on giving four weeks notice.

Evaporation Plant to Be Erected at Soda Lake

The Sodium Mining & Products Co. will erect a new evaporation plant at Soda Lake, near Seventy-Mile House, on the old Cariboo stage road. The company has appealed to the Provincial Government, which owns and operates the Pacific Great Eastern Ry., for a spur-line to the plant. Soda Lake is situated 3,700 ft. above sea level, has an area of 100 acres and a sodium carbonate content of 6 per cent; but this, of course, must vary with the seasons of the year. There are a number of smaller lakes in the vicinity that contain about the same amount of sodium carbonate. In 1918 a small evaporating plant, capable of producing two to three tons of crystals daily, was erected.

Book Reviews

PRIESTLY IN AMERICA. 1794-1804. By *Edgar F. Smith*. Philadelphia: P. Blackiston's Son & Co. 1920. 12mo. pp. 173.

In this little book Dr. Smith has achieved a work of rare literary merit. We knew already that Priestly was an English Unitarian minister, that he discovered oxygen, that for the faith that was in him he was mobbed and persecuted so that he fled to America; that to the end of his days he held to the phlogiston theory, and that he died and was buried at Northumberland, Pa.

Then, when we have read the book through, we feel as though we had at least a bowing acquaintance with the old gentleman, who was sixty-one years old when he came here and seventy-one when he died. We get also a sense of his importance as an international character. He lived in very interesting days, at a time when men thought seriously. He was a man of great influence in England, as is shown by a contemporary caricature on the walls of the Chemists' Club which depicts him as aiding in the service of a troublesome feast for King George IV. We get a sense of his importance as a person when we read the addresses presented to him on his arrival in New York, and again on his advent in Philadelphia. We learn of his scholarship and of his familiarity with and practice of the graces of life, by reading his replies. Intense democrat that he was, he remained to the end of his days a person of quality and distinction. He was never commonplace or vulgar.

He began with a pleasant acquaintance with John Adams, but he had no patience with his administration as President, whereas his admiration for Thomas Jefferson and his hearty friendship with him was of lifelong endurance.

It does not appear that he ever left the State of Pennsylvania after he settled down there and during the years of his life in this country he made but four visits to Phila-

delphia. He declined a professorship in chemistry there. He was maliciously attacked by persons of the same habit of mind as those who had persecuted him in England, but it did not worry him. He was always ambitious to see a college started at Northumberland, where he was content to live. A Mr. Bakewell met him in 1795, and found him "a man rather below the middle size, straight and plain, wearing his own hair; and in his countenance, though you might discern the philosopher, yet it beamed with so much simplicity and freedom as made him very easy of access." Another said of him: "The doctor enjoys a game at whist; and although he never hazards a farthing, is highly diverted with playing good cards, but never ruffled by bad ones."

Very gently Dr. Smith leads us to the Northumberland home when his youngest son Harry, who lived with him and was clearing 300 acres of land, went the way of all flesh. It was among his greatest delights merely to be with this eighteen-year-old boy. No attempt is made to lay bare the old man's heart before us. Indeed, little is said, but that little is very subtle, and it carries us into sincere sympathy with him.

Sir Oliver Lodge has said of Priestly that "his experiments were admirable, but his perceptions of their theoretical relations were entirely inadequate and, as we think now, quite erroneous. . . . In theory he had no instinct for guessing right . . . he may also be said to have had a predilection for the wrong end." This is borne upon us as we read of his chemical activities. There is no doubt in his perseverance in what he held to be right. All his life he held to the phlogiston theory and fought for it. It guided his experiments and led him constantly astray. It effectively spoiled most of his writings on chemistry. Indeed phlogiston seemed to be no less than an obsession with him. It had this value, however, that his championship of the cause brought out such forceful and competent opposition from his fellow chemists in America that it requires no stretch of the imagination to say that the ghost of phlogiston was finally and effectively laid for all time by James Woodhouse and his colleagues.

Much of his attention was given to the preparation of his Church History and his Notes on the Scriptures, which, Dr. Smith says, contain an immense fund of worth-while information and knowledge. The infirmities of age weakened his body, but left his mind clear and vigorous until, in the very act of correcting proof of his Church History, he quietly breathed his last on Feb. 6, 1804.

The book is a rare tribute to a great chemist and one of the leaders of the thought of his day. And it is another token of Dr. Smith's rare gift in literary art. We commend it heartily to our readers.

ELLWOOD HENDRICK.

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"THE MAKING, SHAPING, AND TREATING OF STEEL." By *J. M. Camp* and *C. B. Francis*. Second Edition. Published by the Carnegie Steel Co., Pittsburgh, Pa.* Price \$5, cash with order.

This excellent book is unique in its scope, its accuracy, and its lucidity. Those who work with rolled and semi-finished steel products or buy or sell them in quantity, who by curiosity or ambition attempt to learn something about the industry, may rely upon it to give them the maximum amount of information which can be conveyed without entering the realm of the specialist and employing his oft-unintelligible language.

Heretofore the literature (other than that contained in current periodicals) might be classed in three groups. First is a number of elementary books, written in simple language but unfortunately descriptive of a localized industry or a particular branch of the steel business—in other words, either provincial or specialized—and nearly always out of date and out of print. Next is a number of brief texts designed to give college students an outline view of iron and steel—covering more recent practice, but ordinarily assuming a familiarity with elementary chemistry

*Obtainable by non-employees by addressing the Bureau of Instruction, Carnegie Steel Co., direct. Not sold by or through book stores or dealers.

and physics on the part of the reader. Finally there is a certain small group of really excellent books treating some phase of the industry in an exhaustive manner—books of reference and instruction for the engineer in the industry, and requiring advanced knowledge of its technology on the part of the readers. In this group Harbord and Hall's volumes are the only ones in English which attempt to cover the whole field. Unfortunately these are rather expensive, and are largely occupied by British and Continental practice.

Having these conditions in mind, it is not surprising that the non-technical student found much to discourage him in his search for information, and the expert was hard put to suggest books which were not specialized and yet descriptive of modern operations. This new volume by Messrs. Camp and Francis will supply this need and thus fill the great gap. It is not too much to think that it will also become very popular in engineering colleges offering courses in metallurgy. Doubtless numerous engineers and foremen will find it of considerable service in giving notes on many milling operations not ordinarily described even in the most pretentious works, and in providing clear outlines of related phases of their industry.

It should be easily adopted as a text-book since the volume in fact is "the outcome of several years' experience in attempting to teach the metallurgy of steel to salesmen and other non-technical employees." A passage describing an operation which later turned out to be but hazily comprehended could then be recast into more intelligible language. Many pages bear marks of such painstaking revision—notably in the descriptions of the chemistry of the iron- and steel-making processes. While an intelligent reader can easily grasp the chemistry involving the combustion of coke to CO and CO₂, a clear comprehension of the reversible reactions which occur whenever the C:CO:CO₂ equilibrium is disturbed is not so easy, nor is it apparent at first sight how ores can be reduced, iron carburized and even reoxidized by the same two gases. Lacking any analogous phenomena in everyday life, the student will have extreme difficulty in understanding the reactions between slag and metal in an electric or open-hearth furnace—in fact one could venture the assertion that there are few operators or even advanced investigators who have a workable familiarity with the balanced reactions occurring in steel-making processes.

Naturally the treatment of these matters cannot be rigorous and it is a difficult matter to balance lucidity against chance of misinterpretation or minor inaccuracies, but the reviewer has nothing but praise for the result. He can testify to the great pedagogical value of the conception of iron as the oxygen carrier in the purification stages, even though it is debatable whether the oxide actually exists as a definite and separate entity, and even though all oxides appear to be nearly if not quite insoluble in molten and solid iron.

A good discussion of sulphur in the open-hearth is given on p. 236, especially the gain in sulphur from impure fuel. In this connection, one important limitation to the book should be noted—and would probably be instinctively taken by the expert, and that is that the practice described is Steel Corporation practice. While its plants are numerous and its operations tremendous, there are certain very excellent and useful metallurgical methods in daily operation elsewhere which are not practiced by that corporation. It is consequently a record of contemporary practice in the corporation (especially the Carnegie Steel Co.) and when the authors say (p. 181) that "the removal of sulphur in the mixer at all times is so small as to be of minor importance" the sophisticated reader will immediately visualize low-manganese pig iron from the corporation's blast furnaces, and perhaps at the same instant remember the excellent sulphur elimination between blast-furnace and open-hearth described last year by Wheaton of the Bethlehem Steel Co. Hence also the failure to mention the excellent acid open-hearth process, and various other processes in constant use here and elsewhere—puddling, basic bessemer, cementation, and crucible melting. Doubtless for the same reason forging and heat-treating practice

is confined to a short chapter (pp. 508-515), while steel and iron foundry practice and the production of malleable iron are not mentioned.

Is it possible to assume, conversely, that the scant mention given to heat control is due to a widespread disuse of pyrometers in Steel Corporation plants?

On the other hand, perhaps the fifty pages given to the electric furnace and its operation are due to the necessity of introducing the reader to the elementary electrical facts, and for the benefit of their salesmen selling specialties such as highly refined, multiplex, and alloy steels, rather than an appraisal of the relative importance of the process from a tonnage basis, either present or prospective.

These deficiencies in scope are compensated by good discussions on many lines. First there is a series of chapters containing very clear outlines of elementary physics and chemistry, refractories, ores, fluxes and slags. Especially notable is the chapter on fuels for its full discussion of the use of pulverized fuel in open-hearth furnaces, the authors concluding a very favorable appraisal with the suggestion that while its use was "still experimental," powdered fuel gives promise to replace gas in the steel plant. A description of the installations at Sharon, Clairton and Homestead works is included.

Perusal of the chapters on the constitution, heat-treatment and composition of steel at the end of the book should do much to dispel the idea that metallography is a highly complex and difficult subject largely of academic interest. Praise is also due the 200 pages of Part II on the shaping of steel. They contain the most comprehensive description of all modern rolling mill operations known to the reviewer. Many topics are covered not to be expected in elementary books, notably roll design for rails, the shaping of rail joints, rolling of tires and car wheels, inspection of finished material for defects, and the scheduling of orders.

The book itself is bound in limp leather, and can be carried around in one's pocket despite its 600-odd pages. Unfortunately the thin paper does not reproduce half-tones well—in fact, the authors have been too sparing in the use of line drawings to illustrate the early portions of their book covering furnace design and practice. Their descriptions are quite full, and in fact the text is a veritable glossary of terms; but these descriptions would be much enhanced by appropriate sketches. The second half of the book does not suffer in this respect.

From an instructional standpoint, the worst fault in the book results from its avowed aim: to describe things as the authors found them and why they are so, rather than to discuss what they should be. It might be argued that in educating a steel salesman, it would not be well to tell him that steel might be made better than it is today. The present reviewer apprehends more harm than advantage in half-truths, and directs his greatest criticism at the resulting sentiment—sometimes definitely stated—that we are at the crest of excellence. Thus the statement on p. 130 that the "blast-furnace plant is just approaching the uniformity of perfection" is bad news for the blast-furnace man, condemning him to a lifetime of merely doing what has been done before! Again "the old-time method of charging by hand having been entirely superseded by automatic charging" is somewhat overoptimistic, since hand-fired furnaces of the Shoenberger works may be seen when standing at a window in the Carnegie Building. A strong plea is made in the book against the "ridiculous" insistence upon low limits for sulphur and phosphorus, since "it is becoming increasingly difficult to keep the sulphur content below 0.04 per cent," and when the evidence (Unger's tests probably, made by adding sulphur and phosphorus when pouring an ingot) "points so strongly to 0.10 per cent as a limit that may be made to serve as well, for many purposes, at least."

Some things get to be accepted as facts by the majority of men if they are repeated often enough. It would be unfortunate if young engineers, and doubly unfortunate to the Steel Corporation if its staff were in this way to acquire the idea that further progress in steel making is not to be expected, and that 0.10 per cent sulphur and phosphorus are to be accepted without suspicion.

E. E. THUM.

Personal

Dr. C. L. ALSBERG, retiring president of the Washington Academy of Sciences, will deliver his presidential address on "The Relation of Chemical Structure to Physiological Action" before the joint meeting of the Washington Academy and the Chemical Society of Washington on Thursday, Jan. 20.

Dr. L. H. BAEKELAND is on a business trip to Denver, San Francisco and other Western cities.

KENNETH E. BAIRD, formerly chemist at the Pittsburgh byproduct coke plant of the Jones & Laughlin Steel Co., Pittsburgh, Pa., is now chief chemist of the Donner Union Coke Corporation, Buffalo, N. Y.

J. H. BECQUE resigned his position as assistant superintendent of the U. S. Gypsum Co., Washington County, Virginia, Dec. 1, 1920, to accept a commission in the Chemical Warfare Service, Edgewood Arsenal, Edgewood, Md.

HENRY W. BLAKE, senior editor of the *Electric Railway Journal*, was tendered a dinner by his associates in the McGraw-Hill Co. on Jan. 6 in celebration of Mr. Blake's completion of thirty years of editorial work on this magazine. Mr. Blake graduated as civil engineer at Yale University in 1886 and as electrical engineer at the Massachusetts Institute of Technology in 1888, and consequently brought to his editorial work a degree of technical knowledge unusual in those days.

F. E. COOMBS, consulting engineer, San Francisco, is doing supervisory work for the Asti Grape Products Co., which is installing a grape-sirup manufacturing plant at its winery in Asti, Cal.

LOUIS P. DESTRIKATS, of Trenton, N. J., has resigned as general manager of the Ajax Rubber Co., which operates a large plant in Trenton, N. J. The position is now being filled by A. J. McMann, of Detroit, who has been connected with the company for some time. He formerly was affiliated with the United States Tire Co. Mr. Destriats retains his connection as vice-president and director of the company.

J. A. HYNES, of the U. S. Custom House, spoke before the Chicago Chemists' Club recently on "Some Problems of the Customs Chemist."

ALVA N. JAMES, of Evanston, Ill., has just returned from an extensive trip to the Chilean nitrate fields and copper properties.

WALTER L. JORDAN, formerly chemical engineer of the Celite Products Co., has opened an office in New York City as a consulting chemical engineer and is now carrying on work on filtration.

DAYTON C. MILLER, of the Case School of Applied Science, spoke before the Detroit Engineering Society Jan. 7, on "Photographing the Flash From Large Guns and Projectiles."

STEPHEN SCHWARTZ, formerly of the Empire Refineries, is now in charge of the engineering and construction department of the Indiana Oil Refining Co., Columbus, Ind., which concern will erect a refinery complete with lubricating oil department.

PAUL C. SKINNER, general manager of the General Chemical Co.'s plant, Denver, Col., is making an extended business trip to New York City and the East.

H. G. THIELE is superintendent of the Borosolvay potash plant of the Solvay Process Co. at Borosolvay, Cal.

R. C. TOLMAN, director of the Fixed Nitrogen Laboratories, War Department, addressed the Chemical Society of Washington, on Jan. 13, on the subject, "The Third Law of Thermodynamics."

HAROLD VANDOREN, formerly with the Grasselli Chemical Co., has accepted a position as research chemist with the Koppers Co., Pittsburgh, Pa.

Current Market Reports

The Chemical and Allied Industrial Markets

New York, Jan. 17, 1921.

Improved inquiries and orders from miscellaneous sources resulted in a more active state of business in the chemical market. For the first time in many weeks trade sentiment is cheerful and it is believed that the continued strength among some of the leading chemicals will do a great deal to stimulate confidence in the general market.

Buyers are experiencing great difficulty in placing orders on *soda ash* and *caustic soda*, owing to the pronounced scarcity of offerings and the advancing tendency in prices. At the close of the week light ash was stronger than it has been in the past six months and it was exceptionally hard to find a resale lot of any sizable dimension. Those affiliated with the resale distributors of soda ash had to pass up business in several instances and it is known that orders were placed with producers at \$2.20 per 100 lb. f.o.b. works flat. Export parcels in the open market were quoted as high as 2½c. per lb., although no sales were recorded as far as could be learned above \$2.20. As was expected, the advance in soda ash was directly reflected on the market for caustic soda. Sales for the latter chemical have been made as high as 4c. per lb. This is the highest price recorded since early November. Some large sellers of caustic soda stated that there is only enough resale material available to cover wants for a short time, and that unless producers reduce the price of contracts, they will be compelled to rely upon first hands to cover their requirements.

Spot *bichromate of soda* was quoted firm with sellers asking 9¼@9½c. per lb. for standard material. Dealers stated that only a few small lots could be purchased around the inside figures. A little better inquiry seems to be developing for this material and it looked as though any real buying would strengthen prices. Sellers are not inclined to accept February shipment orders except at about 1c. per lb. premium over spot prices. Sales of foreign *muriate of potash* were reported at \$75 per ton, basis 80 per cent, delivered. Both foreign and domestic *muriate* appear to be on a parity at the present time. Quotations ranged from \$75 to \$80 per ton, according to seller. Some interests assert that a keener competition is developing among the sellers of this chemical, although prices have not changed since the first of the year. Resale lots of *bichromate of potash* were on the market at 16@17c. per lb., spot New York. In some quarters it was intimated that a firm offer of 15c. per lb. would probably be accepted for moderate quantities. Inquiry for this chemical has not been active of late and second-hand competition has resulted in the lowering of the spot quotations. While in some quarters 17c. per lb. for *prussiate of soda* was reported acceptable for limited quantities, in others the market was quoted at 17½c. It is possible that small isolated lots can be purchased a shade under these figures, but the general tone was reported slightly firm with a fair amount of small lot business passing.

Off lots of *oxalic acid* were on the market at 80c. per lb. Sellers' views covered the same wide range lately recorded and some producers are asking 25c. per lb. for material ex-store. The general feeling is firm and some interests assert that actual supplies are relatively small. Reports from some quarters on the export situation of *alcohol* are becoming more optimistic and not only is there a greater number of scattered inquiries, but shipments to some ports are increasing in volume. The domestic demand is confined to small lots on the basis of \$5@\$5.50 per gal. Producers quoted *denatured alcohol* at 68@77c. per gal., depending on formula. The demand is of small volume and some holders are said to be shading where business was possible. Trading in *wood alcohol* remained quiet, although a better inquiry was recently noted. Prices ranged from \$1.30 to

\$1.60 per gal., depending on grade. The general aspect of the *glycerine* market was stronger and trading reflected more activity. A fair volume of the c.p. grade moved into consuming channels on the basis of 20c. per lb. in drums and 22c. in tins.

COAL-TAR MARKET

General conditions seemed to have improved somewhat during the last week in some of the markets that coal-tar products are more or less dependent on. From both local and foreign quarters inquiries have been increasing and many are of the opinion that these inquiries mean real business in the very near future.

Crude producers are candid in stating that there is nothing in the line of large lot business, but small orders are coming in more frequently. Prices are holding steady with prospects of a future demand that will further stabilize the market.

Few inquiries were reported for *dinitrobenzene* and the market continued dull. Supplies were abundant, but outside of occasional small lot offerings at reduced prices, first-hand quotations were holding fairly steady. Spot material ranged from 25c. to 30c. per lb., depending on quantity and sellers. The only activity on *dinitrochlorbenzene* is occasional small lot sales. There were few buyers and these were interested in small quantities only. Prices, however, were held steady at 27@30c. per lb. The market in *para-dichlorbenzene* reflected a firm tendency with supplies quoted in car lots at 10c. per lb., and ranging up to 14c. per lb. for lesser quantities. A steady improvement in the demand is looked for, now that conditions in the textile centers are clearing.

Consumers showed little interest in the market on *para-nitraniline*. Producers reported regular supplies available on spot. Prices ranged from 93c. to \$1 per lb. Very little *paraphenylenediamine* is being moved at present on account of most of the large fur dyers being closed. Stocks are not pressing, however, and prices are fairly well held by producers. The average price is \$2.20 per lb., with some variation noted at both higher and lower levels. Second hands are offering *naphthalene flakes*, 79-81 m.p., American make, at 8c. per lb. spot. Producers are quoting contract and future delivery on the basis of 9c. per lb. Trading in *beta naphthol* continued along quiet lines. Producers are holding steady to the present quotations of 45@50c. per lb. Offerings in second hands are still hovering around the market at much lower prices. Factors reported a regular supply of *monochlorbenzene* on the basis of 14c. per lb. in carload lots and while sales are of a light routine nature as yet, the conditions of the consuming end are much brighter for an increased demand.

RUBBER MARKET

Little variation was noted in crude rubber prices throughout the week. Spot *ribbed smoked* sheets were offered quite freely at 20c. per lb., but as far as could be ascertained no business was transacted at this level. Sellers of January are also asking 20c. per lb. Futures remained nominally unchanged with sellers scarce and a fair amount of inquiries received. January-March closed at 21c., April-June at 22½c., and July-December at 25½@26c. One factor reported a small lot sale for April-June at 22c.

NAVAL STORES

There is a firm belief in the trade that buying interest in the near future will increase and prices were advanced by leading interests. A boost of 6c. per gal. on *turpentine* was noted during the week which is now quoted at 75c. per gal. *Rosin*, however, while firmer, remained quoted at former levels. Trading during the week in general showed a moderate increase in small lot business. The Savannah market has not been subject to any change and remained stagnant with no sales reported in either turpentine or rosins.

CORRECTION

In our issue of Jan. 5 we published a table on sodium compounds for 1918-1919 in which we erroneously transposed figures. The following is a correct table of the vari-

ous important sodium compounds produced during 1918-1919:

	1918 Short Tons	1919 Short Tons
Sodium Acetate.....	2,622	2,426
Sodium Bicarbonate.....	118,535	134,962
Sodium Bichromate.....	28,334	26,526
Soda Ash.....	1,390,628	981,054
Sodium Ferrocyanide.....	4,525	3,437
Sodium Hydroxide.....	513,363	355,466

The Baltimore Market

Baltimore, Md., Jan. 11, 1921.

The expected improvement in the market on fertilizer materials has not yet materialized. Purchases continued to be made on a "hand-to-mouth" basis, and trading is generally in small parcels. Heavy liquidation of stocks held by manufacturers is not to be noted. In fact most of the local fertilizer factories have been closed down since the first of the year and it is thought that normal operations will not be resumed for at least a few weeks. Merchants and speculators, however, are forced by necessity to place some of their materials on the market. These forced sales are being made at prices under nominal quotations.

Fertilizer salesmen are reporting but indifferent success in their campaign for spring business. In certain sections the farmers' organizations have entered into agreements to delay purchasing until fertilizer prices are lowered or prices on farm products are increased.

Acid Phosphate—Acid phosphate can be purchased at \$16 per ton, basis 16 per cent bulk, run of pile. The nominal quotation, however, is about fifty cents per ton above this figure. Raw rock is said to be moving from the mines more rapidly than was the case a few months ago.

Nitrate of Soda—Importers' quotations on this commodity are nominal at \$2.85 per 100 lb. ex-vessel Atlantic ports. Resale lots, however, can be obtained at \$2.75.

Sulphate of Ammonia—Resale lots of sulphate are now offered at \$3.75 per 100 lb., which marks a decline of 25c. since last report. This quotation governs on bagged material in carload lots.

Potash—There are rather heavy stocks of foreign potash in local warehouses at present. It is believed, however, that a surplus does not exist as deliveries from now on will be light. It is also reported that many of the manufacturers have not covered their requirements. The market is quoted nominal; muriate, \$1.70 per unit; kainit and manure salts, \$1.50 per unit. All ex-vessel Atlantic ports. Nebraska potash can be had at a slight premium over the foreign goods.

Fish Scrap—Very little fish scrap has moved since last report. The nominal market has declined 25c. per unit, being now quoted at \$3.75 and 10c. delivered Baltimore in buyers' bags. There are available stocks at the fish factories. Ground scrap sold this week at \$4 and 10c. Baltimore. Prime A menhaden fish oil can be had at 30c. per gal. in tierces delivered Baltimore.

The Iron and Steel Market

Pittsburgh, Pa., Jan. 14, 1921.

Demand in the open market for steel products has not visibly increased. On the whole, demand against old contracts is tending to decrease. With the independents there have been some reinstatements of business, or "releases" in connection with shipping orders previously suspended, the releases being prompted by the revision of contract prices recently down to the Steel Corporation or Industrial Board level, but these hardly make up for the completion from time to time of old orders. With the Steel Corporation, there are still full shipments against contracts on books, but it is apparent that the corporation's customers are not consuming steel in all cases altogether as fast as steel is being received, and an early increase in the rate of consumption will be requisite to forestall a decrease in the Steel Corporation's rate of production and shipments.

Such an increase is not to be expected within the next few weeks. The predictions made in December, that there would be a distinct increase in steel demand immediately after the first of the new year, were probably made from habit. There are many precedents for the making of such a

prediction in December, but there are no precedents for steel demand to increase in January. March or April, and September or October, are the established times for the steel market to broaden. At present, the more sanguine predict a decided improvement in demand before the end of March. Others doubt whether there will be any material improvement before late in the year, if in this year at all.

It is a new situation, or at least a new one for the present generation. The country is not, apparently, suffering from over-expansion in material development, in railroads, office and hotel buildings and dwelling houses. It does not seem to be overstocked with goods, except perhaps in some goods upon which wholesalers or retailers refuse to take the necessary loss, and of course excepting copper, which stands in altogether unique position and must not be used as a basis for generalizing. There is no very serious credit strain, as testified by the smallness of business failures. In other periods of depression and readjustment a decline in prices was essential, but the operation was distinctly subsidiary. Now the principal thing is a great readjustment in values of all commodities and in wage rates and compensation for personal service of various descriptions. It is known what needs to be done, but from lack of precedent it is difficult to estimate the length of time that will be required. The time may prove much shorter than many now estimate, for it is largely a matter of men changing their minds. Experience is still fresh as to how rapidly men can do that in one direction. Why not rapidly in the other?

STEEL CORPORATION TONNAGE

The Steel Corporation's unfilled obligations decreased by 873,359 tons during December. The first decrease was in August, and the decreases have steadily grown larger. There were fair bookings in December, however, for while the decrease in unfilled obligations represented 64 per cent of capacity for the month the shipments may be estimated at about 94 per cent, production being at about 92 per cent, while there was a large movement of tubular goods accumulated, in addition to the current output. Thus the net bookings must have been about 30 per cent, total bookings being in excess of this, in offset of cancellations, of which there certainly were some. The independents, although their order books were almost bare, had light bookings. There is no trend, as was expected by some, for buyers to leave the corporation and patronize independents, while on the other hand there are some instances of buyers, formerly customers of independents, now seeking to obtain a place as Steel Corporation customers.

PRICES

At various times from the middle of November to the end of December the independent market on the different steel products receded to the Steel Corporation or Industrial Board level. The markets are now steady at those prices. There is occasional shading in some commodities by independents, but this shading is distinctly exceptional. The majority of independents are firm in their price views, while the Steel Corporation, with well-filled order books, has no occasion to give the subject a thought.

It is a fair statement that the independents do not cut prices because there is no sufficiently attractive business in sight. Some independents might cut the price on a commodity to secure one fair-sized order, but in general the attitude is that price cutting would not pay. As between operating at 20 to 50 per cent, which is the prevailing range with plants that are not closed entirely, at present prices, and operating at 80 to 100 per cent at prices quite a number of dollars a ton below the present level, the choice would no doubt be instant. When such an operation becomes a possibility the whole price structure in the steel market will be recast if necessary to attain the end.

Steel ingot production in December was at the rate of about 21,000,000 tons a year by the Steel Corporation and at about 10,000,000 tons a year by the independents, or 31,000,000 tons altogether. Independent operations decreased rather steadily during December, but the rate now is about the same as that at the end of December, say 7,000,000 or 8,000,000 tons, while the Steel Corporation's rate remains at about 21,000,000 tons.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.			\$0.55 - \$0.60	
Acetone.....lb.	\$0.13 - \$0.13		.13 - .14	
Acid, acetic, 28 per cent.....100 lbs.	3.00 - 3.25		3.50 - 3.75	
Acetic, 56 per cent.....100 lbs.	6.00 - 6.25		6.50 - 6.75	
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.50 - 11.00		11.25 - 11.50	
Boric, crystals.....lb.	.14 - .15		.15 - .16	
Boric, powder.....lb.	.15 - .16		.17 - .18	
Citric.....lb.			.50 - .52	
Hydrochloric.....100 lb.	1.85 - 2.25		2.75 - 3.00	
Hydrofluoric, 52 per cent.....lb.	.15 - .16		.16 - .18	
Lactic, 44 per cent tech.....lb.	.10 - .11		.11 - .12	
Lactic, 22 per cent tech.....lb.	.04 - .05		.06 - .07	
Molybdic, C. F.....lb.	4.00 - 4.50		4.50 - 5.00	
Muriatic, 20 deg. (see hydrochloric).....lb.	.07 - .07		.08 - .08	
Nitric, 40 deg.....lb.	.08 - .09		.09 - .10	
Nitric, 42 deg.....lb.	.18 - .18		.19 - .20	
Oxalic, crystals.....lb.	.18 - .18		.18 - .19	
Phosphoric, Crtho, 50 per cent solution.....lb.	.28 - .35		.40 - .50	
Picric.....lb.			2.30 - 2.40	
Pyrogallie, resublimed.....lb.			14.00 - 15.00	
Sulphuric, 60 deg., tank cars.....ton			18.00 - 19.00	
Sulphuric, 60 deg., drums.....ton	21.00 - 22.00		22.50 - 23.00	
Sulphuric, 66 deg., tank cars.....ton				
Sulphuric, 66 deg., drums.....ton				
Sulphuric, 66 deg., carboys.....ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 - 24.00			
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 - 26.00		26.50 - 27.00	
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 - 35.00		40.00 -	
Tannic, U. S. P.....lb.			1.30 - 1.35	
Tannic (tech.).....lb.	.48 - .50		.51 - .52	
Tartaric, crystals.....lb.			.33 - .35	
Tungstic, per lb. of WO.....lb.			1.20 - 1.40	
Alcohol, Ethyl.....gal.			5.00 - 5.50	
Alcohol, Methyl (see methanol).....gal.				
Alcohol, denatured, 188 proof.....gal.			.68 - .72	
Alcohol, denatured, 190 proof.....gal.			.73 - .77	
Alum, ammonia lump.....lb.	.04 - .04		.05 - .05	
Alum, potash lump.....lb.	.05 - .06		.06 - .07	
Alum, chrome lump.....lb.	.13 - .13		.14 - .14	
Aluminum sulphate, commercial.....lb.	.02 - .03		.03 - .03	
Aluminum sulphate, iron free.....lb.	.03 - .03		.04 - .04	
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.06 - .07		.07 - .08	
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 - .32		.33 - .35	
Ammonium carbonate, powder.....lb.	.12 - .12		.13 - .13	
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	.09 - .10		.10 - .10	
Ammonium chloride, granular (gray salamoniac).....lb.	.09 - .09		.09 - .10	
Ammonium nitrate.....lb.	.09 - .09		.10 - .10	
Ammonium sulphate.....lb.	.03 - .03		.04 - .04	
Amylacetate.....gal.			4.25 - 4.50	
Amylacetate tech.....gal.			3.50 - 3.75	
Arsenic oxide, lumps (white arsenic).....lb.	.10 - .11		.11 - .11	
Arsenic, sulphide, powdered (red arsenic).....lb.	.15 - .15		.15 - .16	
Barium chloride.....ton	75.00 - 80.00		85.00 - 90.00	
Barium dioxide (peroxide).....lb.	.24 - .25		.26 - .27	
Barium nitrate.....lb.	.10 - .10		.10 - .11	
Barium sulphate (precip.) (blanc fixe).....lb.	.04 - .05		.05 - .06	
Bleaching powder (see calc. hypochlorite).....				
Blue vitriol (see copper sulphate).....				
Borax (see sodium borate).....				
Brimstone (see sulphur, roll).....				
Bromine.....lb.	.50 - .52		.54 - .56	
Calcium acetate.....100 lbs.	2.00 - 2.05			
Calcium carbide.....lb.	.04 - .04		.04 - .05	
Calcium chloride, fused, lump.....ton	27.00 - 29.00		30.00 - 32.00	
Calcium chloride, granulated.....lb.	.02 - .02		.02 - .03	
Calcium hypochlorite (bleach'g powder).....lb.	.02 - .03		.03 - .03	
Calcium peroxide.....lb.			1.25 - 1.30	
Calcium phosphate, monobasic.....lb.			.16 - .18	
Calcium sulphate, pure.....lb.			.05 - .06	
Camphor.....lb.			.88 - .90	
Carbon bisulphide.....lb.	.08 - .08		.09 - .09	
Carbon tetrachloride, drums.....lb.	.11 - .11		.11 - .12	
Carbonyl chloride (phosgene).....lb.			.60 - .75	
Caustic potash (see potassium hydroxide).....				
Caustic soda (see sodium hydroxide).....				
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.09 - .09		.10 - .10	
Chloroform.....lb.			.43 - .50	
Cobalt oxide.....lb.			3.90 - 4.00	
Copper as (see iron sulphate).....				
Copper carbonate, green precipitate.....lb.	.22 - .22		.24 - .25	
Copper cyanide.....lb.			.40 - .50	
Copper sulphate, crystals.....lb.	.06 - .06		.06 - .07	
Cream of tartar (see potassium bitartrate).....				
Epsom salt (see magnesium sulphate).....				
Ethyl Acetate Com. 85%.....gal.			1.05 - 1.10	
Ethyl Acetate pure (acetic ether 98% to 100%).....gal.				
Formaldehyde, 40 per cent.....lb.	.18 - .18		.19 - .19	
Fusel oil, ref.....gal.			3.50 - 3.60	
Fusel oil, crude.....gal.			2.75 - 3.00	
Glauber's salt (see sodium sulphate).....				
Glycerine, C. P. drums extra.....lb.			.20 - .21	
Iodine, resublimed.....lb.			3.85 - 4.00	
Iron oxide, red.....lb.			.10 - .20	
Iron sulphate (copperas).....100 lb.	1.50 - 1.5		2.00 - 2.25	
Lead acetate, normal.....lb.			.14 - .16	
Lead arsenate (paste).....lb.	.13 - .14		.14 - .15	
Lead nitrate, crystals.....lb.			.90 - 1.00	
Litharge.....lb.	.09 - .09		.09 - .10	
Lithium carbonate.....lb.			1.50 -	
Magnesium carbonate, technical.....lb.	.10 - .11		.11 - .12	
Magnesium sulphate, U. S. P.....100 lb.	2.50 - 3.00			
Magnesium sulphate, commercial.....100 lb.			1.50 - 1.75	
Methanol, 95%.....gal.			1.30 - 1.40	
Methanol, pure.....gal.			1.50 - 1.70	
Nickel salt, double.....lb.			.12 - .12	
Nickel salt, single.....lb.			.13 - .13	
Phosgene (see carbonyl chloride).....				
Phosphorus, red.....lb.	.45 - .46		.47 - .50	
Phosphorus, yellow.....lb.			.35 - .37	
Potassium bichromate.....lb.	.16 - .15		.16 - .17	

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$ 37 — \$ 38	\$ 37 — \$ 38
Potassium bromide, granular..... lb.	25 — 40	25 — 40
Potassium carbonate, U. S. P..... lb.	35 — 40	45 — 50
Potassium carbonate, crude..... lb.	11 — 11 1/2	11 1/2 — 12
Potassium chlorate, crystals..... lb.	10 — 11	12 — 18
Potassium cyanide..... lb.	65 — 70	65 — 70
Potassium hydroxide (caustic potash)..... lb.	14 — 14 1/2	15 — 16
Potassium muriate..... ton	75 00 — 80 00	3 00 — 3 20
Potassium iodide..... lb.	11 1/2 — 12	12 1/2 — 13
Potassium nitrate..... lb.	60 — 63	65 — 70
Potassium permanganate..... lb.	50 — 52	53 — 55
Potassium prussiate, red..... lb.	31 — 31 1/2	32 — 33
Potassium prussiate, yellow..... lb.	225 00 — 230 00	
Potassium sulphate (powdered)..... ton		
Rochelle salts (see sodium potas. tartrate)		
Salammoniac (see ammonium chloride)		
Salt soda (see sodium carbonate)		
Salt cake..... ton	33 00 — 35 00	
Silver cyanide..... oz.	1 25 — 43	45
Silver nitrate..... oz.	2 05 — 2 15	2 20 — 2 50
Soda ash, light..... 100 lb.	2 50 — 2 60	2 70 — 3 00
Soda ash, dense..... 100 lb.	05 1/2 — 05 3/4	06 — 06 1/2
Sodium acetate..... lb.	2 40 — 2 50	2 60 — 2 90
Sodium bicarbonate..... 100 lb.	09 1/2 — 09 3/4	09 1/2 — 10
Sodium bichromate..... lb.	7 00 — 7 50	8 00 — 11 00
Sodium bisulphate (nitre cake)..... ton	06 1/2 — 07	07 1/2 — 08
Sodium bisulphate powdered, U.S.P..... lb.	07 — 07 1/2	07 1/2 — 08
Sodium borate (borax)..... lb.	2 00 — 2 25	2 50 — 2 75
Sodium carbonate (sal soda)..... 100 lb.	10 — 10 1/2	10 1/2 — 11
Sodium chlorate..... lb.	21 — 23	24 — 30
Sodium cyanide, 96-98 per cent..... lb.	17 — 17 1/2	17 1/2 — 18 1/2
Sodium fluoride..... lb.	3 90 — 4 00	4 10 — 4 60
Sodium hydroxide (caustic soda)..... 100 lb.	2 85 — 3 00	3 00 — 3 00
Sodium hyposulphite..... lb.	06 — 06 1/2	06 1/2 — 07
Sodium nitrate..... lb.	30 — 31	32 — 34
Sodium nitrite..... lb.	03 1/2 — 04 1/2	04 1/2 — 05
Sodium peroxide, powdered..... lb.	33 — 35	
Sodium phosphate, dibasic..... lb.	17 — 17 1/2	17 1/2 — 18
Sodium potassium tartrate (Rochelle salts) lb.	01 1/2 — 01 3/4	02 — 02 1/2
Sodium prussiate, yellow..... lb.	03 — 03 1/4	03 1/2 — 04
Sodium silicate, solution (40 deg.)..... lb.	1 75 — 2 00	2 25 — 2 50
Sodium silicate, solution (60 deg.)..... lb.	05 1/2 — 05 3/4	06 — 06 1/2
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	04 — 04 1/2	04 1/2 — 05
Sodium sulphide, crystal, 60-62 per cent (conc.) lb.	20 — 20 1/2	21 — 22
Sodium sulphite, crystals..... lb.	08 — 09	10 — 10 1/2
Strontium nitrate, powdered..... lb.	16 00 — 20 00	
Sulphur chl. ride, red..... lb.	09 — 10	10 — 12
Sulphur, crude..... ton	3 70 — 4 35	
Sulphur dioxide, liquid, cylinders..... lb.	3 40 — 3 90	
Sulphur (sublimed), flour..... 100 lb.	18 — 19	
Sulphur, roll (brimstone)..... 100 lb.	50 — 51	
Tin bichloride, 50 per cent..... lb.	16 — 18	19 — 20
Tin oxide..... lb.	11 1/2 — 12	12 1/2 — 13
Zinc carbonate, precipitate..... lb.	45 — 49	50 — 60
Zinc chloride, gran..... lb.	12 — 13	13 1/2 — 14
Zinc cyanide..... lb.	10 — 10 1/2	11 — 11 1/2
Zinc dust..... lb.	03 1/2 — 03 3/4	04 — 06
Zinc oxide, XX..... lb.		
Zinc sulphate..... lb.		

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1 10 — \$1 15
Alpha-naphthol, refined..... lb.	1 45 — 1 50
Alpha-naphthylamine..... lb.	40 — 44
Aniline oil, drums extra..... lb.	23 — 25
Aniline salts..... lb.	27 — 30
Anthracene, 80% in drums (100 lb.)..... lb.	85 — 1 00
Benzaldehyde (f.f.c.)..... lb.	2 00 — 2 10
Benzidine, base..... lb.	1 00 — 1 10
Benzidine sulphate..... lb.	85 — 90
Benzoic acid, U.S.P..... lb.	70 — 75
Benzoate of soda, U.S.P..... lb.	75 — 85
Benzene, pure, water-white, in drums (100 gal.)..... gal.	30 — 35
Benzene, 90%, in drums (100 gal.)..... gal.	28 — 32
Benzyl chloride, 95-97%, refined..... lb.	35 — 40
Benzyl chloride, tech..... lb.	25 — 35
Beta-naphthol benzoate..... lb.	3 50 — 4 00
Beta-naphthol, sublimed..... lb.	75 — 80
Beta-naphthol, tech (nominal)..... lb.	38 — 42
Beta-naphthylamine, sublimed..... lb.	2 25 — 2 40
Cresol, U. S. P., in drums (100 lb.)..... lb.	16 — 18
Ortho-cresol, in drums (100 lb.)..... lb.	23 — 25
Cresylic acid, 97-99%, straw color, in drums..... gal.	95 — 1 00
Cresylic acid, 95-97%, dark, in drums..... gal.	90 — 95
Cresylic acid, 50%, first quality, drums..... lb.	65 — 75
Dichlorobenzene..... lb.	06 1/2 — 15
Diethylaniline..... lb.	1 25 — 1 30
Dimethylaniline..... lb.	65 — 90
Dinitrobenzene..... lb.	27 — 30
Dinitrochlorobenzene..... lb.	25 — 30
Dinitronaphthalene..... lb.	35 — 40
Dinitrophenol..... lb.	40 — 45
Dinitrotoluene..... lb.	37 — 30
Dip oil, 25%, tar acids, car lots, in drums..... gal.	28 — 40
Diphenylamine..... lb.	70 — 75
H-acid..... lb.	1 40 — 1 55
Meta-phenylenediamine..... lb.	1 25 — 1 30
Monochlorobenzene..... lb.	14 — 16
Monoethylaniline..... lb.	1 75 — 2 25
Naphthalene crushed, in bbls. (250 lb.)..... lb.	08 — 08 1/2
Naphthalene, flake..... lb.	08 — 08 1/2
Naphthalene, balls..... lb.	09 — 09 1/2
Naphthionic acid, crude..... lb.	70 — 75
Nitrobenzene..... lb.	12 — 15
Nitro-naphthalene..... lb.	40 — 50
Nitro-toluene..... lb.	18 — 25
Ortho-amidophenol..... lb.	3 20 — 3 75
Ortho-dichlor-benzene..... lb.	15 — 20
Ortho-nitro-phenol..... lb.	75 — 80
Ortho-nitro-toluene..... lb.	23 — 30
Ortho-toluidine..... lb.	25 — 30
Para-amidophenol, base..... lb.	1 90 — 2 00
Para-amidophenol, HCl..... lb.	2 20 — 2 25

Para-dichlorobenzene..... lb.	10 — 15
Paranitroaniline..... lb.	93 — 1 00
Para-nitrotoluene..... lb.	1 25 — 1 40
Para-phenylenediamine..... lb.	2 20 — 2 35
Para-toluidine..... lb.	1 70 — 1 80
Phthalic anhydride..... lb.	55 — 60
Phenol, U. S. P., drums (dest.), (240 lb.)..... lb.	09 — 10
Pyridine..... gal.	2 00 — 3 50
Resorcinol, technical..... lb.	2 50 — 2 60
Resorcinol, pure..... lb.	3 60 — 3 80
Salicylic acid, tech., in bbls. (110 lb.)..... lb.	25 — 28
Salicylic acid, U. S. P..... lb.	29 — 35
Salol..... lb.	85 — 95
Solvent naphtha, water-white, in drums, 100 gal..... gal.	28 — 32
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	16 — 18
Sulphanilic acid, crude..... lb.	30 — 35
Tolidine..... lb.	1 35 — 1 40
Toluidine, mixed..... lb.	40 — 45
Toluene, in tank cars..... gal.	30 — 32
Toluene, in drums..... gal.	33 — 35
Xylidines, drums, 100 gal..... lb.	45 — 50
Xylene, pure, in drums..... gal.	42 — 45
Xylene, pure, in tank cars..... gal.	45 — 45
Xylene, commercial, in drums, 100 gal..... gal.	33 — 35
Xylene, commercial, in tank cars..... gal.	30 — 35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0 24 — \$0 26
Beeswax, refined, light..... lb.	27 — 28
Beeswax, white pure..... lb.	35 — 40
Carnauba, No. 1..... lb.	85 — 90
Carnauba, No. 2, North Country..... lb.	35 — 40
Carnauba, No. 3, North Country..... lb.	19 — 20
Japan..... lb.	19 — 20
Montan, crude..... lb.	07 — 08
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	05 — 05 1/2
Paraffine waxes, crude, scale 124-126 m.p..... lb.	04 1/2 — 05 1/2
Paraffine waxes, refined, 118-120 m.p..... lb.	06 — 06 1/2
Paraffine waxes, refined, 125 m.p..... lb.	07 — 07 1/2
Paraffine waxes, refined, 128-130 m.p..... lb.	07 — 08
Paraffine waxes, refined, 133-135 m.p..... lb.	09 — 09 1/2
Paraffine waxes, refined, 135-137 m.p..... lb.	10 — 11
Stearic acid, single pressed..... lb.	13 — 13 1/2
Stearic acid, double pressed..... lb.	13 1/2 — 14
Stearic acid, triple pressed..... lb.	14 1/2 — 14 1/2

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1 90
Pine oil, pure, dest. dist..... gal.	1 50
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	75
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	36
Turpentine, crude, sp. gr. 0.900-0.970..... gal.	1 25
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	35
Pinewood creosote, ref..... gal.	52

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl..... 280 lb.	\$8 75
Rosin E-I..... 280 lb.	8 75
Rosin K-N..... 280 lb.	8 75
Rosin W. G. W. W..... 280 lb.	9 00
Wood rosin, bbl..... 280 lb.	9 00
Spirits of turpentine..... gal.	75
Wood turpentine, steam dist..... gal.	70
Wood turpentine, dest. dist..... gal.	69
Pine tar pitch, bbl..... 200 lb.	8 50
Tar, kiln burned, bbl. (500 lb.)..... bbl.	15 00
Retort tar, bbl..... 500 lb.	15 00
Rosin oil, first run..... gal.	60
Rosin oil, second run..... gal.	62
Rosin oil, third run..... gal.	72

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0 41
70-72 deg., steel bbls. (85 lb.)..... gal.	39
68-70 deg., steel bbls. (85 lb.)..... gal.	38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	30

Crude Rubber

Para-Upriver fine..... lb.	\$0 18 — \$0 19
Upriver coarse..... lb.	14 — 14 1/2
Upriver caucho ball..... lb.	14 1/2 — 14 1/2
Plantation—First latex crepe..... lb.	21 — 21
Ribbed smoked sheets..... lb.	20 — 20
Brown crepe, thin, clean..... lb.	18 — 18
Amber crepe No. 1..... lb.	20 — 20

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0 09 — \$0 10
Castor oil, AA, in bbls..... lb.	11 — 12
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	08 — 09
Cocoonut oil, Ceylon grade, in bbls..... lb.	12 — 13
Cocoonut oil, Cochin grade, in bbls..... lb.	13 — 13 1/2
Corn oil, crude, in bbls..... lb.	09 — 09 1/2
Cottonseed oil, crude (f. o. b. mill)..... lb.	06 — 07
Cottonseed oil, summer yellow..... lb.	09 — 09 1/2
Cottonseed oil, winter yellow..... lb.	09 1/2 — 09 1/2
Linseed oil, raw, car lots (domestic)..... gal.	76 — 77
Linseed oil, raw, tank cars (domestic)..... gal.	69 — 70
Linseed oil, boiled, car lots (domestic)..... gal.	78 — 79

Olive oil, commercial.....	gal.	\$2 90	\$3 00
Palm, Lagos.....	lb.	08	08½
Palm, Niger.....	lb.	07	07½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	07	07½
Peanut oil, refined, in bbls.....	lb.	13	13½
Rapeseed oil, refined in bbls.....	gal.	1 10	1 15
Rapeseed oil, blown, in bbls.....	gal.	1 20	1 25
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	08½	09
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	05½	06

FISH

Light pressed menhaden.....	gal.	\$0 53	\$0 55
Yellow bleached menhaden.....	gal.	55	58
White bleached menhaden.....	gal.	57	60
Blown menhaden.....	gal.	1.00	—

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	— 30 00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	— 26 00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	— 12 00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	— 28 00
Barytes, crude, first grade, Missouri.....	net ton	10.00	— —
Blanc fixe, dry.....	lb.	05	— 05½
Blanc fixe, pulp.....	net ton	60.00	— 65 00
Casein.....	lb.	14	— 18
Chalk, domestic, extra light.....	lb.	05	— 06
Chalk, domestic, light.....	lb.	04½	— 05½
Chalk, domestic, heavy.....	lb.	04	— 05
Chalk, English, extra light.....	lb.	05	— 07
Chalk, English, light.....	lb.	05	— 06
Chalk, English, dense.....	lb.	04½	— 05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	— 10 00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	— 15 00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	— 22 00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	— 12 00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	— 40 00
China clay (kaolin), imported, lump.....	net ton	25.00	— 35 00
China clay (kaolin), imported, powdered.....	net ton	30.00	— 35 00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	— 14 00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	— 10 00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	— 23 00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	— 21 00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	— 21 00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	— 30 00
Fullers earth, f.o.b. New York.....	net ton	16.00	— 17 00
Fullers earth, granular, f.o.b. Fla.....	net ton	25.00	— —
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	— —
Fullers earth, imported, powdered.....	net ton	35.00	— 40 00
Graphite, crucible, 90% carbon, Ashland, Ala.....	lb.	—	09
Graphite, crucible, 85% carbon, Ashland, Ala.....	lb.	07	— 09
Graphite, higher lubricating grades.....	lb.	11	— 40
Pumice stone, imported, lump.....	lb.	04	— 50
Pumice stone, domestic lump.....	lb.	06	— —
Pumice stone, ground.....	lb.	04	— 07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	—	10 00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	—	14 00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	—	17 00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	— 7 50
Shellac, orange fine.....	lb.	80	— 85
Shellac, orange superfine.....	lb.	95	— 1 00
Shellac, A. C. garnet.....	lb.	70	— 75
Shellac, T. N.....	lb.	68	— 70
Soapstone.....	ton	15.00	— 25 00
Sodium chloride.....	long ton	—	17 50
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	— 22 00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	— 15 00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	— 18 00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	— 15 00
Talc, imported.....	ton	60.00	— 70 00
Talc, California talcum powder grade.....	ton	20.00	— 45 00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160
Chrome brick, f.o.b. Eastern shipping points.....	net ton	100- 110
Chrome cement, 40-45% Cr ₂ O ₃	net ton	55- 60
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	60- 65
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55- 60
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45- 50
Magnesite brick, 9-in. straight.....	net ton	110
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	121
Magnesite brick, soaps and splits.....	net ton	134
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65- 70
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56- 61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	55-60

Ferro-Alloys

All f.o.b. Works

Ferrocen-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	— \$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	16	— 17
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	17	— 18
Ferromanganese, 76-80% Mn, domestic.....	gross ton	110.00	— 115.00
Ferromanganese, 76-80% Mn, English.....	gross ton	130.00	— 135.00
Spiegelisen, 18-22% Mn.....	gross ton	60.00	— 65.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.00	— 2.50
Ferrosilicon, 10-15%.....	gross ton	55.00	— 60.00
Ferrosilicon, 50%.....	gross ton	78.00	— 80.00
Ferrosilicon, 75%.....	gross ton	—	150.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	55	— 60
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	7.00	— —
Ferrovandium, 30-40% per lb. of contained V.....	lb.	6.50	— 7.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content, less than 2% Fe ₂ O ₃ , up to 20% silica, not more than H 4% moisture.....	gross ton	\$10 00	— \$11 00
Chrome ore, Calif concentrates, 50% min Cr ₂ O ₃	unit	60	— 65
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	55	— 60
Coke, foundry, f.o.b. ovens.....	net ton	—	7 00
Coke, furnace, f.o.b. ovens.....	net ton	—	6 00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	21.00	— 22 00
Fluorspar, lump, f.o.b. Tonuco, New Mexico.....	net ton	17.50	— —
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	— 25 00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	01½	— 01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	40	— 45
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	— 65 00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	55	— 65
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	35.00	— —
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	12	— —
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	17	— —
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	12	— 14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	15	— —
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.75	— 4 00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	4.00	— 4 25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	2.75	— 3 00
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.75	— 3 00
Vanadium pentoxide, 99%.....	lb.	12.00	— 14 00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	— —
Zircon, washed, iron free.....	lb.	05	— —

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	15.00
Aluminum, 98 to 99 per cent.....	27.50
Antimony, wholesale lots, Chinese and Japanese.....	5.25 @ 5 37½
Nickel, ordinary (ingot).....	43.00
Nickel, electrolytic.....	45.00
Monel metal, spot and bl cks.....	35
Monel metal ingots.....	38
Monel metal, sheet bars.....	40
Tin, 5-ton lots.....	34.02½
Lead, New York, spot.....	5.37½
Lead, E. St. Louis, spot.....	6.25
Zinc, spot, New York.....	7.00
Zinc, spot, E. St. Louis.....	6.75

OTHER METALS

Silver (commercial).....	oz.	\$0.66½
Cadmium.....	lb.	1.40 @ 1.50
Bismuth (500 lb. lots).....	lb.	2.40
Cobalt.....	lb.	6.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.35
Platinum.....	oz.	75.00
Iridium.....	oz.	350.00 @ 400.00
Palladium.....	oz.	75.00
Mercury.....	75 lb.	50.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per Lb.

Copper sheets, hot rolled.....	22.50
Copper bottoms.....	34.00
Copper rods.....	29.00
High brass wire and sheets.....	20.25
High brass rods.....	18.25
Low brass wire and sheets.....	30.50
Low brass rods.....	19.50
Brazed brass tubing.....	36.25
Brazed bronze tubing.....	41.50
Seamless copper tubing.....	26.00
Seamless high brass tubing.....	25.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	12.00	17.00	10.00	11.50
Copper, heavy and wire.....	11.50	16.00	9.50	11.00
Copper, light and bottoms.....	10.00	14.00	9.00	9.50
Lead, heavy.....	4.00	4.75	4.00	4.50
Lead, tea.....	3.00	3.75	3.00	3.50
Brass, heavy.....	7.00	10.50	7.00	10.50
Brass, light.....	5.50	7.50	5.00	5.50
No. 1 yellow brass turnings.....	6.50	10.00	5.50	5.50
Zinc.....	4.50	5.00	3.00	4.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes.....	\$3.80	\$4.15	\$3.47	\$3.58	\$3.37	\$3.58	\$3.47
Soft steel bars.....	3.70	4.15	3.37	3.34	3.27	3.48	3.37
Soft steel bar shapes.....	3.70	4.15	3.37	3.48	3.27	3.48	3.37
Soft steel bands.....	4.65	5.50	4.07	6.25	—	—	—
Plates, ½ to 1 in. thick.....	4.00	4.15	3.67	3.78	3.57	3.78	3.67

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

EL SEGUNDO—The General Chemical Co. is building a four-unit contract acid plant. This plant will go in operation some time soon.

Idaho

KELLOGG—The Bunker Hill and Sullivan Mining & Concentrating Co. plans to construct an electrolytic zinc refinery. Estimated cost, \$1,000,000.

Illinois

KENNEY—The Kenney Community High School has awarded the contract for the construction of a 2-story, 104x106-ft. high school, to C. J. Newlin, Normal. Estimated cost, \$84,000.

MARION—The Bd. of Local Impvts. will receive bids about March 15 for building sewerage system and sewage disposal plant. Estimated cost, \$164,000. P. B. Wilson, city engr.

Iowa

PLEASANT PRAIRIE — Bd. Educ., Prairie (Fairport P. O.) is having plans prepared for the construction of a 2-story, 87x116-ft. consolidated school. A chemical laboratory will be installed in same. Estimated cost, \$125,000. Notcott, Donnan & Notcott Co., 516 Black Bldg., Waterloo, archts.

Kansas

WICHITA—The Concrete Products Co., Caldwell Murdock Bldg., plans to construct a 2-story, 150x210-ft. cement plant and warehouse on Rock Island Ave. and 13th St. Estimated cost, \$50,000. Archt. and engr. not selected.

Kentucky

CYNTHIANA—The city is having plans prepared for the construction and equipment of a filtration plant. Estimated cost, \$25,000. J. T. Gillig, engr.

Louisiana

NEW ORLEANS — The Natl. Brewing Co., c/o C. A. Wagner, pres., 2600 Gravier St., has awarded the contract for converting its brewery on Dorgenois and Gravier Sts., into an alcohol manufacturing plant, and constructing a 1-story, 30x75-ft. fermenter building and 4-story, 30x54x75-ft. distillery building. Estimated cost, \$140,000.

Massachusetts

EVERETT—J. Briggs & Co., Inc., manufacturer of paint, 45 Purchase St., Boston, is having plans prepared for the construction of a factory on Paris St., here. Estimated cost, \$25,000.

WOBURN—F. C. Parker & Son, Inc., plans to rebuild tannery which was recently destroyed by fire. Loss \$200,000.

Michigan

DETROIT—Park, Davis & Co., Atwater St. and McDougall Ave., plans to build a 4-story, 100x200-ft. drug factory. Above project is first unit of plant expansion to cost approximately \$4,000,000. Smith, Hinchman & Grylls, 710 Washington Arcade, archts.

TRAVERSE CITY—The Traverse City General Hospital is having plans prepared for the construction of a 3-story, 50x300-ft. hospital. Laboratory equipment will be installed in same. Malcolmson, Higginbotham & Palmer, 405 Moffat Bldg., Detroit, archts.

Minnesota

EVELETH—The city plans to build disposal plant, septic tank and sewer extensions. Estimated cost, \$500,000.

LITTLE FALLS—The Hennepin Paper Co., c/o C. E. Sager, Secy., 1128 Plymouth Rd., Minneapolis, plans to construct a sulphide paper factory here. Estimated cost, \$500,000. Engineer not announced.

Missouri

CLAYTON—City will receive bids about April 1 for building sewers in sewer District 1, 2 and 3. A 50,000-gal. concrete septic tank will be installed in each. Noted Oct. 13.

KANSAS CITY—The C. & C. Developing Co., 705 Ridge Arcade, is building a refinery at 13th and Winchester Sts. This plant will increase its capacity to 1,500 bbl. per day within the next year.

New Jersey

PRINCETON—Boro. plans to construct a sewage disposal plant. Estimated cost, \$30,000. C. P. Browne, mayor.

North Dakota

UNDERWOOD—The Bd. Educ. is having plans prepared for the construction of a 3-story, 80x120-ft. consolidated school. A chemical laboratory will be installed in same. Estimated cost, \$100,000. W. D. Gillespie, Fargo, archt.

Ohio

AKRON—University of Akron, College of Engineering, plans to construct new building to include an engineering laboratory. Estimated cost, \$100,000.

BUCKEYE LAKE—State Bd. Pub. Wks., Capitol, Columbus, and Licking Co. plan to construct a sewage disposal plant, here. Estimated cost, \$75,000. Kenmor & Whitlock, State House, engr.

FRANKLIN—The Bd. Educ. will open bids about March 1 for construction of a 3-story high and grade school. A chemical laboratory will be installed in same. Estimated cost, \$170,000. G. H. Girke, supt. of schools.

WAUSEON — Bd. of Trustees, Pub. Affairs, will receive bids until Jan. 30 for the construction of a earthen reservoir, auxiliary pumping station and water filtration and sedimentation plant. Estimated cost, \$25,000. W. T. Sherman & Co., Toledo, engr.

Pennsylvania

BELLWOOD—The Natl. Steel Constr. Co., 237 4th Ave., Pittsburgh, purchasing the plant of the Bellwood Eng. Co., here, and plans to enlarge and equip same for the manufacture of electrical equipment for the production of fabricated steel plate. S. Kazorski, Bellwood, mgr.

South Dakota

PIERRE—The State plans to construct a cement plant at Lime Creek. Estimated cost, \$100,000.

Texas

DALLAS—The Gulf Refining Co., Frick Annex, Pittsburgh, Pa., has awarded the contract for the construction of several 1- and 2-story buildings, to Bowden Constr. Co., Galveston. Cost between \$150,000 and \$200,000.

Wisconsin

BLACKCREEK—The Outagamie Limestone Co. is having plans prepared for the construction of a plant. J. B. Huhn, Secy.-Treas. H. O. Weldon, 10 La Salle St., Chicago, Ill., archt.

HARTFORD—City is having plans prepared for the construction of a sewage disposal plant and intercepting and storm sewers. Estimated cost, \$100,000. J. Donohue, 608 North 8th St., Sheboygan, engr.

TAYCHEEDA—The State Bd. of Control of Wisconsin, Capitol Bldg., Madison, receiving sealed proposals for furnishing 1 cold process water softener of 3,000 gal. per hour capacity for Wisconsin Industrial Home for Women, here. J. G. D. Mack, state ch. engr.

NEENAH—The Wolfax Co., Main St., plans to construct a 4-story, 60x150-ft. factory for the manufacture of pottery and porcelain ware. Estimated cost, \$80,000. Architect not selected.

PLYMOUTH — City is having surveys made for a sewage disposal system. J. Donohue, 608 North 8th St. Sheboygan, engr.

REEDSEBURG—Bd. Educ., c/o A. Bolson, plans to construct a 4-story, 60x185-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$125,000. Architect not selected.

British Columbia

VANCOUVER — The Harrison Pulp & Paper Co., will construct a mill for the manufacture of kraft paper at the mouth of the Harrison River. Estimated cost, \$3,000,000.

New Brunswick

ST. GEORGE—The New York World Publishing Co., 63 Park Row, New York City, has purchased the plant of the St. George Pulp Co. here, and plans to enlarge same. The plans call for an increased output of from 30 to 100 tons daily.

Nova Scotia

HALIFAX—Silliker & McMann, Cragg Bldg., have purchased the pulp mill and timber property at Hartville and plan to rebuild the plant. P. H. Moore, local mgr.

WOLFVILLE — The Gaspereau River Light, Heat & Power Co. plans to build a 10-ton dry ground wood pulp mill.

Ontario

CORNWALL—The Can Linoleum & Oil Cloth Co., plans to construct a 2-story addition to its plant. Estimated cost, \$35,000.

CORNWALL—The Howard Smith Paper Mills, Ltd., 138 McGill St., Montreal, will receive bids in the spring for enlarging its sulphate plant, here, increasing output to 50 tons daily.

IROQUOIS FALLS — Abitibi Power & Paper Co. plans to enlarge its plant. Estimated cost, \$250,000.

PETERBOROUGH — City will receive bids about Feb. 1 for the construction of a 6,000,000-gal. filtration plant and a 2,000,000-gal. reservoir. Estimated cost, \$350,000. R. L. Dobbin, water-works, supt.

PORT ARTHUR — The Kaministiquia Pulp & Paper Co., Ltd., will receive bids in the spring for building a new pulp mill which will have 250 tons daily capacity.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its annual meeting Feb. 21 to 24 at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting Feb. 14 to 17 in New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA will hold its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.

NATIONAL PETROLEUM CONGRESS will meet at the Hotel Baltimore, Kansas City, Mo., March 22 to 25.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

THE SEVENTH EXPOSITION OF CHEMICAL INDUSTRIES will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society, Nichols Medal award; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

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A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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Western Editor
CHESTER H. JONES
CHARLES A. BLATCHLEY
Industrial Editors
J. S. NEGRU
Managing Editor

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Dividing the Sheep From The Goats in Research

MOST interesting men have opinions, and if we look for them we can find them. In reading over lately a number of scholarly addresses on research by Dr. JOHN J. CARTY, vice president of the American Telephone & Telegraph Co., we find a clearly marked conviction that is indicated in all of them and which opens up an interesting and almost endless subject for debate. It is doubtful if in this or any other country there is so large a sum expended annually for industrial research under the supervision of any one man as is done under the supervision of Colonel CARTY. He is familiar with the haunts of discovery as well as with a great number of problems of applied physics, chemistry and mechanics, and he has participated in the solution of many of them.

In all these writings we find the line drawn between research in pure and in applied science. Pure science, to his mind, is properly the subject for research in universities—which includes colleges of technology—whereas research in applied science belongs within the scope of study of industrial and commercial laboratories, institutions and consultants. This is a general statement of his attitude which includes the frank admission of exceptions. It is not an infallible rule. It is a rather a general principle designed to serve as an aid to progress, while experience and common sense should prevent it from becoming a hindrance. Even in a discussion of research any rule of thumb will only mislead us, while headwork is constantly necessary.

The distinction which he draws is not between things done; the electrical engineer, as he says, may work to remove an objectionable feature in electric lamps, while the man of pure science may investigate precisely the same phenomenon in precisely the same manner for the entirely different purpose of obtaining an explanation of a physical occurrence, the nature of which cannot be explained by known facts. The only difference in the work of the two men is one of motive. As another indication of this division we quote from his presidential address at the thirty-third annual convention of the American Institute of Electrical Engineers in Cleveland.

"The investigator in pure science," he said, "may be likened to the explorer who discovers new continents and islands or hitherto unknown territory. He is continually seeking to extend the boundaries of knowledge.

"The investigator in industrial research may be compared to the pioneers who survey the newly-discovered territory in the endeavor to locate its mineral resources, determine the extent of its forests and the location of its arable land, and in other ways precede the settlers and prepare for their occupation of the new territory."

As the same gentleman stated on another occasion, "I would not try to divide science up into two kinds, but rather divide research into two kinds—that is, research conducted from a pure science motive, and research con-

ducted with the applied science motive. The ethics and methods of procedure in these two cases are in many respects conflicting when this distinction is not made. When the distinction is made, the conflict disappears and harmonious co-operation is obtained."

Now temperament will guide motives better than motives will guide temperament, and with the division made, as Dr. CARTY would have it, the two fields call for different temperaments. The man who works in pure science must have what he calls the Divine Spark and what we are disposed to call the Gift of Curiosity, to make him persevere as a seeker after the truth; who can sense what HUXLEY called "the supreme delight of extending the realm of law and order ever further toward the unattainable goals of the infinitely great and the infinitely small, between which our little race of life is run."

We must be constantly on our guard not to let the distinction run away with us, or to draw from it such conclusions as were not intended. Nothing was further from Dr. CARTY's thought than the abolition of engineering and technical schools. Engineering is a profession which has to do with the application of science, and this profession has certain fundamental principles which require study before practice. The distinction has to do with research only, and not with the practical training of students, which is greatly to be desired. His point is that in research it is pure science that should be the field for institutions of learning; that specific problems in industry, if worked out in university laboratories, narrow the general field of study for those under instruction and call for more intimate contacts between laboratory and plant than are possible in universities; that the frank and free exposition of needs, costs, applications, etc., is not so available to the university staff and students as to the industrial laboratory, whether privately supported or privately retained.

Therefore, without desiring to put a brake on progress, he would make a division wherever possible—allot the fundamental problems, the questions in pure science, to the universities, and support them generously. This he regards as a legitimate expenditure by corporations and firms. It is work which universities are peculiarly fitted to perform. The vast number of undetermined chemical and physical constants that are needed almost more than anything else and which are so slow in coming out are within this domain, and university laboratories all over the country should be busy with them. The industries could well afford to pay for it.

Apart from this, however, the general fields of the unknown are so very great that, as a scientific nation, we need this constant study and research in pure science for the inspiration of progress. If the universities look too hard for practical uses; if utility is the motive rather than the all-embracing curiosity to increase the boundaries of knowledge, then the scope of research is

bound to be so restricted that we shall miss the big things. In other words, whenever in pure science we want to be too practical we put on blinders.

This is the trend of thought we read in Dr. CARTY'S various utterances and in which we heartily concur. It is opposed to an equally earnest disposition on the part of others to co-ordinate universities and industries so that, to use a popular expression, they interlock.

If universities are to become great consulting establishments, they must adjust their work to problems of consultation. Here we return to the question of motive. A great industrial consulting and research establishment must have service to industry as its primary motive. If it attempts to train students, the motive to train them must become secondary and not primary; and if students are trained "on the side," as it were, their training is likely to suffer. While it is very desirable for professors of pure science to get out into the industries to see their science applied, their real business is to teach fundamentals and research in pure science.

Sursum Corda

IN AN article on "The Future of the Cotton Industry" in a late number of the *Atlantic Monthly*, Professor MELVIN T. COPELAND of Harvard University tells how the prestige of English cotton mills has been endangered during the last year from a cause which is all too familiar over here, but which applies to other industries as well as to textile mills.

"As a result of the inflation of values," he says, "arising from credit and currency conditions in England, the nominal worth of cotton mills rose far above their original cost. Financial promoters grasped the opportunity to enter the industry. Mills were purchased at what, in the long run, is likely to prove exorbitant prices. Amalgamations of mills have been formed that we should call 'trusts' with heavy capitalization." They have grown beyond manageable size. Heretofore managers of mills have been part owners. They were competent, and the overhead expense for good management was slight. As partners they gave time and divided profits. With the sale of the properties these experienced managers have been supplanted and the establishments have grown too big for the eye of any other master than an industrial genius. The need to pay dividends on excessive capitalization works against proper maintenance and upkeep. This same excessive capitalization increases unrest among the workers of the mills, and the industry is thoroughly unionized, with fifty years' experience in collective bargaining. Then follow troubles and strikes and losses and the discouragement of other investors.

We have had so much experience with this very type of mismanagement of industry in this country that no warning should be needed, but it seems to be, all the time. Just because great corporations organized with scrupulous care do succeed occasionally is no reason why loosely jointed units should make for consolidated success. The incidence of greatest fault is usually upon so-called investment bankers who do not know one industry from another. The consolidation of interests into great corporations is sound only when all the talent and interest is held close to every job and all the fear of making mistakes is kept alive in the heart of every department chief while at the same time encouragement for work well done is constantly studied and applied.

Sursum corda, lift up your hearts, is an old ecclesiastical shibboleth, but it is needed in industry as well. As soon as it weakens, as soon as the men engaged cease to feel the inspiration that they are responsible parts of something alive and vital, their hearts sink. Then somebody else with a small establishment that he understands and can manage well and who has his heart in his work will naturally undermine the big concern and get its business.

Opportunity for Engineer-Citizens

THOUGHTFUL readers will be impressed, if not depressed, at the revelations made by RAYMOND B. FOSDICK in his book on American Police Systems. Whenever we are disposed to let the eagle scream and thank the LORD that we are better than other folks, it may be worth while for our own illumination and better understanding to ponder over a few of the statistics which the book contains. We present a few of his figures without further introduction:

In 1918 the arrests made in Boston, Philadelphia, Chicago and New York exceeded those made in London during the same year by 32,520, 20,005, 61,874 and 111,877, respectively. In 1919 there were 5,527 automobiles stolen in New York against 290 in London and ten in Liverpool—better than fifteen a day in New York as against less than one a day in London and Liverpool. In 1918 the ratio of robberies in London to those in Chicago was as 1 to 22, and there were in that time fourteen robberies in Chicago to every one in all of England and Wales. But not only have New York and Chicago been wallowing in the muck of misgovernment during the past few years, achieving such unhappy distinction. There's Los Angeles, that had in 1916 sixty-four more robberies than England, Scotland and Wales combined. Cleveland has three-fourths the population of Liverpool, and last year reported thirty-one times as many robberies. In 1917 Chicago had more murders than England, Scotland and Wales together.

"Well," as the late WILLIAM M. TWEED asked, "what are you going to do about it?" What shall we do? Go right on boasting and bragging and letting things go to the devil? Haven't we as engineer-citizens any responsibilities? The majority of crimes are committed by young men; men under twenty-five years of age, as we recall it. A few years ago these boys were toddling about the streets; most of them in this country. Those that were born abroad might not have engaged in careers of crime if they had not come over. The fact that they did engage in crime here is our fault. It's pretty hard to tell just what the fault is, but it rests upon us all. In a little while the boys that are now toddling about the streets will have reached the criminal age, and their ideals are at present in the making. Have we any means of molding these ideals into good citizenship? If we have, isn't it about time we began to think about doing some of this molding and getting it done?

One thing is certain, and that is that we can't lead these young criminals into enlightenment by legislation. The more laws we make the more they'll break. The most hopeful means now available seems to be in the organization of boys' clubs, plenty of boys' clubs, under competent supervision. An immense number of these are needed, and they can't be run by machinery; they

require, each, a sympathetic, firm, intelligent and sporty director. One of the best and most successful leaders of boys we know is a chemical and metallurgical engineer whose hobby is good citizenship through the Boy Scouts movement. Other engineers might follow his example with profit to themselves and the community. Given the right men in charge, gangs disappear from the neighborhood. The gang is the principal nursery for our criminals.

Efficiency in Freight Movement

WHAT a diversity of counsels there is with respect to our railroads! There are those who argue that now is the time for the railroads to buy, so as to act as business stabilizers. There are others who insist that now is the time for the railroads to economize and develop efficiency. In one quarter it is urged that shippers should ship now if they can, for later there may be great delays. In other quarters the feeling prevails that the heavy freight rate advances of last August were accepted cheerfully by the public because they promised better freight service, so that consumers would not need to carry stocks.

One of the chief sources of trouble is that many people have ulterior motives. They think of the railroads not as servants of the public but as patrons. They are less interested in seeing the railroads furnish good service than in seeing them place large orders. They have noticed in the past that when railroads were large buyers business was good, hence they assumed that these things stood in the relation of cause and effect. If it is a case of *post hoc, ergo propter hoc*, it would be more to the point to note that every industrial depression we have had has been preceded by a period of marked railroad expansion, either in building new road or in adding to equipment.

In our issue of Nov. 10, 1920, reference was made to our troubles about coal, the explanation proposed being that the coal industry had grown so large that it could not grow the way people wanted it to because it was beginning to interfere with other industries. This same principle applies to railroading, and will apply to any activity in similar circumstances. In fact, the principle applies even more pointedly to railroading than to coal mining, for as indicated in the discussion as to coal the rate of increase in production and consumption has been tending to decrease, whereas in railroading the rate of increase in freight ton-mileage has shown no signs of coming down.

All along the line, moreover, the tendency in the past few years has been for men connected with the railroad service, whether on the railroads or in shops serving the railroads, to do less work. Incidentally there are the full crew laws, the Adamson law and the abolition of piece work. Last summer there was loud complaint that railroad service was insufficient. We could not build enough roads because road material was lacking, we could not build enough automobiles, we could not make enough steel, we could not do enough anything, because we hadn't enough railroad facilities to move freight. Yet everybody was at work. There were more jobs than men. What would have occurred if there had been twice as much railroad capacity? There might have been twice as many jobs, but there would have been still fewer men working at the jobs, because more would have been working at railroad jobs.

Obviously, then, what is needed is more efficiency at both ends. The railroads should handle more freight per unit of equipment and per man employed, and the public should get along with less freight movement in proportion to its industrial activity.

Conversion of Sawdust Into Cattle Feed

ON ANOTHER page E. C. SHERRARD tells of his experiments in making cattle feed from sawdust, which is interesting from several points of view. He secures a conversion of about 20 per cent of the wood into sugar, which seems large from the published records of the producers of alcohol from this source. It would be interesting to know how large a part of these sugars is fermentable. The extraction of the sugars from the digested dust and the evaporation of the sugar solution to a thick sirup are processes which, it would appear, might be done at the sawmills, whether the product is to be fed or fermented. Mixing the sirup with the wood residue seems to indicate a plentiful and eventually a cheap fodder, for the cows get all there is to the sawdust, while nothing but the moisture in the mixture is wasted.

When the fodder consisting of 26 per cent of hydrolyzed sawdust was administered, the cows gave an increased production of butter fat and they gained markedly in weight. The "wood meal" was substituted for barley in the ratio of 2 to 1, the cattle obtaining their protein from the other parts of their ration which was mixed with it, for the protein content of sawdust is admittedly light.

The experiment was made with Eastern white pine. We have no idea what would happen if hemlock or oak sawdust were used. Maybe the pine wood meal contains some kind of vitamine that makes cows give milk, although Mr. SHERRARD doesn't say so. That the cows were fed by the "reversal method" worried us until we discovered that *reversal* is a stock breeder's technical expression for *alternating*.

The Chemical Engineer And the Human Viewpoint

IT IS SAID of many chemists and other scientific men that they are lacking in an appreciation of human relations, that they are unsociable and that they need a training in personal salesmanship. This cannot be true of the successful chemical engineer. If he is to carry the ideal of winning the top notch for the benefit of chemistry to the industries he must have, above all knowledge of the phases of business, a human sympathy and understanding of men.

This has been said before regarding success in other ways, but it should be practiced. The man in the plant does well to lunch with the laborers, discuss with them the things of interest in their lives. It is entertaining as well as profitable. Some practical philosophy may be instilled by conversation but without preaching. If a wheel becomes stuck during the work, the chemist may well throw in his shoulder, even though he may dirty his Sunday clothes. Later on when gentlemen are subordinates on his staff he will have acquired the ability to be kind and considerate. The main difference between the office man and the laborer is a mighty thin polish. Elementally, they are alike. Finally, when subordinates feel that the executive chemist is with them, he is qualified to sit in high places.

Readers' Views and Comments

Electric Furnace Refractories

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to Mr. Greaves-Walker's reply to my comments on "Electric Furnace Refractories" (CHEMICAL & METALLURGICAL ENGINEERING, Dec. 22, 1920, vol. 23, p. 1196), I am sorry that Mr. Walker received the impression that I intended to ignore the existence of certain dead-burning plants in the Eastern United States which were put into operation before the plant of the Northwest Magnesite Co. Such was not my intention, as I was referring to magnesite producers and the Northwest Magnesite Co. *was* the first magnesite producer to erect a dead-burning plant at the mine.

The plants to which Mr. Greaves-Walker refers ceased operations when the Northwest Magnesite Co. began producing dead-burned magnesite, because there was no economic reason for their existence. If they burned crude magnesite they would have to pay freight on the CO₂ gas shipped into the plant, and if they reburned calcined magnesite they would have to stand the cost of a second handling and burning. Aside from any other considerations, therefore, their operation was impractical as soon as properly made dead-burned magnesite was produced at the mine. ROBERT D. PIKE.

San Francisco, Cal.

Relationship Between Segregation and Rail Failures

To the Editor of Chemical & Metallurgical Engineering

SIR:—Dr. Burgess' recent series of articles on comparative rail tests has doubtless aroused considerable interest among your readers, but I do not think you are quite fair to Dr. Burgess in your editorial entitled "Good Rails Are More Than Sulphur Prints." This statement is, of course, true, as Dr. Burgess also would readily admit, but the following statement that all the rails that he tested were good is open to very serious questioning. I would like to emphasize that goodness in a steel rail implies much more than resistance to wear; a worn-out rail can easily be replaced when its appearance shows it has become weak, but the damage done when a good-looking but brittle rail breaks under a fast train is a very serious matter.

It is a great pity that Dr. Burgess' careful testing of these rails was not followed to its logical conclusion of a service test on the basis of safety or resistance to breakage, instead of merely wearing them out by excessively heavy traffic before they had a chance to fail from cracking or fatigue. But the omission of such a test in this case is hardly a good reason for your sweeping criticism of metallographists and testing engineers who have found out by study and experience what defects usually make rails fail in service and who thus feel justified in classing rails without these defects as better than those which contain them. Sulphur prints are probably the most valuable and trustworthy means of showing one of the most dangerous of these defects—namely, segregation. If the drop-test does not reveal these defects clearly, Dr. Burgess has done well in calling attention to its limitations.

Another point which you have apparently failed to

consider, in stating that all the rails tested by Dr. Burgess were good because no failures in track were reported, is that the bad portions of all these rails were cropped off during his careful inspection and search for segregation, piping, etc. It is hardly necessary to state that discards of 60 per cent, or even of 30 per cent, are unheard of in ordinary rail-mill practice, so that in making these discards from the defective ingots the rails which might be expected to break in service were eliminated.

I am in hearty agreement with your statement that Dr. Burgess' tests are "probably the most minute study ever made of a rail rolling," but they are open to the objection from a practical standpoint of having been concentrated on comparatively few ingots and rails. This is admitted in his discussion of "performance in service" on page 1021 of your issue of Nov. 24. On this account I would like to call attention to the series of tests made a few years ago in our laboratories on samples of A-rails from a number of rollings at different mills.

These tests were made to determine the general effect of titanium treatment of rail steel, and the samples were obtained in pairs, the same number of titanium-treated A-rails and of ordinary untreated A-rails being obtained from each mill, from rollings as near together as possible, and with the same top-discard, usually 9 per cent, from both kinds of steel.

Tests made on these rails included chemical analyses, tensile, hardness, impact, endurance and vibratory tests at various parts of the rail section, and also metallographic studies both by macroscopic etchings and by examinations of non-metallic inclusions and microstructures with a microscope.

The average results obtained from the physical tests were as follows:

		Plain Steel	Treated Steel
Elastic limit.....	Head	56,936	59,441
	Flange	57,005	59,841
Tensile strength.....	Head	119,900	125,723
	Flange	121,523	126,370
Elongation.....	Head	12.9	13.5
	Flange	15.3	15.1
Reduction of area.....	Head	14.3	16.0
	Flange	18.4	19.2
Brinell hardness.....	Head	219	224
	Web	249	235
	Flange	215	225
Impact resistance.....	Head	1.48	1.60
	Web	1.11	1.24
	Flange	1.29	1.44
Endurance test.....		20,404,456	27,501,196
Vibratory test.....	Head	1,275	1,252
	Web	919	1,047
	Flange	1,310	1,236

We determined from these tests that the essential improvement obtained by titanium treatment consisted in the elimination of segregation, without any simultaneous contamination of the steel by a deoxidation product such as alumina or silicates. We then made a much more extensive test of smaller samples of A-rails, both treated and untreated, to determine how general and infallible this action of our alloy on segregation was. This investigation was made by sulphur prints

and by chemical determinations of carbon at an upper corner of the head and just above the junction of head and web. Excessive segregation, accompanied by a streaky condition as indicated by sulphur prints, was found surprisingly prevalent among the samples examined from 111 different heats of ordinary untreated steel, but it was rare among the titanium-treated samples, which came from 101 different heats.

	Plain Steel	Treated Steel
Total number of heats.....	111	101
Number with less than 1 per cent segregation.....	6	29
Number with 1 per cent to 12 per cent segregation.....	34	65
Number with 12 per cent to 20 per cent segregation.....	27	5
Number with over 20 per cent segregation.....	44	2

We have continued our work in examining numerous other heats of titanium-treated steel for segregation, and we still find it rare in this class of steel. We have found, moreover, that no titanium-treated rail is ever segregated if the treatment has been properly made so that there is a small residual content of titanium. Segregated titanium-treated A-rails always show a titanium content below this required minimum. We feel that this is rather an important discovery, affording a simple practical test whereby the purchaser of steel rails may be assured that his material is free from segregation.

I would like to emphasize the above in comparison with Dr. Burgess' results on segregation. From the thirty-six sink-head ingots, seven of the A-rails showed over 20 per cent segregation and seven others showed between 12 and 20 per cent. In other words, 42 per cent of the sink-head A-rails showed over 12 per cent segregation, while only 7 per cent of our titanium-treated A-rails were similarly segregated. The average discard necessary for segregation from the sink-head ingots was 11.5 per cent, while our titanium-treated samples were cut after an average discard of 9 per cent. It is true that the Maryland comparison ingots killed with aluminum required a smaller discard for segregation than 9 per cent, but their additional discard for pipe was excessive. Theoretically there is no question that the sink-head process is effective in eliminating pipe from ingots, but piping can be controlled also by care in the ordinary methods of ingot manufacture. For instance, in a recent rolling of standard titanium-treated rails, the top discard averaged 8.3 per cent from the ingot, and by keeping the silicon content of the steel below 0.10 per cent and pouring the ingots slowly, the piped rails were kept down to 4.5 per cent, as determined by the nick-and-break test on every ingot. No special molds or hot-tops were used.

It has been brought out by some of the American Railway Engineering Association's reports and those of the bureau of safety of the Interstate Commerce Commission, that split heads and webs, which constitute about half of the causes of rail failures, are due to segregated streaks and generally occur in the A-rails. This, of course, is the reason why it is so important from the standpoint of safety to eliminate segregation from rails. The head failures for 1919 constitute over half of the total. An I. C. C. committee has recently reported that "seaminess plays an important part in many rail failures, the elimination of which or partial

success in their avoidance should reduce the number of failures." This seaminess has been shown to be merely a form of segregation and is nearly always indicated by sulphur prints of ordinary A-rails. "Accident Bulletin No. 84" of the Interstate Commerce Commission states that 631 accidents in 1919 were attributable to broken rails and ten persons were killed in them. Of the rail accidents whose detailed causes are given, almost 70 per cent were due to "crushed heads, split heads or split webs," all the result of segregated steel without much doubt. The practical importance of avoiding segregation in steel rails should therefore be evident to all.

We are in a somewhat stronger position than Dr. Burgess in regard to actual service tests, for all the titanium-treated rails that we examined for segregation with the results noted above have been in track long enough to give an accurate idea of their average endurance. We have taken all these service records directly from the rail failure statistics of the A.R.E.A. The average data taken from the 1918 report for open-hearth steel only will be given here. The average failures per year in service per 100 track-miles were 6.8 for all titanium-treated open-hearth rails. For ordinary untreated rails the best showing from any mill was 8.7 failures per year in service per 100 track-miles, and this was for rails from a mill where it is understood the A-rails are discarded and rolled into small bars for miscellaneous uses. The records from other mills for untreated rails were 9.0, 12.7, 14.0, 15.0, 15.2, 15.3, 16.3, 16.5 and 26.2 respectively, the average record for all untreated rails being 14.3. Thus the failures in service of titanium-treated open-hearth rails were only 48 per cent of those for ordinary untreated open-hearth rails, which proves that by eliminating segregation we have indeed prevented half the rail failures.

Since the above data were tabulated, the rail failure statistics for 1919 have been published, and we find a different set of figures, since these reports cover only the rails that have been in track for five years or less, and hence each year the oldest lots from the year before are dropped. Also in this report the bessemer and open-hearth rails are grouped together and not kept separate as formerly. Six lots of titanium-treated rails are included in this report, and four of them stood five years' service with no failures, one stood four years' service with no failures, and one stood five years' service with thirteen failures, nearly all of which were flange breaks or clean transverse fractures, as reported to us by the railroad. These failures average up to the very low figure of 3.3 per 100 track-miles per year. Two lots of sink-head ingots are also shown in these rail failure statistics, one of them giving twenty failures in five years' service and the other eleven failures in four years, making an average of 12.2 failures per 100 track-miles per year. The averages for all rails from the various mills were respectively as follows: 8.4, 8.5, 11.9, 12.0, 13.4, 15.6, 19.3, 19.4, 22.5 and 41.7, giving a grand average of 14.7. The showing for the sink-head ingots is thus very little better than the average, while the titanium-treated steel showed only about one-fourth of the average number of failures per 100 track-miles per year and less than half as many as the ordinary rails from the mill that had the best record of all.

GEORGE F. COMSTOCK,

Metallurgical Engineer,
Titanium Alloy Manufacturing Co.

Niagara Falls, N. Y.



RESEARCH LABORATORIES AT SHADYSIDE, EDGEWATER, N. J.
 Old-Laboratory Building Wooden Experimental Buildings New Laboratory Building

Coal-Tar Research at Shadyside

An Account of the Expansion of the Scope and Facilities of the Research Department of The Barrett Company—Study of Physical Properties, Methods of Testing and Development of Synthetic Products

BY JOHN MORRIS WEISS AND CHARLES RAYMOND DOWNS

A STUDY of the recent *Bulletin* of the National Research Council by A. D. Flinn entitled "Research Laboratories in Industrial Establishments in the United States of America" is indeed gratifying, as it indicates the widespread appreciation of research by the industries of the country. Industrial research laboratories have greatly increased in numbers and size in the last few years. The great improvements in both quality and diversity of products already evident should result in accelerating advances in the near future as these laboratories gain more experience in attacking the problems vital to the betterment of national security and independence.

To accomplish this desirable objective it is imperative that the brilliant young minds of the country appreciate the fascinating game of research and be attracted to it in proportion to its importance as a national insurance. It is also vital for the faculties of our universities to realize that in the past they have been perhaps too prone to evaluate their students upon the basis of memory and upon parrot-like repetitions of the contents of textbooks. Chemical research needs men with creative imagination who are sufficiently familiar with the work of the past so that new advances can be made by studying the effect of materials under new conditions, by examining common materials with improved instruments, by the study of manufacturing wastes, by noting and developing the byproducts of research which may be of more importance than the objective originally conceived.

Many of the most important discoveries of science have been so-called accidental, but had the power of observation and creative imagination been lacking they would have remained unknown for generations. We must admit that a knowledge of the literature is of very great importance, but that even the simplest experiments

reported in the past may have produced an important unrecognized byproduct. For the proper prosecution of such work the mind running in a groove along conventional lines is unproductive of revolutionary discoveries.

We therefore cannot rate or compare industrial research or any other research laboratories by the number of men employed or by the imposing expenditures of money assigned to their construction. Men trained in the fundamental principles of science and retaining mobile, plastic minds are the great unfilled need. The progressive industries are ready enough to supply the proper laboratory equipment and the business organization of the laboratory to relieve the research man of the executive and routine details.

PHYSICAL STUDY OF COAL TARS

The coal-tar business touches in some more or less personal way a great proportion of the manufacturing of modern civilization, and its scope is broadening daily. We have only a dim appreciation of its possibilities even after 150 years of destructive distillation of coal. The officers of The Barrett Co. sensed that there were still great potential treasures locked in the dingy tar vault and that long sustained attack would conquer the vault combination. The process of picking this lock is a fascinating problem and it is only partly solved, although numerous tumblers have shot home during the history of coal-tar chemistry.

In 1911 The Barrett Co. made a small beginning at a systematic study of the research problems connected with coal-tar industry when it established a research department. In the initial stages the work naturally concerned itself with the study of tars obtained from different sources and made by distilling coals in various ways. A large amount of data was collected along these lines. Such data are essential to the proper utilization

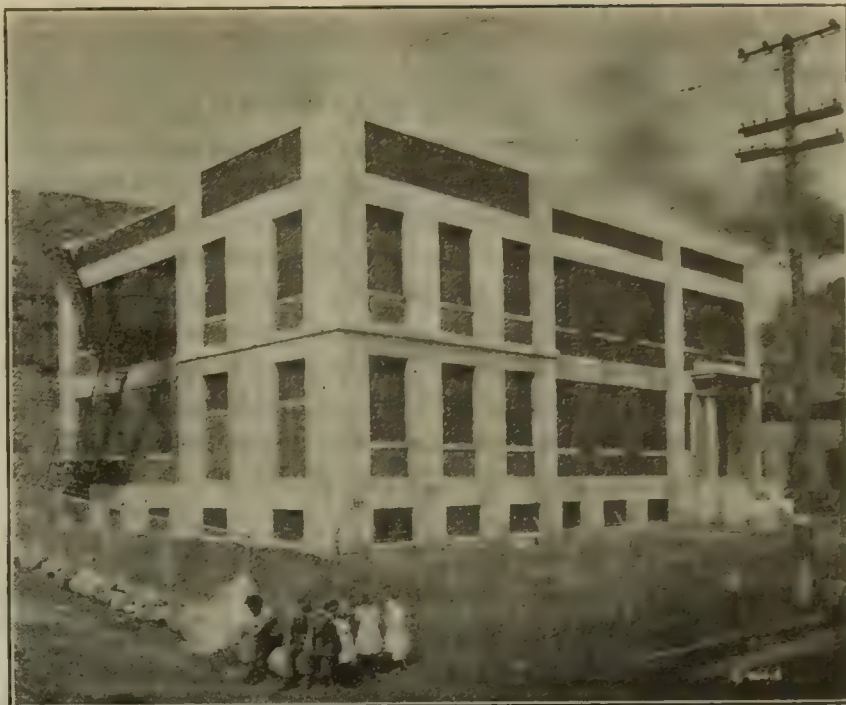
of tar in the manufacture of cruder products, so that tars can be properly blended before distillation to obtain desirable properties in either the residuals or the distillates. Further, in the production of the more refined products, the nature of the crude tars often predetermines their adaptability and use for the manufacture of such products. As the properties of coal tars are continually changing, depending upon the economic conditions which influence the methods of coal carbonization, this problem is a continued one and studies along this line will probably be a permanent part of work in coal-tar chemistry so long as such changes take place.

Naturally also a considerable amount of study was and is being given to the development of suitable testing methods for tars and the various primary materials separated from tars. Many of these testing methods have been described by one of the authors in the *Journal of Industrial and Engineering Chemistry* of September, October, November, and December, 1918, and a number of these methods have been accepted by the American Society for Testing Materials, the American Gas Institute and other technical associations in a substantially unchanged form.

SYNTHETIC CHEMICAL INVESTIGATIONS

As to the work along more strictly chemical lines it is, of course, impossible in a paper of this sort to give very much detail, as naturally such work is of a decidedly confidential nature, so that we can give merely a few examples of developments which will indicate the considerable scope and breadth of the work carried out in the research department of The Barrett Co. Among developments which have reached a full manufacturing scale are: the complete synthesis of alizarin or turkey red; the synthesis of phenylglycine, an intermediate for the manufacture of indigo; and resorcinol, used largely in dyes and hair tonics. The development of catalytic oxidation processes have recently resulted in new manufacturing methods for the production of anthraquinone, phthalic anhydride, maleic, fumaric and malic acids, and these are all being manufactured on a small scale somewhat beyond the experimental laboratory stage.

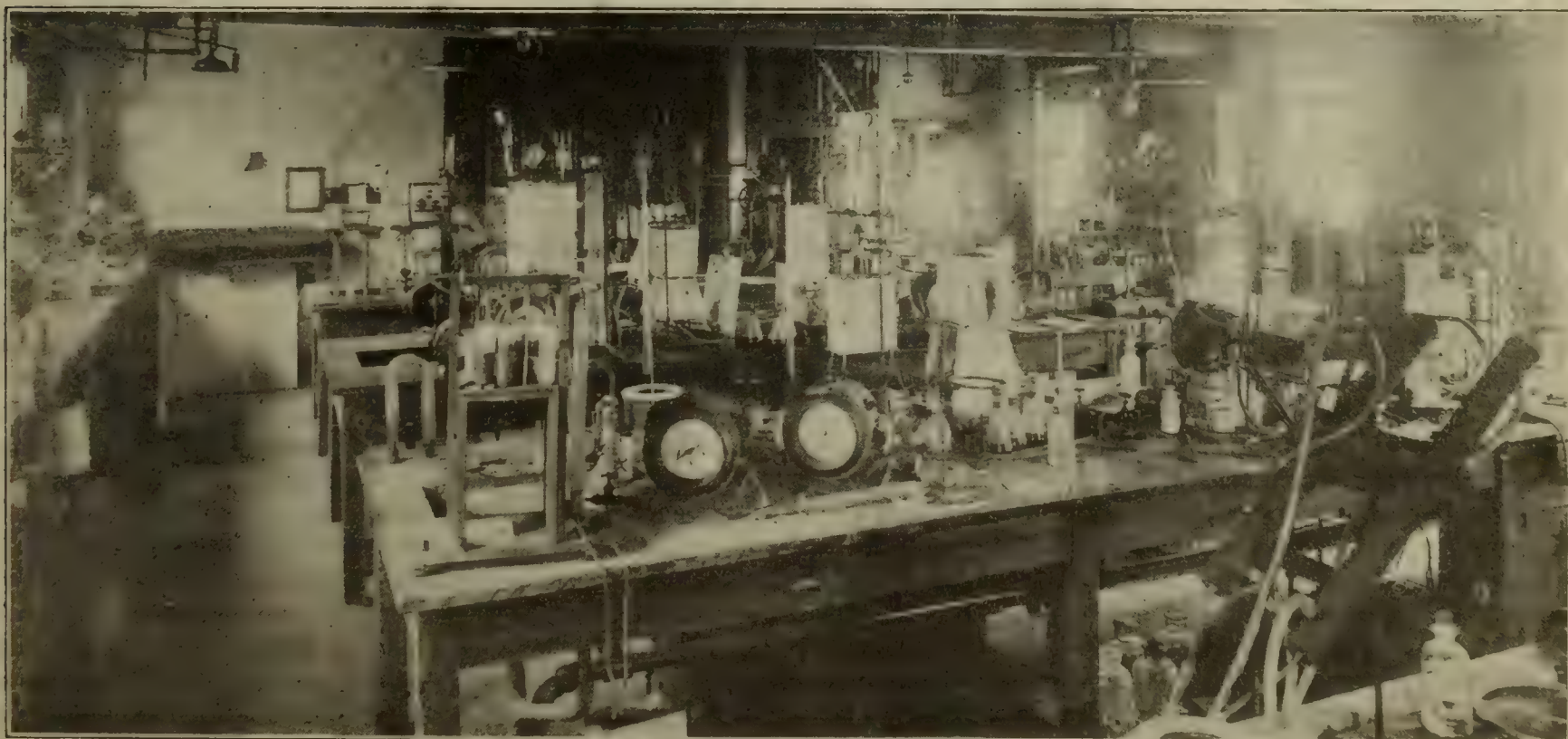
In addition to the work at the research laboratory



NEW LABORATORY BUILDING, ENTRANCE TO BE CENTER OF COMPLETED STRUCTURE

much work has also been done at the laboratory of our chemical department in Frankford, where the Dennis-Bull process for the manufacture of synthetic phenol was developed. Products such as orthocresol, Cumar (coumarone resin) and alpha-naphthylamine have been developed and produced on a large scale. The development of column distillation made it possible to separate orthoxylene from the meta- and para-isomers and produce this as a commercial product. Much investigation has been done on improvements in the manufacture of naphthalene and in the production of high-purity anthracene, carbazol and phenanthrene.

Similarly, methylnaphthalenes, acenaphthene and fluorene have been produced, these awaiting only commercial uses to make their production an accomplished fact. Synthetic tanstuffs have been studied and several grades of satisfactory commercial quality are being manufactured. Another branch of the work of a very different nature has been in the development of disinfectants, which requires bacteriological work as well as chemical work. As a result disinfectants of



LABORATORY IN OLD BUILDING

extremely high germicidal coefficients have been produced.

Also, apart from the research laboratory, there has been considerable development at our various branches in the manufacturing methods as applied to the cruder products. Great improvements in the art of tar distillation have been recorded. Considerable work has been done on paper, as in the manufacture of our saturated felts we have naturally become paper manufacturers on a large scale. Development and investigation have been necessary in these fields and in all of them the research department has co-operated both in an advisory capacity and also with practical experimental work.

As a byproduct of some of this work, a centrifugal machine has been developed whereby bituminous materials and other products can be produced in hair or

present there is a total force of about 100 men in the research department.

Although all of the buildings shown in the sketch are in use, we will describe only a few of the salient points of the new research laboratory. It is built of reinforced concrete with tapestry brick panels.

THE NEW LABORATORY BUILDING

The front member of the L form comprises the office section and is separated from the laboratories, which are situated in the other member of the L, by rolling shutter fire doors released by fusible links. In addition to the fire escapes prescribed by law there is a fire balcony connecting the windows of the various laboratories above the first floor, so that egress is provided from each room both by the doors leading to the corridors and by the windows. Every laboratory in which



STAFF OF THE RESEARCH DEPARTMENT

1. A. Murray
2. T. Nunci
3. R. Weston
4. E. Fay
5. J. McDonough
6. G. Bender
7. J. McCurry
8. L. Pawson
9. J. Gronning
10. F. Curran
11. F. Favre
12. A. Magrino

13. C. Schlick
14. C. Curran
15. F. Zimmerman
16. J. H. Timken
17. F. W. Wagner
18. O. F. Richter
19. V. Maraldo
20. M. Magrino
21. A. Allwood
22. R. Penfield
23. O. Stein
24. W. Wilson

25. H. Kolbe
26. E. H. Lane
27. F. W. Yeager
28. L. Weisberg
29. A. E. Craver
30. W. H. Rile
31. R. M. Strong
32. C. S. Reeve
33. H. G. Sidebottom
34. J. M. Weiss
35. G. Rittenger
36. P. Favre

37. A. Esik
38. F. Spindler
39. A. W. Tracy
40. D. Hageman
41. J. N. Simmonds
42. C. W. Fisher
43. S. C. Levy
44. E. D. Punnet
45. J. H. Mackintosh
46. R. Voorhis
47. E. G. Wadel
48. R. Brooks

shot form. This apparatus is applicable to other substances with suitable melting points and forms a very excellent means of subdivision and cooling.

EXPANSION OF THE RESEARCH DEPARTMENT

Today the tendency is to centralize as far as practicable as much as possible of the varied work at the laboratories of the research department. These have expanded in size from 816 sq.ft. floor area in 1915 to 29,000 sq.ft. in 1920, the comparison being shown in a figure accompanying this article. The sketches do not include some experimental plant buildings which are at present occupied actively on research problems. The new laboratory, built in 1920, is laid out for a possible expansion to a total of 54,000 sq.ft. of floor space, allowing for the accommodation of more than 210 working laboratory chemists in addition to other chemists and chemical engineers in the experimental plants. At

flammable organic materials are in use should be provided with two exits, as a fire may take place in front of one and thus block off the escape of the occupants in that direction.

Shower bath heads are also placed in each laboratory room for the purpose of extinguishing burning clothing or for removing splashes of corrosive liquids. These are provided with chains fastened to a pipe cross-bar so that the water may be released without difficulty in times of accidents. No drain is provided in the floor, as the use of these showers should be very infrequent. Fire blankets are also provided on vertical rollers similar to window-shade rollers so that a man can wrap himself with the least loss of time. A trained fire department and first aid committee are provided. All laboratory rooms are supplied with Foamite and Pyrene extinguishers, sand pails and fire horns, by means of which equipment practically every small fire can be controlled.

The table frames are made of cypress timbers. The floors of the laboratories are of maple laid over concrete. This sort of construction permits simple fastening and staying of miscellaneous semi-fixed apparatus. Alberene tops are used on the tables. The walls are of Pyrobar, plastered and painted with Toch's White Enamel Laboratory Paint. These walls will hold nails, hence shelves or miscellaneous small apparatus may be easily erected without resort to drilling and the use of expansion bolts. After removal of a shelf the holes are easily patched. Glass partitions of standard construction are used throughout for the offices.

Much care was exercised to provide efficient lighting for the new laboratory. The windows are large, being 6 ft. 7 in. high by 4 ft. 2 in. wide. For the artificial lighting the lamps are placed in relation to the tables so that the worker does not work in his own shadow. The

arrangement prevents the ingress of dust from the outside. Outlet for the foul air is provided through the hoods.

Each hood is provided with a separate exhaustor and this discharges directly through the wall of the building to the outside, thus obviating the carrying of large exhaust ducts throughout the building with their liability of corrosion. Only under extreme conditions is there any necessity for operating the individual hood exhaustors, as the air supplied by the ventilating system induces sufficient draft through the hoods.

All of the piping in the building is exposed and easily accessible in case repairs are necessary. The piping system comprises drains, hot and cold water, compressed air, gas and high- and low-pressure steam. Portions of the pipes and valves are painted with distinctive colors denoting their use. Such practice allows of quick shut-



STAFF OF THE RESEARCH DEPARTMENT

49. D. North
50. J. Breckley
51. H. H. Clark
52. L. H. Helfrich
53. J. Gainey
54. J. Cobleigh
55. J. Travis
56. E. Canavan
57. H. E. Williams
58. M. B. Cook
59. J. O'Neil

60. H. Henderson
61. W. Babcock
62. A. La Monte
63. C. R. Downs
64. C. G. Stupp
65. G. C. Bailey
66. W. M. Bywater
67. A. F. Calvin
68. F. Boettner
69. A. S. Williams
70. F. A. Canon

71. C. B. Mayer
72. M. Chieffo
73. E. M. Bradley
74. J. E. Sikorska
75. I. N. Riddervold
76. R. Riegler
77. P. Cernek
78. F. J. Maddocks
79. L. Lehr
80. E. Werle
81. W. F. Schultz

82. M. Bradley
83. F. W. Stetson
84. J. E. Woodcock
85. H. E. Barse
86. L. E. Porter
87. W. Bossenberg
88. G. Holzhausen
89. R. D. Burdick
90. D. Scott

question of artificial lighting is important so as to obtain sufficient light well distributed without so much concentration in any one place that eye strain will develop from glare. To assist in this desirable objective the wall as the back of wall tables is painted with a black enamel to the height of 2 ft. above the table. Direct illumination is used as the cleaning of the bowls of indirect lighting is too laborious.

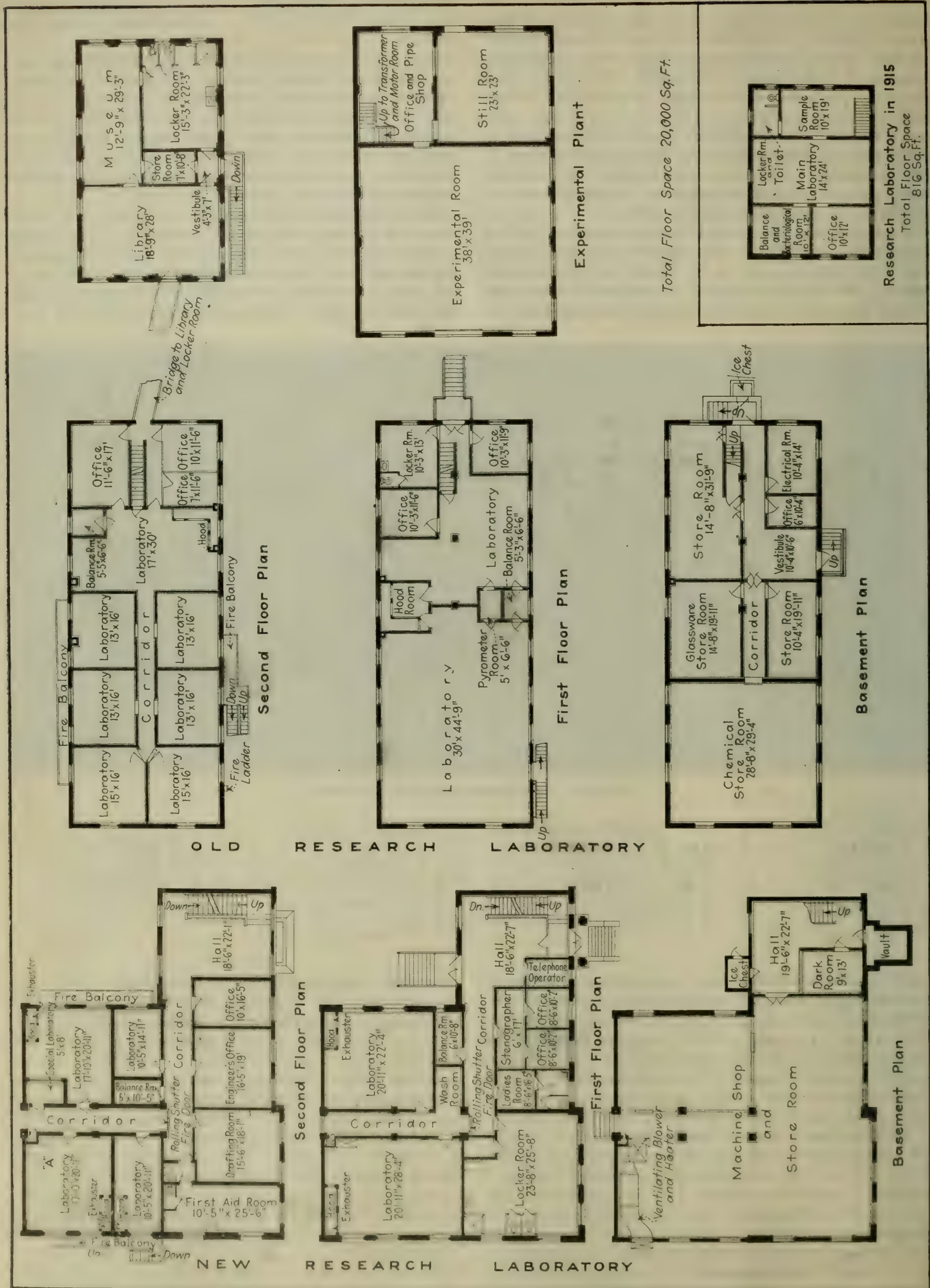
The ventilation of the laboratory rooms is accomplished by discharging into them air heated to 60 deg. F. in cold weather, and whenever additional heating is necessary radiators placed in the individual laboratories may be used. The air of the laboratories is renewed approximately every two minutes and drafts are obviated by special deflectors and by a multiplicity of air inlets wherever needed. There is, therefore, no necessity for open windows and hence the air pressure in the rooms is above the atmospheric pressure. This

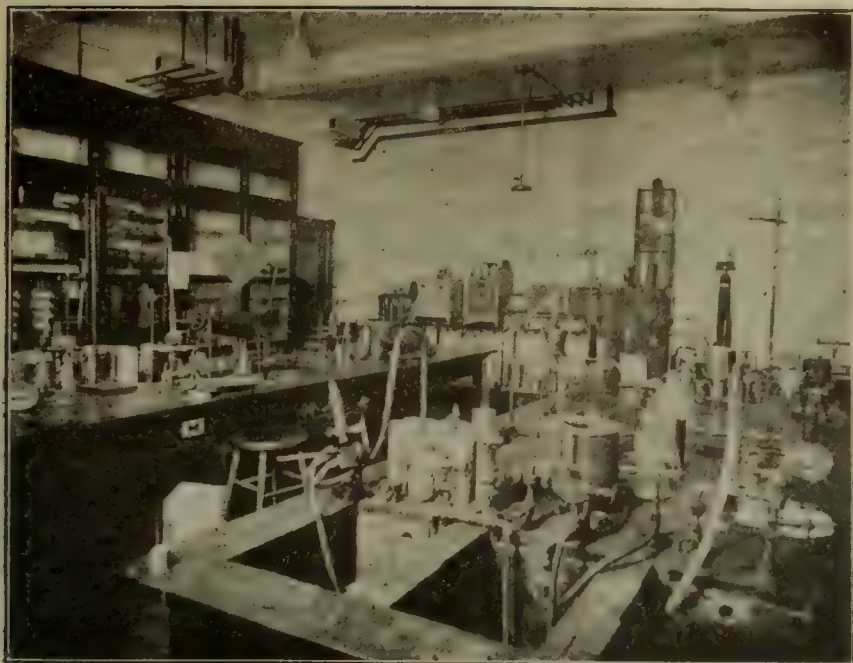
off of gas lines, for instance in case of fire. The tables are provided with numerous electric power plugs for the operation of motors, ovens and the like.

A duct extending from the basement up through the building, denoted in the sketch as A, allows temporary electrical or pipe lines to be brought up to a particular laboratory for specific work which is not cared for by the standard electrical or piping equipment.

Another novel feature is found in room 66, which is provided for the storage of small amounts of flammable solvents used in the laboratories adjoining. It is provided with steam and hot and cold water for the distillation of very flammable materials, such as ether. A transparent wire glass partition separates it from room 65.

There are both temporary and permanent experimental plant buildings, one of the latter being shown in the sketch. This is equipped with vacuum, com-





TYPICAL ROOM IN NEW LABORATORY BUILDING, SHOWING EMERGENCY SHOWER, FIRE BLANKET ROLL. EXPOSED PIPING OVERHEAD AND AIR INLET PORTS

pressed air, gas, water, high- and low-pressure steam lines and floor drains. The headroom is 18 ft. to the eaves and power shafting is hung from the roof beams. Electric power drop cords are also suspended from the roof to take care of electrically-heated portable apparatus. In this building small-scale plant apparatus may be arranged in proper flow relation by framing.

LARGE-SCALE LABORATORIES

Large-scale laboratory work is provided for in one of the experimental plant buildings. The equipment consists of type apparatus not necessarily arranged in a flow relation as would be used in either an experimental or large-scale manufacturing plant. It is used for preparing batches of materials on a scale considerably larger than laboratory practice, so that sufficient material can be produced to determine its application.

DEPARTMENTAL ORGANIZATION

For the proper allocation and handling of the work the laboratory personnel is subdivided at present, under the chief chemist and assistant chief chemist, into five divisions, namely: tar and oil division, organic research, experimental plant, engineering and clerical.

In order to harmonize the working of the laboratory an operating committee composed of the heads of the divisions, the chief chemist and assistant chief chemist and also other members of the divisions whose ability and loyalty warrant their attendance meets one afternoon each week. It considers in more or less detail, depending upon exigencies, the entire work of the department.

The executive committee, made up of the divisional heads, chief chemist and assistant chief chemist, meets for about one hour once a week to consider questions of general welfare and also to provide an opportunity for the chemists to express their opinions concerning the mechanical service supplied.

Seminars are held occasionally where papers are presented either by men in the department or by sales or manufacturing men. Co-operation not only in the department itself but with the rest of the company is earnestly sought and nurtured, and upon this principle depends the success or failure of any of our large, complex, present-day manufacturing organizations.

The hack work of literature searches is well taken care of by a librarian and library chemist, these jointly

preparing bibliographies and abstracts of all articles in a given field, thus placing the chemist in a position to select his reading intelligently and efficiently.

An entirely different type of research and investigation work being carried on by The Barrett Co. is embodied in part of the efforts of the so-called technical service staff. This staff is composed of trained chemists and engineers and its work is directed from the general offices of the company. Its efforts are devoted to technical problems outside our own four walls, determining and developing possible uses for Barrett products, taking the new ideas in the research laboratory to the outside trades, and bringing to the company suggestions of its own as to new products that may be manufactured.

The physical development of our research laboratory is constantly increasing, as we have not only to deal with the production of new materials and the improvement of processes but also with many problems in which the utilization of our products is involved, and as the field into which our products enter is quite varied this work also is naturally quite varied and requires special types of apparatus, particularly adapted to the industries in which our products are used. Coal-tar products and derivatives roof our homes and factories; protect our roads from disintegration and decay; prevent the attack of fungi and marine bores on structural timber; separate ores from accompanying gangue; disinfect our public places and sick rooms; form part of both preventive and curative medicines; color textiles, leathers, inks and what not in our everyday life; waterproof dams, concrete barges, subways and underground conduits; are found in our chewing gums; furnish power in our internal combustion engines whether on land, sea or overhead; comprise a large part of our military and domestic explosives; assist in making up for the lack of natural crude acids for our beverages; protect our structural steel against corrosion; protect our clothes against moths; enter into the composition of our varnishes, of electrical insulators, of clay pigeons, of case hardening compounds for steel treating, of electrodes for arc lights, electrochemical smelting and manufacture of metallic aluminum; are essential constituents of many of the rubber compounds used in various ways; in grinding lenses for our opera glasses, and in fact, enter into almost all phases of our daily life.



VIEW SHOWING HOOD EXHAUSTER, LIGHTING ARRANGEMENTS AND RADIATORS FOR SUPPLYING SECONDARY HEATING

Gasoline by the Charcoal Absorption Process

Description of the Activated Charcoal Process for Absorbing Vapors From Natural Gas—Comparison With Commercial Processes—Activated Coconut Shell Charcoal—Absorption and Selection—Steam Distillation of Saturated Carbon—Yields and Quality of Products

By G. A. BURRELL, G. G. OBERFELL AND C. L. VORESS

TWO methods of extracting gasoline from natural gas—compression and oil absorption—are now used extensively, while refrigeration is used to a limited extent. The charcoal process, a recent development operating on entirely new and scientific principles, compares most favorably with either of these methods. It produces higher yields and a better grade of gasoline. It does not require heavy initial installation costs and can be operated more cheaply. The apparatus has longer life and is not subjected to inefficiency due to wear. Its adaptability to field conditions is enhanced by the fact that it operates on either lean or rich gas at either high or low pressures.

This year there will be practically 300,000,000 gal. of gasoline produced from natural gas. Where the salable vapors in the gas are over a gallon per thousand cubic feet, it is possible to recover a considerable proportion by directly compressing and cooling the entire volume of gas. Where the salable vapors in the gas are not so plentiful, it has been the custom to resort to the oil absorption process, which is simply a method whereby the desirable vapors are concentrated by partial fractionation so that pressure and cooling may be effectively applied as in the original compression process. The gas is made to bubble or flow through absorbers where the gas comes in contact with a high-boiling mineral oil or naphtha which absorbs the heavier fractions in excess of the lighter ones. The oil or naphtha is then subjected to steam or direct heat to vaporize again the absorbed fractions so that they may later be condensed by cooling and compression.

DISADVANTAGES OF THE COMPRESSION AND ABSORPTION PROCESSES

There are several features of the present processes which are considered obnoxious by practical operators.

Both the oil absorption and compression systems require considerable pressure. The oil absorption may be used at low pressures, but it is not considered good practice because of the low saturations which must be adhered to. These high pressures are not only expensive to produce but mean large outlays for repairs and renewal of machinery. They also increase the danger of explosions.

Quite a little difficulty is experienced in marketing the product because of the large amount of so-called "wild" vapors which it contains. These vapors are the lower boiling fractions which have been absorbed and condensed in the higher boiling fractions by the compression, cooling and solvent action of the liquid. It has been apparent to many men for some time that a method whereby a sharp fractionation could be obtained would eliminate much of this trouble. Methods of hot blending and steam treatment have been used with varying success as a substitute for the original frac-

tionation, but all admit that there is still much room for improvement.

The present oil plants are far from simple both in number of units and operation. Constant supervision is necessary if the oil plant is to be operated at as high a degree of efficiency as 75 per cent of gasoline extraction.

From the standpoint of pressures used, of quality of product, of efficiency of extraction, of simplicity of apparatus and operation, and of cost, a new process, one working on an entirely new principle, has been demanded.

CHARCOAL ABSORPTION PROCESS

The charcoal absorption process consists of bringing the natural gas into intimate contact with activated charcoal, in the capillaries of which the vapors are condensed and the dried gas allowed to return to the distribution lines. When a predetermined saturation of absorbed vapors has been attained in the charcoal, the gas is allowed to come into contact with a fresh supply of carbon. The vapors retained in the first mass of charcoal are then evacuated by distilling off with superheated steam, condensed in water-cooled condensers, blended and stored preparatory to marketing. Fig. 1 is a flow sheet diagram of the plant.

ACTIVATED CHARCOAL

The charcoal best suited for the successful operation of the process is made from coconut shells by the steam activation process developed during and since the war. Charcoals made by other methods do not possess sufficient absorptivity to pay for the costs of recovery and therefore are of no use in this process. Even at the close of the war, the better grades of charcoal, those testing from fifty to sixty minutes by the accelerated chlorpicrin test, had not been produced in quantity.

Any charcoal suitable for absorption of vapors from gas must be capable of readily condensing and retaining large quantities of liquid in capillary equilibrium with its vapor and at the same time offer a minimum resistance against recovery. It has been found when applied to gasoline production, if coconut charcoal is activated up to forty, fifty or sixty minutes for the absorption service time, that the retentivity factor tends to decrease above fifty minutes. The curves given in Fig. 2 were obtained with our standard laboratory testing outfit, the glycerine distillation method being used in obtaining the data. It will be noted that there is not a great amount of difference in the maximums of the curves. The big difference is in their decrease in efficiency due to oversaturation. In other words, it is the retentivity function. Fig. 2B shows the same curves corrected for gravity. The twenty-minute material shows a large lack of retentivity, probably due to the shallow capillaries. The fifty-minute

material shows up best here, due no doubt to the capillaries being of the correct size to permit of selection, a term which we shall discuss later. Fifty- to sixty-minute charcoal will absorb from 10 to 15 per cent of its own weight and retain the salable vapors for later recovery.

One very essential feature that the charcoal must possess is what we term selective absorption. Natural gas consists of the gases and vapors of the paraffine hydrocarbon series, the higher members of which have an appreciable vapor pressure at the temperature of the gas. When the gas is first brought into contact with the charcoal the lighter, high-volatile vapors, such as ethane, propane, butane, etc., are absorbed in the capillaries, but as the saturation increases a selection or equilibrium adjustment takes place with the result that these high vapor pressure and undesirable fractions are left in the gas. The heavier fractions are thus isolated and can then be condensed after steam

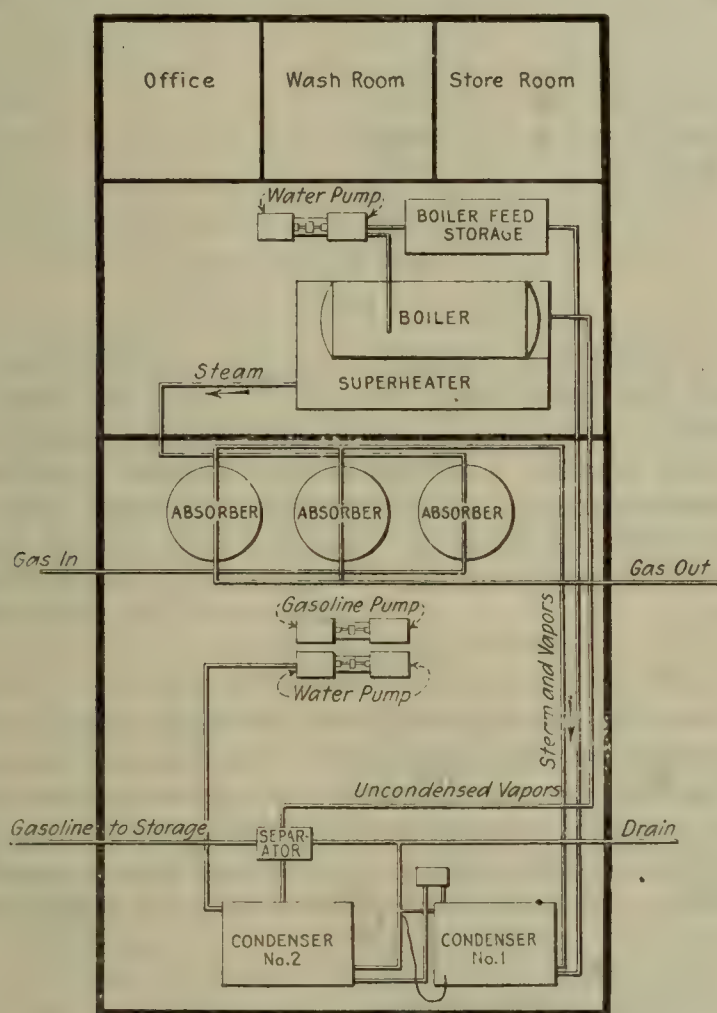


FIG. 1. FLOW SHEET DIAGRAM OF THE PLANT

distillation without the use of high pressures. Regulation of the vapor tension of the final product is thus obtained by preventing the absorption of the higher boiling fractions.

The size of the granules of charcoal should be from 8 to 14 mesh. Smaller mesh material has slightly greater absorbing qualities, but the resistance to the

gas passage rapidly increases as the size of the granules decreases. Gas flowing through a column of charcoal 5 ft. in depth at the rate of 40 cu.ft. per hr. per sq.in. of base surface and flowing against atmospheric pressure will show a retardation of from 1 to 2 lb. due to the charcoal resistance.

ABSORPTION

When natural gas first comes into contact with charcoal considerable heat is developed, which is the latent heat of vaporization from the condensing vapors. After a few minutes the temperature stops rising, which indi-

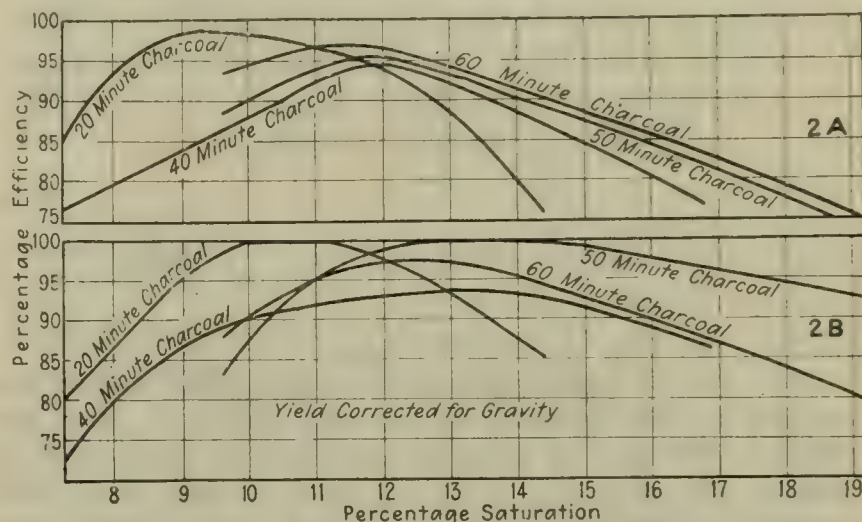


FIG. 2A. CHARCOAL QUALITY CURVES
FIG. 2B. 2A YIELD CORRECTED FOR GRAVITY

cates that selection is taking place and the heat of condensation is being used to re-volatilize the highest condensed liquids, which must be eliminated from the final product. Many investigators have ignored this phenomenon, and have stopped when no more heat evolution was noticeable, thinking that the absorption was complete. With gas rich in vapors we have observed a temperature increase of 60 deg. C. in the charcoal due to the latent heat in condensation. This does not mean that the entire body of charcoal increased 60 deg. simultaneously. The heated volume travels in a zone in the direction in which the gas flows. When using a tube of charcoal $\frac{1}{4}$ in. in diameter and 1 ft. in depth and passing rich gas at the rate of 10 ft. per hr., the heated zone is about 2 in. in depth.

The temperature of the charcoal at the beginning of the gas passage is not very important when using gas of low gasoline content. It quickly gains the temperature of the incoming gas. A loss of about 6 per cent in final recovery was experienced when tests were run with the initial temperature of the charcoal 300 deg. C. However, the temperature of the inflowing gas is more important. Fig. 3 shows that the curve of recoverable efficiency is practically a straight line function of the temperature, other things being constant. This curve reaches its zenith at 300 deg. C. Above that there is no recovery at all.

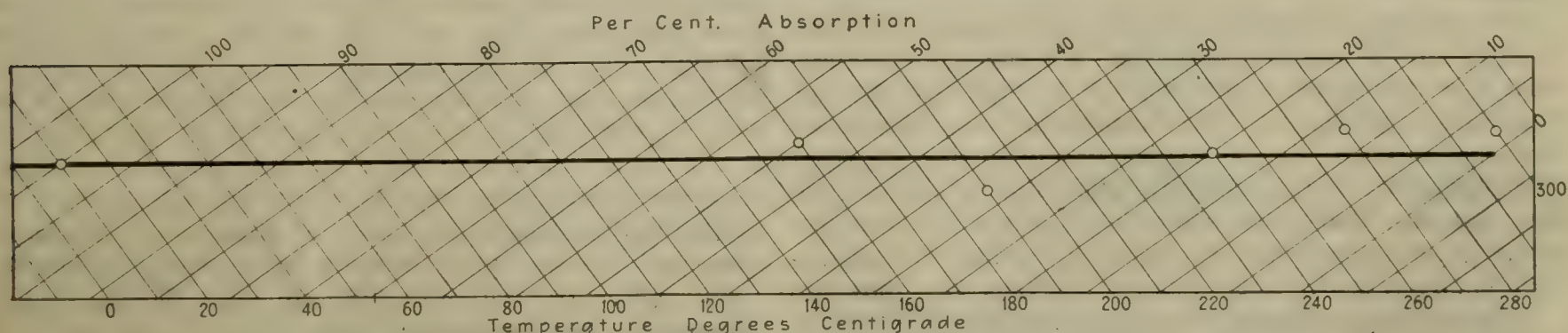


FIG. 3. EFFECT OF TEMPERATURE ON ABSORPTION

TABLE I. HEAT REQUIREMENTS

Weight of gallon gasoline, lb.....	5.5
Saturation of 13 per cent by weight required, lb. of charcoal	42.3
Specific heat of charcoal	0.3
Specific heat of gasoline	0.58
Latent heat of gasoline, B.t.u. per lb.	100
Average b.p of gasoline, deg. F.....	210
Highest temperature of distillation, deg. F.	400
Temperature of charcoal by saturated steam, deg. F.....	230
Superheat (400 — 230), deg. F.	170
Superheat required for charcoal ($42.3 \times 0.3 \times 170$).....	2,157
Heat to raise charcoal 60 to 230 deg. F.	170
Heat required to raise charcoal 60 to 230 ($42.3 \times 0.3 \times 170$)	2,157
Distillation of 60 per cent made without superheat.	
Heat required for gasoline distillation (60 to 230 plus latent heat) ($5.5 \times 150 \times 0.58$) + (5.5×100), B.t.u.	1,030
Superheat required for 40 per cent of gasoline distilled..	411
Heat required for first 60 per cent distilled, B.t.u.....	618
Total heat required to raise to temperature of superheat, B.t.u.	2,775
Total amount superheat required, B.t.u.....	2,568
Theoretical amount of heat required, B.t.u.....	5,343
Specific heat superheated steam 15 lb. 400 deg. F.....	0.5
Superheat available per lb. of steam $0.5 \times (400 - 230)$, B.t.u.	85
$2568 \div 85$, lb. of water	30.21
Boiler feed water, deg. F.	200
Boiler heat required, (200 to 400 deg. F.), B.t.u. per lb..	1,089
Total amount boiler heat required (30.21×1089), B.t.u.	32,900
Boiler hp. per gal. gasoline per day	0.045

The rate at which absorption takes place varies according to the richness of the gas mixture. For gas yielding 400 gal. of gasoline per million cubic feet, a rate of 40 cu.ft. per sq.in. of base surface in a 5-ft. column of charcoal is not too high a rate. Above this rate the back pressure due to the resistance of the charcoal itself begins to enter as a factor against higher rates. Fig. 4 presents graphically a series of experiments on rates under these conditions.

The volume of gas to be passed is determined by the nature of the product desired by the operator. If he desires a very volatile product, a low saturation of the charcoal must be had so as not to allow selection to eliminate too much butane, etc. If a staple low volatile product is desired, more gas is passed and the selection is carried as far as desired. This determines the nature of the product and will be discussed later. The volume to be passed to secure the maximum yields for the different grades of charcoal may easily be calculated by the curves given in Fig. 2.

DISTILLATION

After absorption has been completed, it is necessary to expel the condensed vapors from the charcoal. This is done by blowing superheated steam directly through the charcoal. The superheat should be as high as local conditions will allow. There will be a decrease in fuel used per gallon of gasoline recovered, as the temperature of the superheated steam is increased up to the point where the radiation factor of the carrying lines and the efficiency factor of the heater itself become so large as to interfere. Local conditions affect this to a great extent. It will be found, however, that under ordinary conditions 250 deg. C. may be maintained with good results.

The amount of steam required depends upon the percentage of the available heat that is utilized. The charcoal must be heated to 200 deg. C. to dispel the heavier fractions of gasoline. This temperature also insures an active absorbent. The work done is mainly derived from the superheat. The accompanying calculations show that theoretically there are about 5,343 B.t.u. of heat required to produce a gallon of gasoline when the saturation is 13 per cent. Table I shows the heat requirements.

The question is repeatedly asked, "Does this steam distillation injure the charcoal for the other absorptions?"

The steam distillation does not injure the absorptive capacity. In fact, it leaves it in a somewhat better condition than dry heating would conduce. The steam drives out gases and absorbed vapors at a somewhat higher temperature than will permit condensation. The first rush of cooling gas will displace the steam and the first condensation will be of the vapors in the gas. Fig. 5 (solid lines) shows the curves for two samples of charcoal, one of which was being used for the first time for gasoline absorption, the other being taken from the large plant after serving ninety-five absorptions and steam distillations.

A sample of charcoal which had been exposed to the air for a month was divided into two equal portions

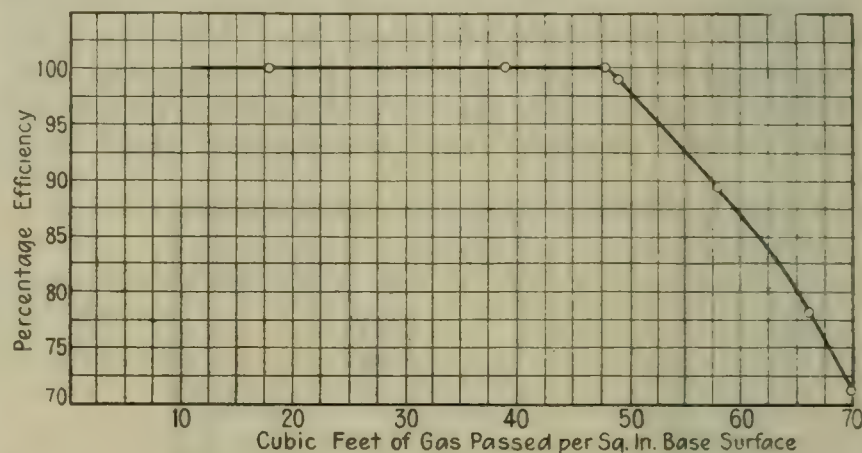


FIG. 4. RATE CURVE

One portion was heated to over 500 deg. C. in an open vessel for more than two hours, and the other was treated to 300 deg. C. with superheated steam. The portion treated with superheated steam exhibits an absorption curve which reaches its peak later and shows more retentivity than the dry heated sample. Fig. 5 (dotted lines) shows the curves for this experiment.

CONDENSATION

The gasoline vapors driven from the absorber with the steam may be condensed in any type of condenser. We prefer two water-cooled condensers in series. The cooling water around the first condenser can be circulated just swiftly enough to condense the major portion of steam and allow for its being trapped away without

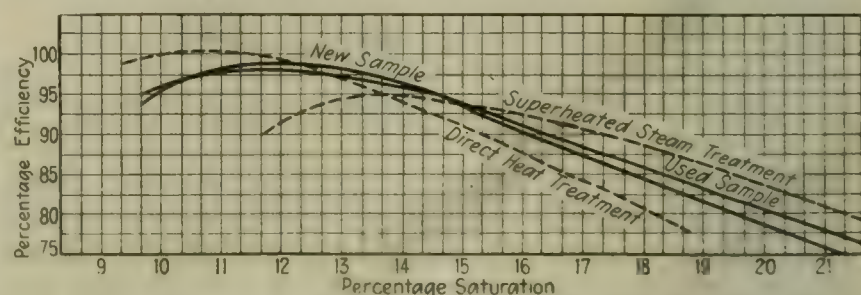


FIG. 5. EFFECT OF USE ON ACTIVATED CHARCOAL (FULL LINES). EFFECT OF DRY HEAT VS. STEAM ON CHARCOAL (DOTTED LINES)

being cooled much under 100 deg. C. In many localities this condenser may well be an air condenser with enough of the line jacketed to heat the boiler feed water.

The second condenser must be an efficient one. With cooling water at 15 deg. C. or thereabout very efficient condensation will take place at atmospheric pressure.

The condensed gasoline and water flows from the condenser into a separating tank. If it is desired to blend the final product with heavier naphtha to reduce its vapor pressure, that may also be done at this point. We prefer to blend with from 10 to 15 per cent of about 56 deg. B. naphtha.

An examination of the gasoline produced has brought to light the fact that the gravity and vapor tension of this gasoline is less than the gravity and vapor tension of that made from the same gas by either compression or oil absorption. Fig. 6 is a set of curves illustrating this point. There are several reasons for this. Conditions under which the condensation is made affect the character of the final condensate. It has already been noted that the charcoal process gasoline is condensed from a vapor-gas system under atmospheric pressure. This is in direct contrast to the methods of condensation used in the compression or oil absorption processes, where the pressure generally ranges between 90 and 250 lb. When these gasolines are placed in storage or released from compression, evaporation begins to take place immediately and desirable fractions of the gaso-

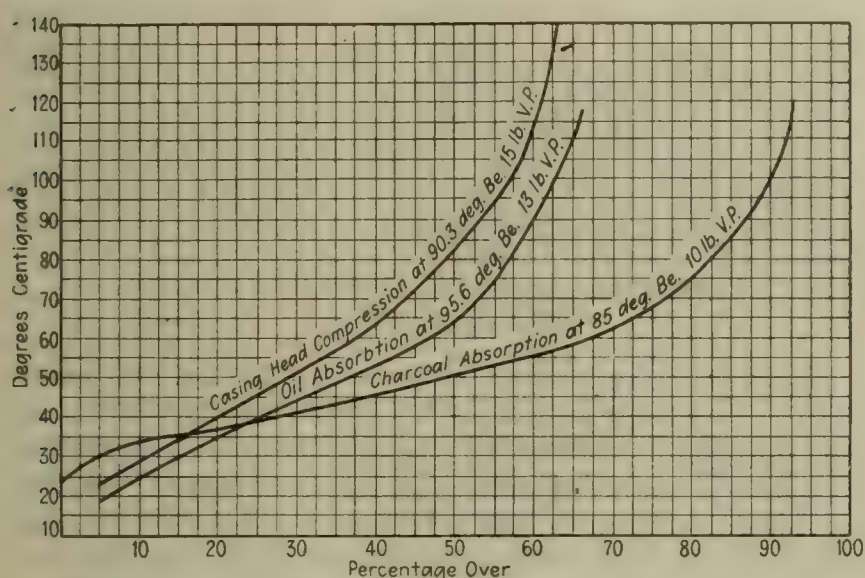


FIG. 6. COMPARISON OF GASOLINE PRODUCTS

line are carried away mechanically with the escaping undesirable wild vapors.

The method by which the condensation is carried on is also an important factor in determining the character of the condensate. The charcoal process is a batch process. Consecutive distillations of a series of absorbers are made rather than continuous distillations of a single still. This drives out the lighter vapors first and makes possible the addition of the blending naphtha to the fraction that actually needs blending. If there are any very volatile vapors left in the charcoal, they are driven out first by the lowest temperature and do not come into contact with the salable gasoline. By the oil absorption method, which is a continuous process, all fractions are driven out and carried to the compressors together. Here the salable vapors are condensed in the presence of the very volatile vapors under pressure, so that all the salable liquid must be saturated with wild vapors at the temperature and pressure used.

A third explanation for the better quality is found in the method of absorption itself. We have already mentioned selective absorption, which gives clear-cut fractionation controlled by the operator. The wild vapors are practically all re-evaporated into the gas within the absorber itself, thus preventing their presence in the steam-distilled vapors and condensate later on.

Experience has shown that the product from charcoal absorption plants has 3 lb. less vapor tension and 10 deg. less gravity than gasoline made by an oil absorption plant operating on the same gas.

Referring to Fig. 6, we see the results of applying the standard Bureau of Mines distillation test to the gaso-

line produced by the different methods. The initial boiling point of both compression and oil absorption gasoline is from 5 to 10 deg. below the initial boiling point of the charcoal gasoline. The final boiling points and the residue are practically the same. The curves of these distillations show that the big gain in yield is in the recovery of that product boiling between 30 and 70 deg. C., or within the range of the pentanes and hexanes. About 73 per cent of the charcoal absorption gasoline is within this class. Approximately 33 per cent of the compression and 38 per cent of the oil absorption are condensed between these temperatures.

The same series of tests showed that 93 per cent of the charcoal absorption gasoline is recondensed after

TABLE II. WEATHERING TESTS

I—First Pair. Air Temperature 65 Deg. F.								
Time in hours.....	0	1	2	4	5	18	22	
Oil absorption.....	1,000	995	970	950	940	856	850	
Charcoal absorption.....	1,000	1,000	998	993	990	930	925	
II—Second Pair. Air Temperature 65 Deg. F.								
Time in hours.....	0	1	2	4	5	18	22	
Oil absorption.....	1,000	994	968	950	938	854	847	
Charcoal absorption.....	1,000	1,000	998	994	990	930	927	
III—Third Pair. Air Temperature 80 Deg. F.								
Time in hours.....	0	2	3	4	5	9	22	25
Oil absorption.....	1,000	965	945	935	922	890	830	828
Charcoal absorption...	1,000	995	988	982	977	960	900	898

the standard Bureau of Mines distillation and approximately 66 per cent of the oil absorption and 63 per cent of the compression material were recovered. None of these samples had been blended before they were tested. The oil absorption sample had been made under a final pressure of 90 lb.

Fig. 7 is a curve showing the application of the Bureau of Mines distillation test to three different fractions of charcoal absorption gasoline. This brings out the fact that the fractionation was very sharp and even the first cut was quite staple.

The weathering losses of gasoline made by the charcoal process are very light. Table II shows three pairs of weathering tests, comparing samples of gasoline taken directly from the blender of a charcoal plant and

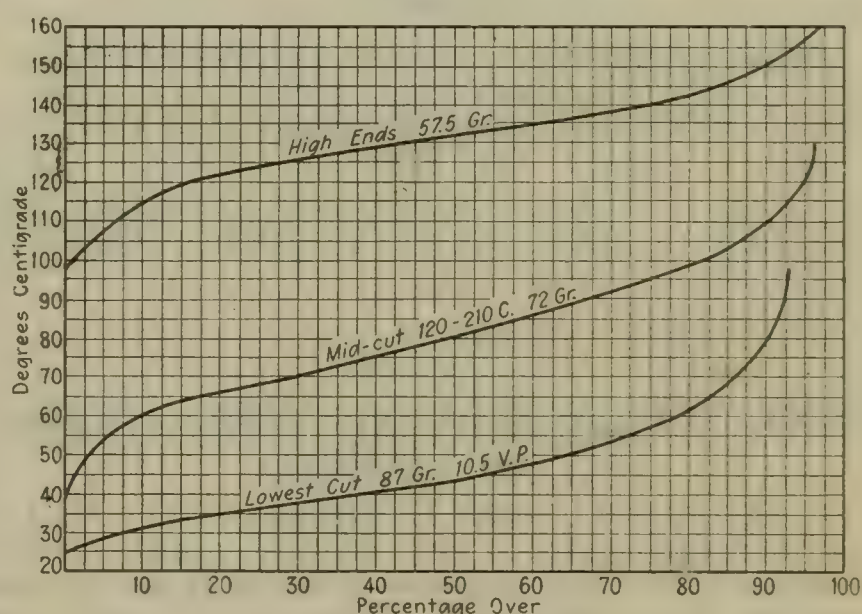


FIG. 7. CHARCOAL ABSORPTION GASOLINE CUTS

gasoline taken from the storage tanks of an oil absorption plant, where it has been allowed to weather under about 3 lb. pressure for more than two weeks. All samples were blended with 12½ per cent naphtha 56 deg. Bé. Each pair was kept under the same atmospheric and temperature conditions.

After what has been said about quality, the reader

may infer that the yield is being sacrificed. Such is not the case. A direct comparison between an oil plant and a charcoal plant operating on very lean gas showed that the oil plant averaged around 125 gal. per million cu.ft. of gas and had a weathering loss of 20 to 30 gal. before shipment. The charcoal plant produced an average of 203 gal. of high quality gasoline from this same gas on the same days. The reasons for this wide variation between the two plants are numerous. The problem of bringing every particle of gas into intimate contact with oil capable of absorbing the commercial vapors has always been difficult. Many kinds of baffles and sprays have been tried with varying degrees of success. With an absorber packed with from 8- to 14-mesh charcoal there is no difficulty in getting proper contact for complete extraction.

The absorption of the vapors by a solid medium is governed by conditions entirely different from those governing the absorption by a liquid which depends on reduction of molecular area of the dissolved vapor. It is the capillaries of the charcoal which alter the vapor tension of the absorbed paraffine and make the absorption possible. The degree to which the capillaries are deepened and oxidized free from interfering compounds determines the absorptive capacity of any particular charcoal. However, difference in grades of carbon or any other substance which might be used for the framework of these capillaries is an important factor which must not be overlooked when studying the conditions governing the absorption of gasoline.

The absorption process is actually a modification of the compression process, which consists of concentrating the recoverable vapors before applying the compression. But by the compression method it is possible to condense only a certain part of each fraction included in the gas. This part is determined by the number of fractions present, by the percentage of the different fractions present and by the temperature and pressure employed. It is only a specific application of the partial pressure laws. The addition of air or any gas not condensable at the working pressures means loss in efficiency.

PLANT

Suitable apparatus to practice the charcoal absorption process will include three essential units—viz., a power unit consisting of a boiler equipped with a superheater, an absorber unit consisting of at least three absorbers or charcoal containers, and a condenser unit consisting of cooling coils and a separation and blending tank.

Gasoline Recovery Corp.,
New York City.

Bureau of Standards Has New Standard Samples of Steel and Bronze

A new standard sample of electric steel No. 51, 1.2 per cent carbon, and a new standard sample of cast bronze No. 52 (approximate composition, copper 88 per cent, tin 8 per cent, zinc 2 per cent, lead 1.5 per cent, antimony 0.15 per cent, iron 0.10 per cent and nickel 0.10 per cent) have recently been prepared by the Bureau of Standards and are now ready for distribution with provisional certificates.

Standard sample No. 23a, a renewal of the exhausted sample No. 23, bessemer steel, 0.8 carbon, has also been prepared and is now ready for distribution with a provisional certificate.

The Conversion of Sawdust Into Cattle Feed

BY E. C. SHERRARD*

RECENT investigations carried out at the Forest Products Laboratory indicate that the sawdust of coniferous woods can be converted into a wholesome cattle feed.

The process for preparing such cattle feed depends upon the conversion of part of the wood into sugar by cooking it for about fifteen minutes with a dilute acid under 120 lb. pressure. In this treatment about 20 per cent of the wood is converted into sugar and the remainder rendered more digestible. The sugars are then extracted from the digested dust with hot water, the acid is removed from the resulting solution by neutralization, and the liquor is evaporated under reduced pressure to a thick sirup. The concentrated sugar solution thus obtained is then mixed with the residue left after cooking and the whole is dried to less than 15 per cent moisture content. The finished material is darker than the original sawdust, is very brittle, and contains a larger proportion of fine dust.

FAVORABLE RESULTS AT PRELIMINARY FEEDING TRIAL

A preliminary feeding trial, using a product prepared in this way from Eastern white pine, was conducted by the Wisconsin College of Agriculture with favorable results. Three cows were fed by the reversal method for three periods of four weeks each. In the first and third periods they were given an excellent ration, consisting of alfalfa hay, corn silage and a concentrate mixture of 55 parts of ground barley, 30 parts of wheat bran and 15 parts of linseed meal. In the second period hydrolized sawdust was substituted for part of the barley, 2 lb. of sawdust being fed in place of each pound of barley, as it was not expected that hydrolized sawdust would have as high a feeding value, pound for pound, as barley. The mixture used during the second period contained about 26 per cent of hydrolized sawdust. At no time was any difficulty experienced in getting the cows to clean up this concentrate mixture. The cows maintained their production of milk in the second period as well as in the first and third and showed an appreciable increase in butter fat production. A decided increase in weight was noted during the period in which they were fed the treated sawdust.

NO DEFINITE CONCLUSION YET

While no definite conclusions can be reached from this brief trial, the results do show that cattle may be fed a limited amount of hydrolized sawdust with beneficial results. It should be pointed out that hydrolized sawdust contains only a negligible amount of protein and that it must necessarily be fed in conjunction with other nitrogen-containing materials. In both rations used in this trial plenty of protein was furnished by the other feeds used.

We wish to emphasize the fact that these experiments are preliminary and that as yet the laboratory is not in position to advise as to the commercial application of the process. Further trials will be carried out to furnish additional data on the feeding value and methods of preparation.

Madison, Wis.

*Chemist in Forest Products, Forest Service, U. S. Department of Agriculture.

Steel Castings of High Strength and Toughness—II

A Chapter From a Forthcoming Book Giving Data on the Improvement to Be Expected After Properly Heat-Treating Steel Castings, With Illustrative Tests on Strong, Tough Castings Which Have Replaced Forgings on Gun Mounts

BY FEDERICO GIOLITTI

Bessemer Medalist

IT WOULD be easy to record a great number of other examples similar to the ones mentioned in the first part of this chapter¹ and illustrates still better the results which may be obtained on steel castings by means of rational normalizing.

Those steel castings already described in an earlier portion of the book would be especially interesting. In these the correct selection of the steel's composition, the special precautions taken during the melting and pouring operations, and the rational application of homogeneity and final heat-treatments would procure articles whose metal would possess physical properties fully comparable to those of the best forged and treated steels.

This is especially interesting in showing how suitably manufactured castings, subjected to a rational heat-treatment, may be substituted in many cases and with great advantage—especially as far as rapidity of manufacture is concerned—for pieces of steel which formerly were necessarily forged and heat-treated. Forged pieces naturally require very tedious and expensive machining operations, in order to be brought to the final form, which in good casting practice is almost entirely obtained by the molding.

Even before 1915 a great deal of study was given to the fabrication and heat-treatment of high strength special steel castings at the steel works of Gio. Ansaldo & Co., obtaining results so satisfactory as to permit castings being used for a great number of gun-carriage

and gunmount parts and of machine parts which had heretofore been fabricated exclusively by tedious machining from heat-treated forgings. The use of these special castings allowed that firm largely to increase its production, and the practice has therefore been greatly extended. Experience with several thousand gun carriages under the severe and exacting use demanded during three years of the great war has fully confirmed the practical advantage and the reliability inherent in the substitution of heat-treated special steel

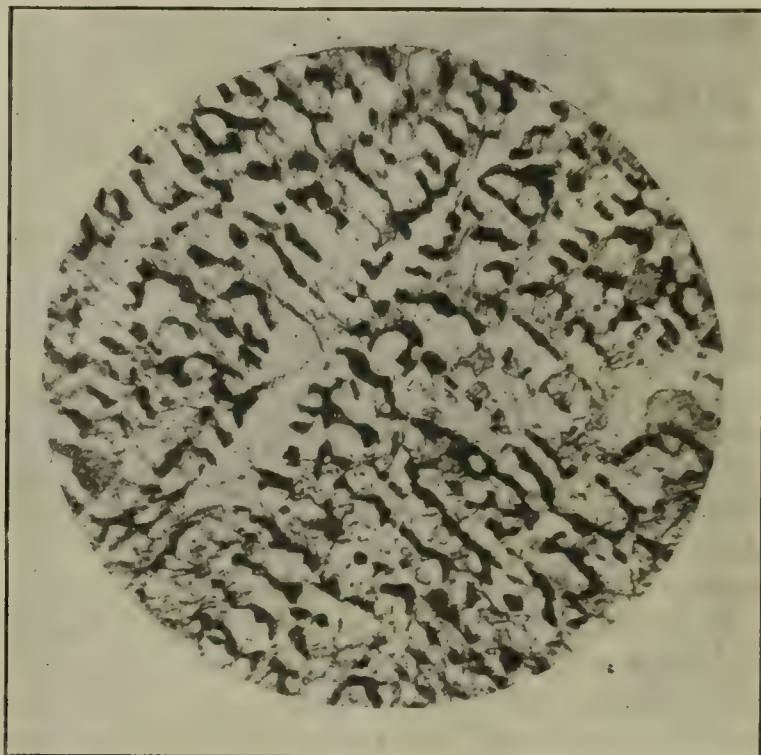


FIG. 24. MICROSTRUCTURE OF UNTREATED NICKEL STEEL CASTING. $\times 80$

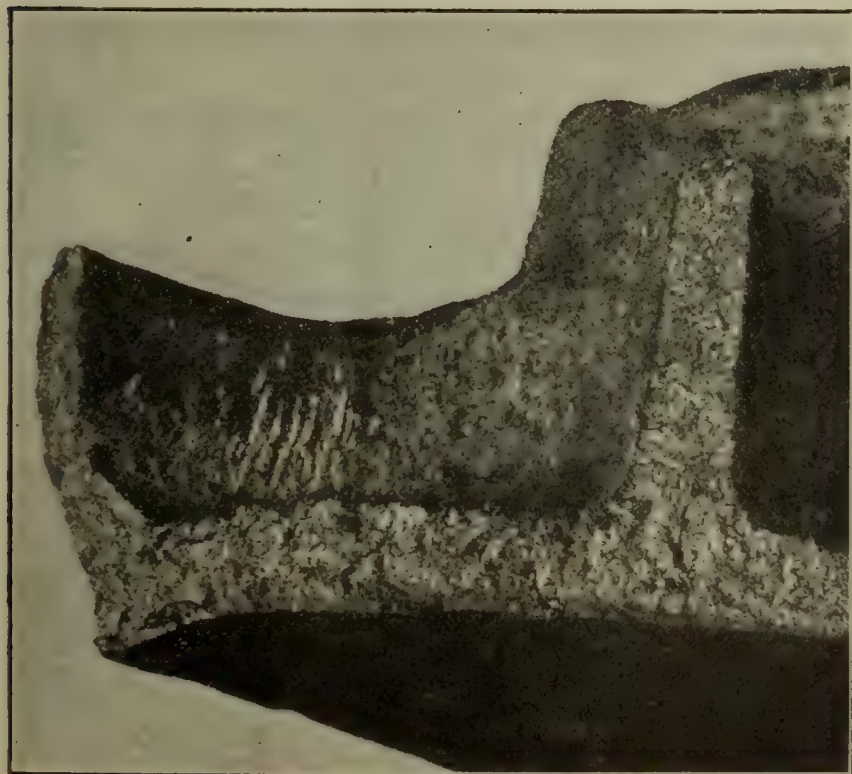


FIG. 23. FRACTURE OF UNTREATED NICKEL STEEL CASTING

castings for steel forgings. This substitution can fortunately be done in a great number of cases where the intensity and nature of the forces to which the mechanical parts must be subjected in service were such as to establish the conviction, held even by the Ansaldo company until a comparatively short time ago, that such substitution was practically impossible.

It is from among these very cases that the following examples will be selected.

CHARACTERISTICS OF MEDIUM HARD NICKEL STEELS

The steels used in the Ansaldo works for the manufacture of such castings are made in the acid open hearth, and the practice has been studied essentially with the end in view of obtaining perfect "deoxidation" of the metal, and the highest possible elimination of "emulsified" non-metallic inclusions which possess an oxidizing power upon the mass of the steel. Another characteristic of the steels in question, due in part to the specific action of the titanium and vanadium used

¹For Part I see CHEM. & MET. ENG., vol. 24, No. 3, Jan. 19, 1921, p. 113.



FIG. 25. TESTS ON ANNEALED NICKEL STEEL CASTING

in their manufacture, is the great "frequency" of the centers of alpha crystallization which form in austenite during allotropic transformation. The great practical importance of this fact has already been set forth by numerous examples, illustrating how the potency and reliability of the heat-treatments are affected.

The steels we are now concerned with belong to the group of the medium hard nickel steels. They are quite brittle when cast and tested prior to any heat-treatment—in fact, averaging the following physical properties:

Tensile strength.....	71,100 to 76,800
Elastic limit.....	54,000 to 61,200
Elongation, per cent.....	3 to 5
Reduction of area, per cent.....	2 to 4
Charpy impact test, kg.-m. per sq.cm.....	1 to 2

A flexure test-piece breaks before even slight bending. The coarsely crystalline structure, typical of these steels as cast, appears still better developed upon the fractured surfaces obtained by bending untreated castings of medium or large dimensions in a press. A typical example of such structures is reproduced in Fig. 23. Fig. 24 shows the normal microstructure of these cast steels before any heat-treatment.

Even simple reheating followed by slow cooling remarkably improves the properties of these steels. Thus, annealing for about three hours at 850 deg. C. imparts variable physical properties within the follow-

ing limits depending upon the composition of the steel and the dimensions of the castings:

Tensile strength.....	71,100 to 78,200
Elastic limit.....	54,000 to 61,200
Elongation, per cent.....	15 to 22
Reduction of area, per cent.....	25 to 35
Impact tensile strength, kg.-m.....	80 to 110
Impact elongation, per cent.....	18 to 27
Transverse impact (Charpy test), kg.-m. per sq.cm.....	4 to 6

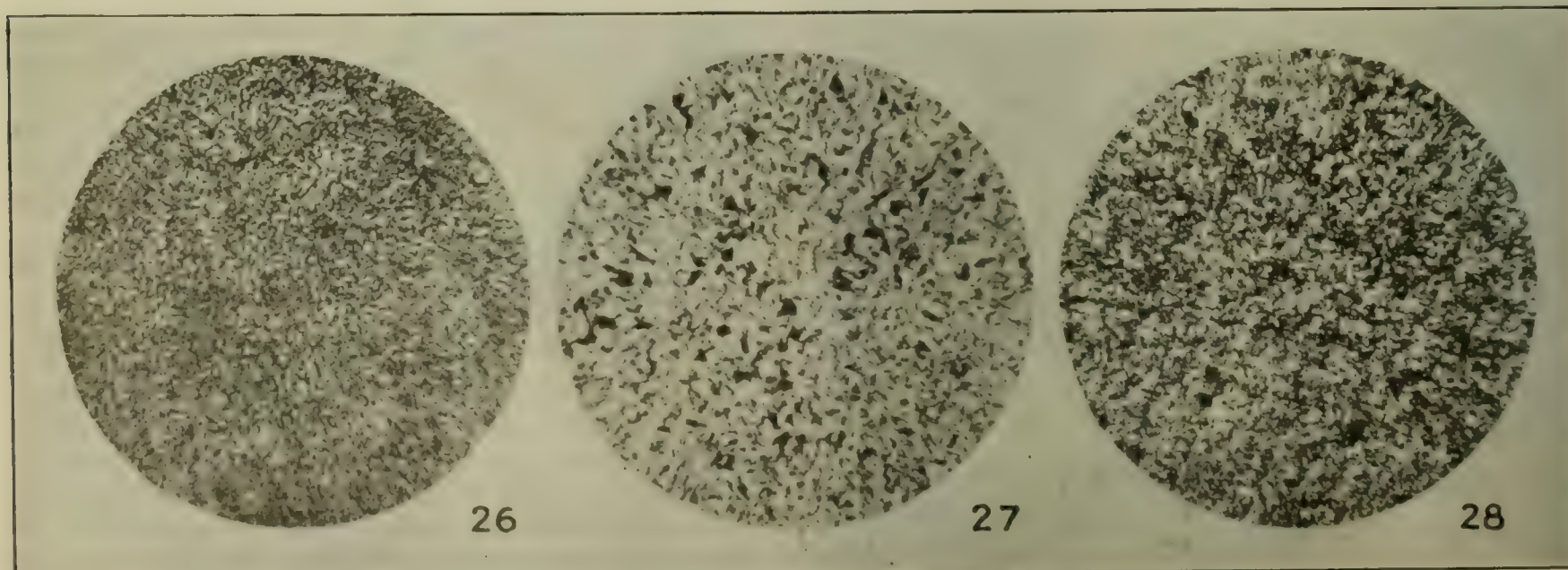
A beam subjected to gradual loading usually breaks at an angle of about 90 to 110 deg., as shown in Fig. 25, which also reproduces the appearance of the other fractures. The broken surfaces still show evident traces of the dendrites. Microstructure of the annealed steel is generally as shown (enlargement 60 diameters).

Mild homogeneity heat-treatments such as those studied in the previous chapters modify the structure, which we have often noted as that normal for hypoeutectoid steels of medium carbon content. For instance, annealing followed by rapid cooling in air causes a microstructure of the type reproduced in Fig. 26. A



FIG. 29. FRACTURE OF HEAT-TREATED SPECIAL STEEL CASTING

drawing operation following such an air quenching will give rise to the structure reproduced in Fig. 27. The slight ferrite segregation is entirely normal. As a comparison, Fig. 28 at the same magnification repro-



FIGS. 26 TO 28

Fig. 26. Annealed, air-quenched

Fig. 27. Same as Fig. 26, then drawn

Fig. 28. Air-quenched after forging



FIG. 30. YOKE BEFORE TESTING

duces the structure of the same steel as the one shown in Fig. 27, when quenched in air *after forging*. Evidently the difference between the two microstructures is not remarkable.

APPLICATION OF MULTIPLE HEAT-TREATMENTS

We have previously noted the reasons why a *simple* homogeneity heat-treatment consisting of a single annealing or quenching, even if followed by drawing, does not give results so good as those which can be obtained by more complex treatments. Without going over arguments already discussed at sufficient length, I will only recall that this depends upon the fact that the conditions under which the various phases of a complex treatment take place may be so selected that each of them may develop one of the desired characters up to a certain point without introducing dangerous defects which may eventually accompany the development of that desired property to its maximum. In general such a criterion may be applied only under condition that the successive phases of a complex treatment may be conducted in such a way as to eliminate, or at least sufficiently attenuate, such dangerous effects as may take place in the previous phase.

We have seen numerous examples. Here it is sufficient to remember that even though a preliminary annealing or quenching attended by a very prolonged reheating at a high temperature may give special steels of the type now under consideration a very remarkable homogeneity of chemical composition in the austenitic state, yet on the other hand such practice favors grain growth. Then if the metal has to undergo a slow cooling in the



FIG. 31. YOKE IMMEDIATELY AFTER FRACTURE

successive phases of the treatment, it may easily show Widmanstätten structure, more or less well developed. This case is only another example added to those we have already seen, that the advantages of great uniformity in concentration obtained by means of very energetic homogeneity annealings or quenchings cannot be conveniently exploited in industry, except under condition that further phases of the treatment may eliminate the serious injury which always accompanies the above-mentioned advantages in larger or smaller measure.

It has already been pointed out that in practice the steel may be restored by means of hot work and also by means of certain heat-treatments, consisting essentially of quenchings from relatively low temperatures—such as from within the transformation interval—properly conducted in such a way as to graduate their intensity.

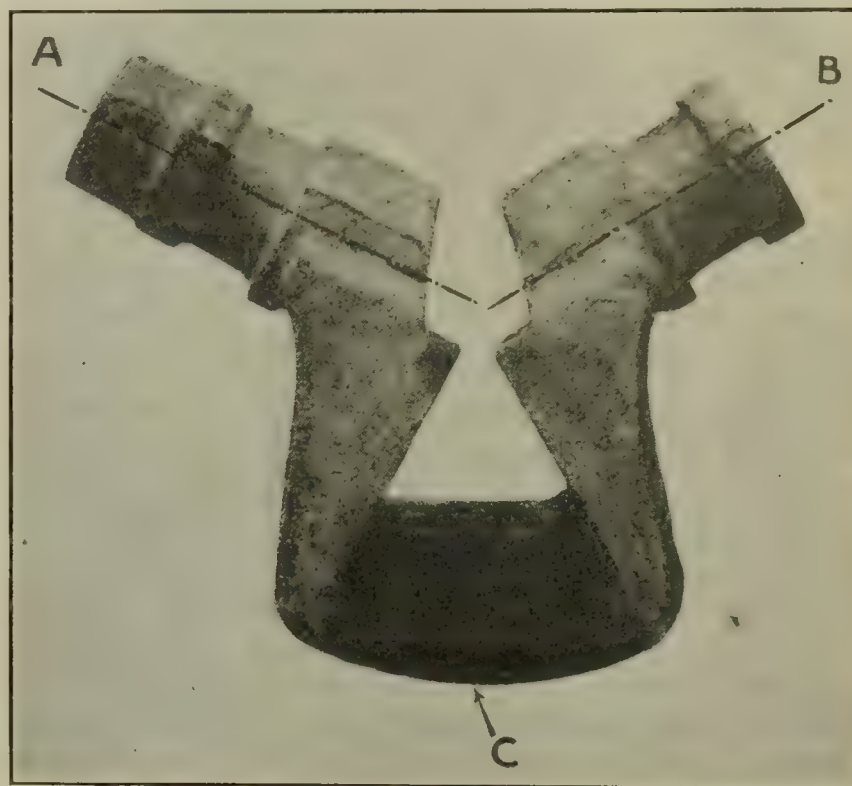


FIG. 32. TRUNNION AFTER BENDING

In these very cases mild quenching as in air, lead, hot oil, boiling water, etc., present the highest practical interest. They permit one to adjust the quenching effect at any desired intensity in the series, starting from the energetic quenchings and ending with quenchings so prolonged as to be comparable to actual annealings. It has already been noted that the special steels lend themselves most favorably to the application of these processes. A correct selection of chemical composition permits a large variation in several different properties: the normal location of $\gamma \rightarrow \alpha$ transformation temperatures, the metastable lowering of these limits, the extreme temperatures of said interval, and, finally, the amount of thermal hysteresis.

Selection of steels possessing strong thermal hysteresis, relatively low transformation points and closely packed centers of ferrite crystallization obviates the necessity of sudden quenchings to preserve the homogeneity obtained at the high temperatures reached in one or more of the phases of the heat-treatment. The main practical consequence of this fact is that the complex heat-treatments may be efficaciously applied to castings of large dimensions and intricate form as well as to simple thin pieces, imparting uniform physical properties to all their parts, even those of varying thickness. Moreover, the application of the desired

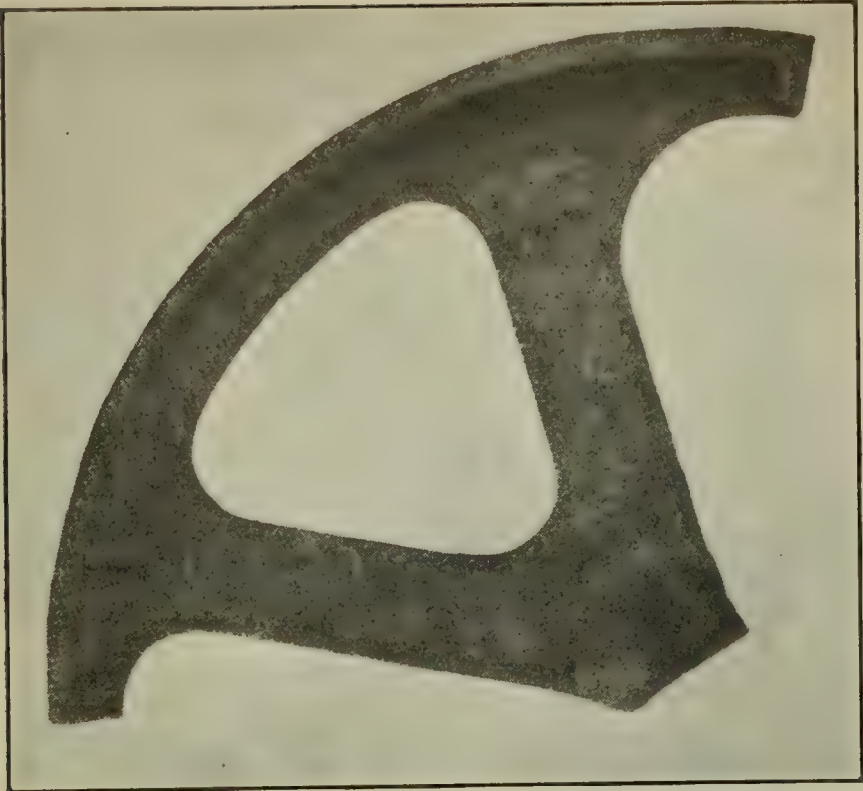


FIG. 33. ORIGINAL CONDITION OF SECTOR

heat-treatments is safer because the elimination of quenching avoids the formation of chance quenching cracks. In the great majority of cases the velocities of cooling obtainable with simple air-chilling is sufficient.

EXCEPTIONAL PHYSICAL PROPERTIES OBTAINED

The physical properties which may be obtained by applying the more complete heat-treatments to the cast special steels under discussion range within the limits given below, according to the composition of the metal and to the dimensions of the castings treated. Bending tests under gradual load always reach the maximum deformation into a "U" without showing any crack. If bent flat upon itself it will develop a perfectly localized break.

All fractures have a finely fibrous structure. An illustrative casting when broken by bending under a press presents uniform fibrous fractures from which every trace of crystalline structure has totally dis-



FIG. 34. SECTOR AFTER TWISTING

appeared. For instance, Fig. 29 clearly shows the characteristic dullness or lack of luster and lacerations proper to the broken surfaces of tough metals.

Tensile strength.....	92,500 to 120,900
Elastic limit.....	56,900 to 106,700
Elongation, per cent.....	15 to 30
Reduction of area, per cent.....	40 to 65
Resistance to impact (Charpy test), kg.-m. per sq.cm.....	9 to 15
Impact tensile strength, kg.-m.....	115 to 145
Impact elongation, per cent.....	25 to 35

Even in harder casting the property of withstanding great deformations when cold before breaking is also

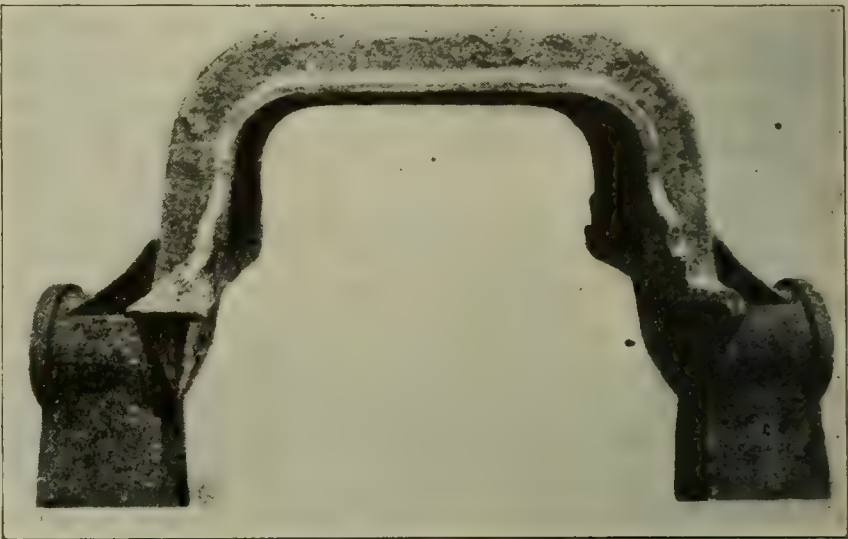


FIG. 35. ORIGINAL CONDITION OF TRUNNION

associated with great toughness, as appears from the above physical properties. I would like to emphasize the fact that the castings which I shall now describe were *all of high tensile strength steel*, in which the tenacity was always above 110,000 lb. per sq.in. and the *elastic limit* above 70,000 lb. per sq in. This remark is of the utmost importance properly to appraise the deformations to be described—deformations which could easily be obtained even after simple annealing with mild steel castings whose elastic limit would not be far

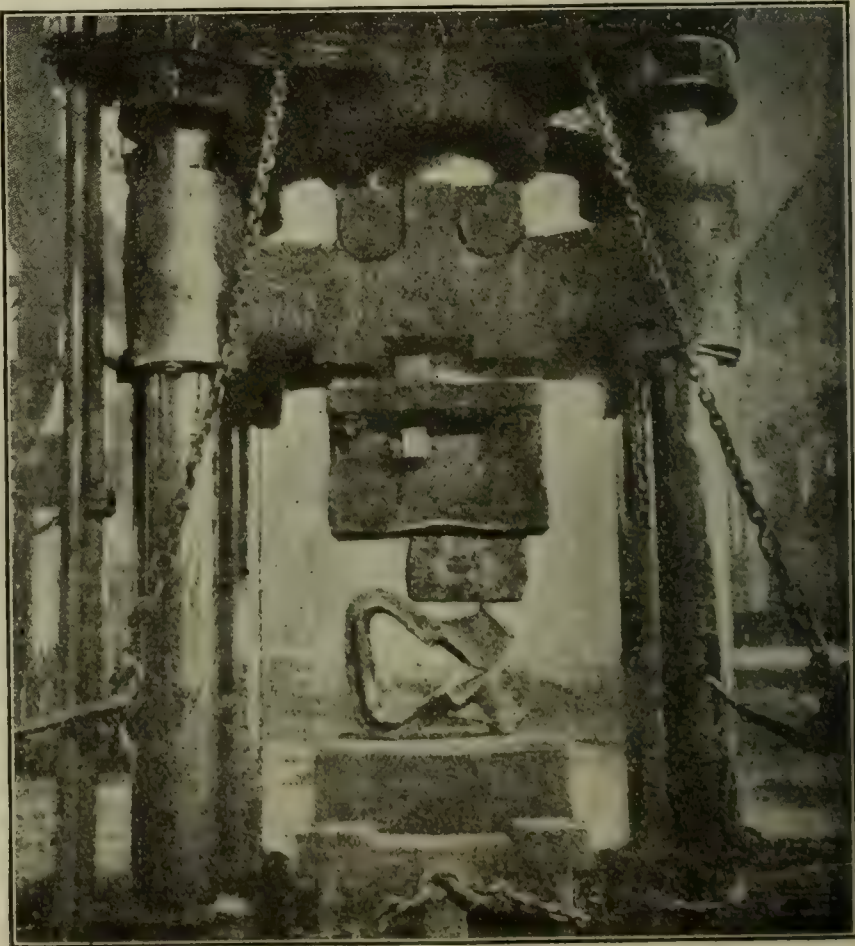


FIG. 36. TRUNNION UNDER TEST



FIG. 37. TURNING FROM A HARD CASTING

from 42,000 to 50,000 lb. per sq.in., but which represent exceptional results for hard, high-strength steels possessing the physical properties comparable only to those which can be obtained with forged and heat-treated steels.

A first example is furnished by the piece shown in Fig. 30. A load of 16½ tons was applied by hydraulic press at the ends of the casting while the central boss rested on a single central support. After bending so that the lugs at the ends were lower than the central support not the least crack was found in the piece. On increasing the pressure the piece broke partly through in the manner shown in Fig. 31. Complete fracture was obtained only when the ends were pressed together in actual contact.

A cast trunnion made of high strength heat-treated steel was deformed by pressing against the two ends so as to squeeze them together in the way indicated in Fig. 32. Line AB was originally straight. During this test high external ribs on the under side at C did not develop the least crack, although they were badly stretched.

The sector illustrated in Fig. 33 was placed in a press so that the two points of the arch were squeezed together until it was deformed as shown in Fig. 34. The metal's exceptional toughness in spite of its hardness is demonstrated especially by the absence of fractures even at places where large difference of thickness occur, and where the lines of deformation "accumulated."

Finally, another large trunnion of the same kind of steel and manufactured in the same way is illustrated in Fig. 35 as it appears before cutting the two risers. It was also loaded by a hydraulic press so as to push the ends toward each other. Having reached a condition where the risers were in contact, they were sawed off and the trunnion again placed under the press, as shown in Fig. 36. Localizing the pressure upon the trunnions by means of a block of steel, placed between the hammer and the upper trunnion as shown in the figure, the bending was continued to the point shown without causing the smallest crack in the piece.

In closing these observations regarding castings of heat-treated special steel, it may be mentioned that even during machining such castings present characters of toughness and plasticity which equal and even exceed

those of very mild steel castings or those of the best forged and heat-treated steels. As an example apt to illustrate this fact, I reproduce in Fig. 37 at about one-sixth natural size the appearance of a turning cut from one of the hard castings in question. The figure needs no comment.

Wood-Preserving Industry in 1919

The following statistics on the wood-preserving industry during 1919 are given in a recent Forest Service bulletin issued by the Department of Agriculture:

In 1919 there were 65,556,247 gal. of creosote, 2,412,592 gal. of paving oil, 102,011 gal. of miscellaneous preservatives used in the United States, in addition to 43,483,000 lb. of zinc chloride, the largest quantity of this preservative ever reported by the industry. Of the creosote, 6,493,000 gal. was imported.

Prior to 1917 the plants of this country depended upon foreign manufacturers for approximately 50 per cent of the cresote consumed. Most of this oil came from Germany and England. During the war, however, this supply was cut off, and the plants looked to domestic producers for their supply. Nearly all of the importations in 1919 were from England and Canada.

The material treated consisted of cross-ties, poles, wood blocks, crossarms, construction timbers and miscellaneous material, largely for railroads, mines and telegraph and telephone companies. The total amount of wood subjected to preservative treatment by the 108 plants that were active during 1919 was 139,878,584 cu.ft., or 17,265,694 more than the previous year. About 80 per cent of this wood consisted of railroad cross-ties.

Comparison of Five Different Types of Glue*

For the convenience of those who use glue in wood-working, the Forest Products Laboratory has prepared the following tabular summary of the chief characteristics of five types of glue:

Particular Compared	Animal Glue	Casein Glue	Vegetable Glue	Blood Glue	Liquid Glue
Source	Hides, bones, horns, etc.	Casein from milk	Cassava starch	Dried blood	Animal glue or fish parts
Cost per Lb. 1920	25-42 cents	16-20 cents	10-12 cents	20 cents	\$1-\$5 per gal.
Spread in sq.ft. per lb.	25-35	35-55	35-50	30-100	No data
How mixed	Soaked in water and melted	Mixed cold with rapid stirring	Mixed with alkali and cold or hot water	Mixed cold	No preparation
How applied	Warm with brush or mechanical spreader	Cold with brush or mechanical spreader	Cold with mechanical spreader, not by hand	Cold with brush or mechanical spreader	Cold or warm usually applied by hand
Temperature of press	Cold or with hot cauls	Cold	Cold	Hot	Cold
Strength (in shear test)	High grades stronger than strongest woods	Equal to medium grade animal glue	Equal to medium grade animal glue	High strength in plywood Not used for joint work	Best grades equal to medium grade animal glue
Water resistance	Low	High	Low	High	Low
Chief uses in wood-working	For strong joint work	For water resistant plywood or joint work	For veneer work because of cheapness	For water resistant veneers	For repair work and small articles

* From Technical Notes, Forest Products Laboratory.

Abnormal Behavior of a Weston Standard Cell

BY M. G. MELLON

EXPERIMENTAL work has shown that the Weston standard cell furnishes, in general, a very accurate and satisfactory standard of electromotive force, in having a ready reproducibility, a small temperature coefficient and an electromotive force whose value is suitable for most requirements. Generally these cells are very constant, Hulett and Lipscomb¹ having reported recently the use of certain Weston cells over a period of twelve years. Also most of these cells do not show the disturbing phenomenon of hysteresis. Occasionally however, there is encountered a cell which has not maintained the desired constancy, or one which does not show the expected change of electromotive force with corresponding change of temperature—that is, it exhibits hysteresis.

VARIATIONS SHOWN BY ONE CELL

In some recent work a Weston cell was found to have an abnormally low electromotive force, and to show hysteresis. These variations from the expected results are not new observations. The object of the present note is merely to call attention to them again, because of the belief that some, using such standards, may be inclined to put equal dependence upon the reliability of all Weston standard cells, especially since some reputable dealers advertise that these cells' "accuracy and trustworthiness are beyond question, and with careful handling will remain so for many years."

The Weston cell mentioned was of the unsaturated type and was purchased from the Weston Electrical Instrument Co. in 1917. It was certified at the Weston Laboratory on May 1, 1917, as having an electromotive force of 1.01850 international volts at 25 deg. C., and a temperature coefficient of less than 0.00001 volt per degree C.

CONDITIONS UNDER WHICH TESTS WERE MADE

This cell had been used very little, and never as a working standard, its actual use being a reference cell with which to compare other Weston cells employed through a long series of measurements. In 1917 only a few such comparisons were made, and at that time this cell showed its certified value. No more measurements were made with it until about March, 1919. In the meantime it had been kept in a good apparatus case at the ordinary temperature of the chemical laboratory, and had been subjected to no misuse. At the time of the comparisons in 1919, it no longer agreed with two other closely agreeing, although considerably older, similar Weston cells. Different results were obtained on different days, at approximately the same temperatures; and the values were always at least one millivolt below the certified value.

Accordingly, the cell was sent to the Bureau of Standards for an official test, and the following report was issued for it:

TEST OF UNSATURATED WESTON STANDARD CELL 3,539

The cell was maintained throughout the period of observation within a well insulated box to protect it from abrupt changes in room temperature. The electromotive force in international volts is given by adding the difference in hundred-thousandths of a volt,

tabulated below, to 1.01830 volts, the value adopted by international agreement for the Weston normal cell at 20 deg. C.

DIFFERENCES, HUNDRED-THOUSANDTHS OF A VOLT, FROM 1.01830

Date	International Volts Temperature Deg. C.	Differences	E.M.F.*
April 11	25.0	—116	1.01714
April 12	24.8	—111	1.01719
April 14	23.9	—102	1.01728
April 15	24.5	—123	1.01707
April 16	24.5	—122	1.01708
April 17	24.8	—126	1.01704
April 18	24.4	—117	1.01713
April 21	23.9	—121	1.01709
April 22	24.0	—112	1.01718

*This column was calculated and was not included in the original report.

Because of the abnormal value and of the large amount of hysteresis exhibited with relatively small (and necessarily slow) changes in temperature, we cannot issue our usual certificate certifying this cell to an accuracy of 0.01 per cent.

A marked contrast with the above results was observed in the case of a second, similar cell. This one, purchased in 1915, and certified Oct. 15, 1915, as having an electromotive force of 1.01865 volts at 25 deg., was used at the working standard through three extended series of measurements, the first in 1916, the second in 1917 and the third in 1919. During the last series the cell's electromotive force was practically the same as when first certified.

CONCLUSIONS

The phenomenon of hysteresis described above is not a recent observation in connection with Weston cells, as shown by the work of Dearlove,² Barnes,³ Barnes and Lucas,⁴ and Wolff.⁵ One of the main points to be kept in mind seems to be the uncertainty of knowing which cells may be expected to show such results. After measuring about two hundred cells, Wolff states, as part of his conclusions,

1. That Weston cells can be set up which exhibit extremely little hysteresis in the range 0 to 40, even when subjected to large and rapid temperature variations.

2. That some of the cells showed marked and persistent hysteresis, particularly at lower temperatures.

3. That a similar behavior was found in most of the cells having abnormal values at room temperatures.

The conclusions to be drawn from this note are:

1. The necessity of keeping in mind the fact that all Weston cells do not remain constant over an indefinite time, even though used very little.

2. The advisability of standardizing carefully any Weston cell before employing it for accurate measurements.

3. The probability of obtaining uncertain results using any cell showing such a marked hysteresis, unless its temperature is maintained rigidly constant, as in a carefully regulated thermostat.

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Shipments of German Potash

According to figures furnished by the German Potash Syndicate, the sales of potash salts in 1919 reached a total of 4,159,227 metric tons with 812,002 tons of potash. In 1918 the sales amounted to 4,840,934 tons of potash salts with 1,001,664 tons of potash.

²Dearlove, *Electrician*, vol. 31, p. 645 (1893).

³Barnes, *J. Phys. Chem.*, vol. 4, p. 339 (1900).

⁴Barnes and Lucas, *Ibid.*, vol. 8, p. 196 (1904).

⁵Wolff, *Trans. Am. Electrochem. Soc.*, vol. 13 p. 187 (1908).

The Rise and Development of the Electrolytic Alkali and Chlorine Industry in Europe—III

An Outline of the Electrolytic Cells Employed in the Electrolytic Alkali and Chlorine Industry of the United Kingdom, Germany, Austria, France, Italy, Switzerland, Russia and Belgium*

BY JOHN B. C. KERSHAW

Electrolytic Alkali and Chlorine Industry in France

THE war caused a great increase in the number and capacity of the works for the decomposition of brine by electrolysis in France, since the necessity for producing liquid chlorine on a large scale for the use of the army authorities compelled the extension of many existing electrolytic plants and the erection of some new ones.

According to reliable figures published last year in *La Revue des Produits Chimiques* there were nine works producing liquid chlorine by the electrolytic method in France in 1917, and the aggregate capacity of these plants was 73 tons of gas (or the equivalent of 125 tons of salt decomposed) per twenty-four hours. Only two works were engaged in the electrolytic alkali and chlorine industry in 1914, and this rapid expansion was rendered possible only by the large number of electrochemical and electrometallurgical works which had been established in the Rhone Valley and in the Haute Savoie and French Alps before the war. The water power of this district of southeastern France had in fact been largely exploited in the period 1890-1910; and luckily for France this district of the country was far removed from the zone of actual hostilities and thus escaped the devastation which laid waste the coal-mining districts of the north. Had the Germans managed to penetrate the Rhone Valley, not many of the hydroelectric plants would have escaped destruction.

The number of different cells and processes utilized in these nine electrolytic works are four—namely, the Griesheim-Elektron at Lomotte-Breuil; the Outhenin-Chalandre at Pomblieres St. Marcel, Jarrie, Paimboeuf and Mansieux; the Solvay mercury cell at Saint-Aubans; and a cell and process patented by the Soc. pour l'Industrie Chimique a Bâle, at Montereau, Pont de Claix, Peage de Rousillon and Plan du Var.

The Griesheim Elektron and Solvay mercury cells have been already described; and it is only necessary to describe here the Outhenin-Chalandre and Bâle cells.

THE OUTHENIN-CHALANDRE CELL

This cell was patented in 1893 by the Soc. Outhenin Chalandre Fils & Cie. of Paris, but it has never been operated in the United Kingdom or America, and its use is confined to France and Switzerland. One-third of the liquid chlorine produced in France during the war period was obtained from this type of cell.

The cell is of the diaphragm type, but differs from those previously described in the fact that the diaphragms are constructed in the form of tubes and are arranged in tiers almost horizontally under the bell-shaped hood, which contains the anodes and serves

to collect the liberated chlorine gas. Fig. 16 shows vertical sections of the cell, which is seen to be quite complicated in design and character. A represents the main conductor attachment for the anodes, and M that for the cathodes.

Flat carbon anodes (*aaa*), extend between the diaphragm tubes, as shown by the dotted lines, into the brine contained in the closed anode chamber of the cell; and the current is led away from the interior of the diaphragm tubes (*ccc*) by projecting lugs of the iron cathode bar M; these lugs (*mmm*) extend along the interior of the tubes and serve as the disengagement surface for the hydrogen gas. The caustic

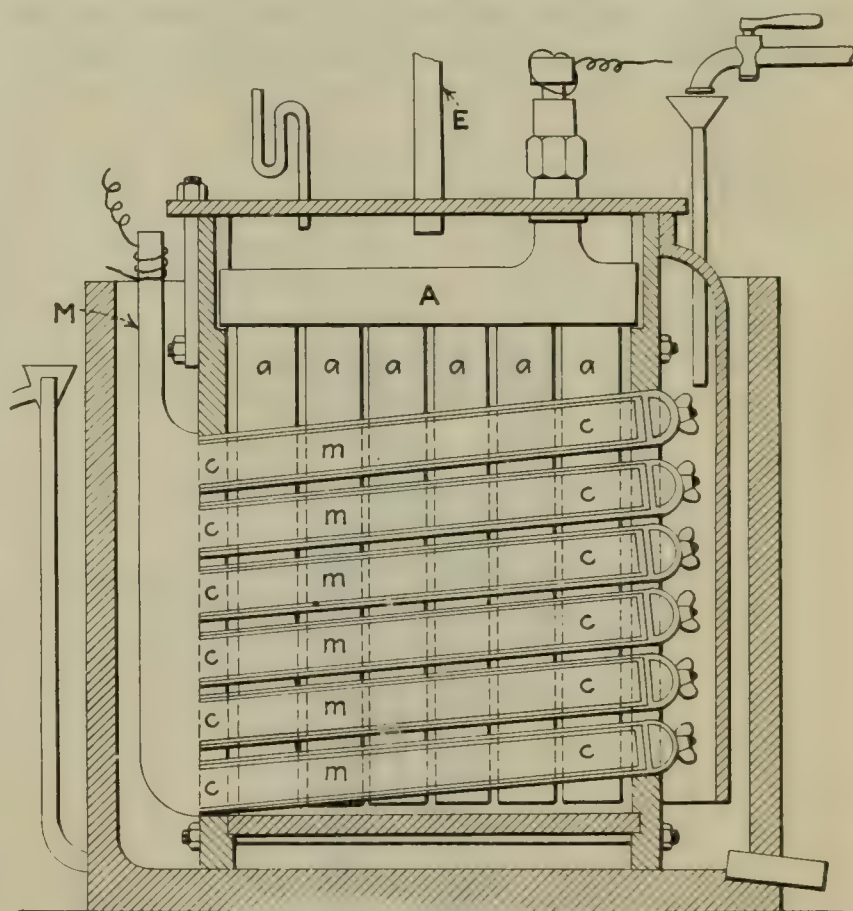


FIG. 16. THE OUTHENIN-CHALANDRE CELL

soda solution which forms on the surface of these cathodes flows by gravity down the interior of the inclined tubes and collects at the bottom of the outer cell, while the chlorine gas is led away from the closed anode chamber or bell by the exit pipe E.

The works at Pomblieres Saint Marcel was started in 1899 by the Société la Volta and was the first operated in France for the electrolytic decomposition of brine. In 1915 it was acquired by the Société d'Electrochimie et d'Electro-Metallurgie of Paris and was greatly extended in order to produce liquid chlorine for war purposes. In 1917 it was producing ten tons of liquid chlorine per day.

The company which now owns this works was origi-

*For Parts I and II see CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, Nos. 2 and 3, pp. 77 and 119.

nally promoted by Gall & Montlaur for the production of electrolytic chlorates at Vallorbes, in Switzerland, with a small water power of 3,000 hp. It has gradually extended its operations until it is now the largest electrochemical and electrometallurgical company in France, controlling over 50,000 kw. of generating plants situated at the following places: St. Michel de Maurienne; St. Avre la Chambre; N. D. de Briançon; Pomblieres St. Marcel; St. Jeoire en Faucigny; Les Clavaux; Pierre Benite; La Barasse; Viellers St. Sepulcre; Vallorbe, and Martigny-Bourg; the last three places in the list being in Switzerland.

THE BASEL TYPE OF CELL

The process and cell of the Soc. pour l'Industrie Chimique a Bâle has been introduced into France during the war, and in 1917 this type of cell was producing nearly one-half of the total output in France (72 tons) of liquid chlorine per day of twenty-four hours. The cell in some respects resembles the Outhenin-Chalandre type of cell, but is rather less complicated in design and is also less costly in upkeep.

This cell is now employed in a large number of electrolytic works in France, Italy and Switzerland, and has been adopted recently by the Soc. Italiana di Elettrochimica of Rome, for its works at Bussi.

The cell is protected by British patent 11,872 of 1913. The following account is based partly on the British patent specifications and partly on a communi-

caustic hydrate formed at the same point and shall carry this hydrate to the surface of the electrolyte and thus remove it from the sphere of secondary chemical and electrolytic reactions.

For this purpose the cathode is placed within a comparatively narrow cathode chamber, constructed of a material permeable to brine, as for example, within a bag having roughly the same form as the cathode and made of a narrow-meshed asbestos fabric. The hydrogen eliminated in this relatively small cathode chamber produces on the surface of the electrolyte a froth consisting of bubbles of hydrogen, the shells of which con-

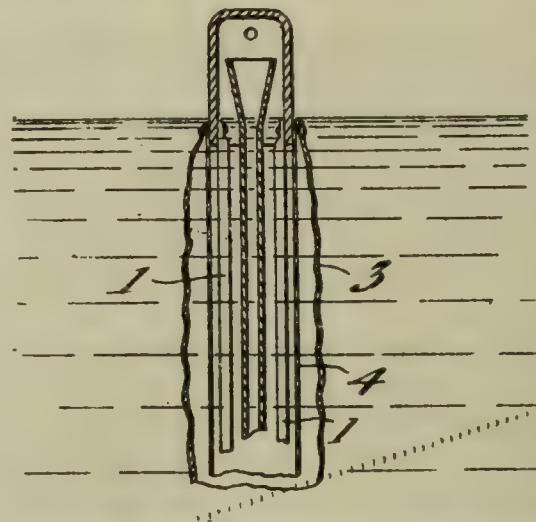


FIG. 18. MODIFIED FORM OF UPPER PART OF BASEL CELL CATHODE

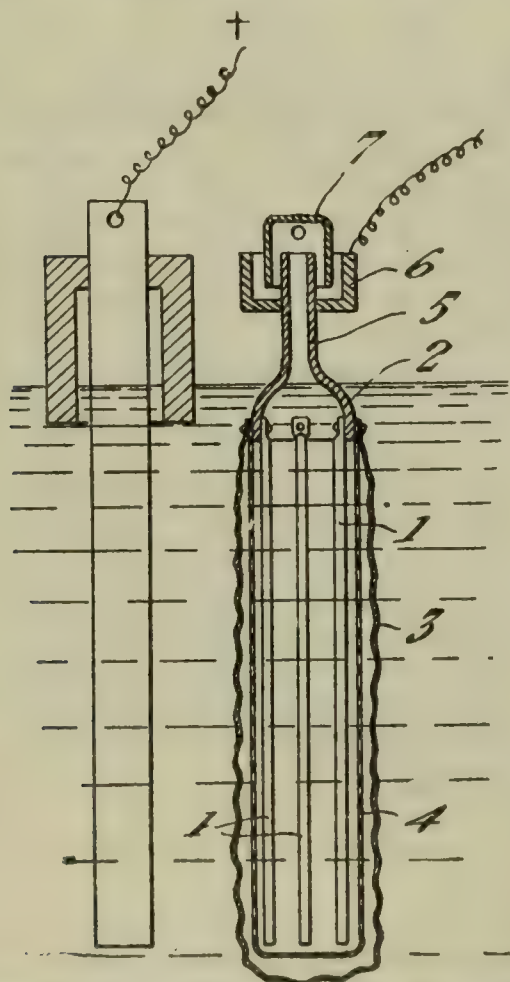


FIG. 17. GENERAL FEATURES OF THE BASEL CELL TUBE FORM OF CATHODE

cation from the Swiss company received recently by the writer. The chief distinctive feature is what its designers and patentees call a "propulsive cathode," which permits the attainment of a high current capacity in cells covering only a small area and produces at the same time a liquor containing a fairly high percentage of alkali.

The principle of this electrode is that the hydrogen gas evolved at its surface shall act as carrier for the

sist of solution of alkali carried up by the gas. In order to conduct away this froth the upper part of the cathode chamber is contracted so that froth rises in this contracted part and flows over into a suitable receiver in which the hydrogen separates from the cathode liquid that has been carried with it. The cathode may be of various forms, for instance, a rod, in which case the cathode chamber is most suitably formed as a tube; or a plate, in which case the cathode chamber has the form of a narrow box.

The portion of the cathode sheath, or bag, immersed in the electrolyte is permeable and is usually made of coarse asbestos cloth. The upper part, which projects above the electrolyte, is impermeable and is contracted into a narrow iron pipe which serves as conductor for the electric current and is coated with an insulating paint.

GENERAL FEATURES OF THE BASEL TYPE OF CELL

Fig. 17 from the patent specification shows the general features of the tube form of cathode in sectional elevation and indicates the method by which the asbestos sheath, or bag, is attached to the metal top (2). The line marked (4) represents a frame of wire-netting which is used to keep the asbestos cloth extended and also may serve as an extension of the cathode surface. The contracted portion or pipe (5) of the upper part (2) is fixed in a receiving gutter (6). This gutter may also act advantageously as a current conductor for a large number of individual cathode cells, since any desired number of such cells can be attached to it. Within the gutter there may be a hood (7) beneath which the hydrogen collects. It will be obvious that there are many ways of conducting away the cathode current and the hydrogen from the cell. For example, the pipe (5) may be curved over, so as to deliver the solution into a receiver arranged on one side; or as another example, the upper part of the cathode cell can

be formed as shown in Fig. 18. In this case, there extends through the cathode chamber a pipe widened at its upper end to form a funnel and the alkali solution flows down through this pipe.

When such a propulsive cathode, together with a carbon anode, is immersed in a solution of brine and an electric current is passed through it, the current operates in the following manner: In the interior, caustic soda and hydrogen are liberated. The latter carries, in rising through the liquid, the caustic soda solution upward. A froth is formed, consisting of hydrogen bubbles contained in shells of solution of alkali; this froth rises in the contracted iron tube (5) very quickly, and flows over at the top in a continual stream into the receiver (7), in which a separation into hydrogen gas and caustic soda solution at once takes place. The rising hydrogen bubbles and the continual

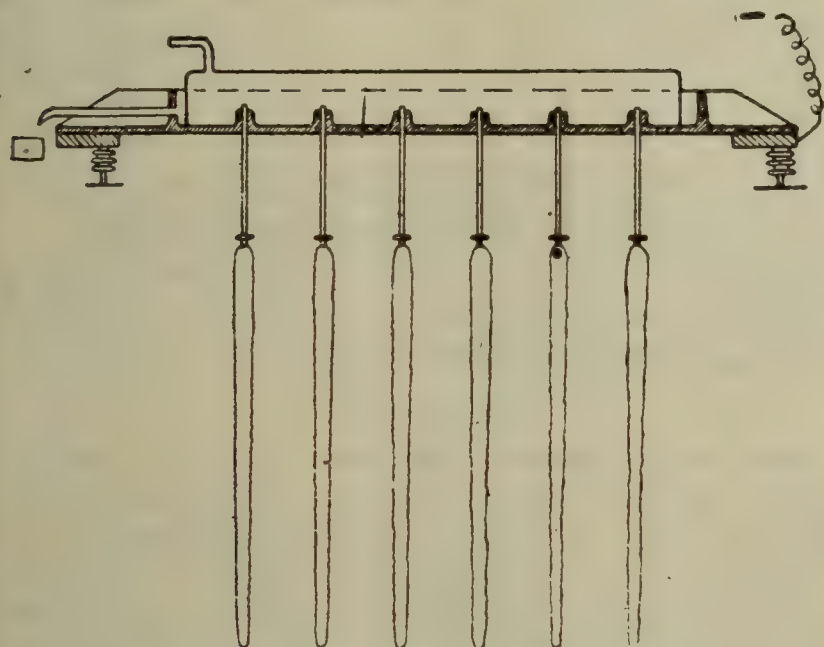


FIG. 19. BASEL CELL CATHODE UNIT

upward streaming of the electrolyzed liquid act on the brine outside with a strong suction, the result being that over the whole surface of the permeable casing of the cathode a continual stream of fresh electrolyte percolates into the interior, forcing the OH ions (which are usually a source of loss) constantly backward in the direction of the cathode. The rate of upward flow of the cathode liquid and the automatic percolation of fresh brine corresponds to the number of amperes with which the cathode is loaded at any moment. This load may fluctuate within fairly wide limits without having any influence on the efficiency of the cathode, and owing to the permeability of the asbestos bag, the voltage drop is low. As a rule only the resistance of the brine comes into account.

The propulsive cathodes are now manufactured on a large scale to a standard size. Any number can be screwed from below into an iron gutter, and one obtains in this manner the larger cathode unit, shown in Fig. 19. This gutter is fitted to a frame which serves as negative current conductor, and the electric current is carried by this gutter to all the cathodes of the cell. The gutter serves also as receiver for the alkali solution overflowing from each cathode tube. It is covered by a collecting hood for the hydrogen separating from the solution. Gutters and hoods are connected with collecting pipes for the alkali solution and the hydrogen respectively.

As a second component part of the Basel type of cell, in connection with the construction of larger electro-

lyzers, a new form of anode unit is being employed. This consists of a long narrow bell made of some non-conducting material, into which a number of carbon anodes are fixed. In order to obtain as small a distance as possible between the cathodes and the anodes, it has been found advantageous to fix to the bell a bag of the same texture as that employed for the cathodes. The bell has, of course, an opening at the top through which the chlorine rising from the anodes enters the collecting pipe line, by which it is conducted away.

Every electrolyzer is made up of a definite number of the anode and cathode units described above, according to the kw. capacity of the cell and yield of caustic soda and chlorine required. The anodes and cathodes are connected in parallel as shown in Fig. 20. The size of cell employed by the patentees in their own works at Basel produces about 190 kilos of chlorine per twenty-four hours, with the equivalent quantities of NaOH and hydrogen. An electrolyzer having this output requires a depth of rather more than 40 in., and a superficial area of 5 ft. by 10 ft. Usually thirty cells of this size are connected in series.

PRODUCT OF THE BASEL CELL

The concentration of the alkali liquor from the Basel cell varies from 11 to 13 per cent NaOH, or 15 to 17 per cent KOH. The liquor contains some undecomposed chloride, but the amount is not specified. The gas liberated at the anodes tests 98 per cent chlorine, and always less than 2 per cent carbon dioxide, with traces of oxygen. The hydrogen is quite free from impurity. The gases are collected under slight pressure, and any mixing of the gases is absolutely excluded by the design and structure of the cell.

The anode carbons are stated to last three years, a result due to the suppression of OH migration; the asbestos bags incasing the same last, it is claimed, about the same period of time, which is surprising, as

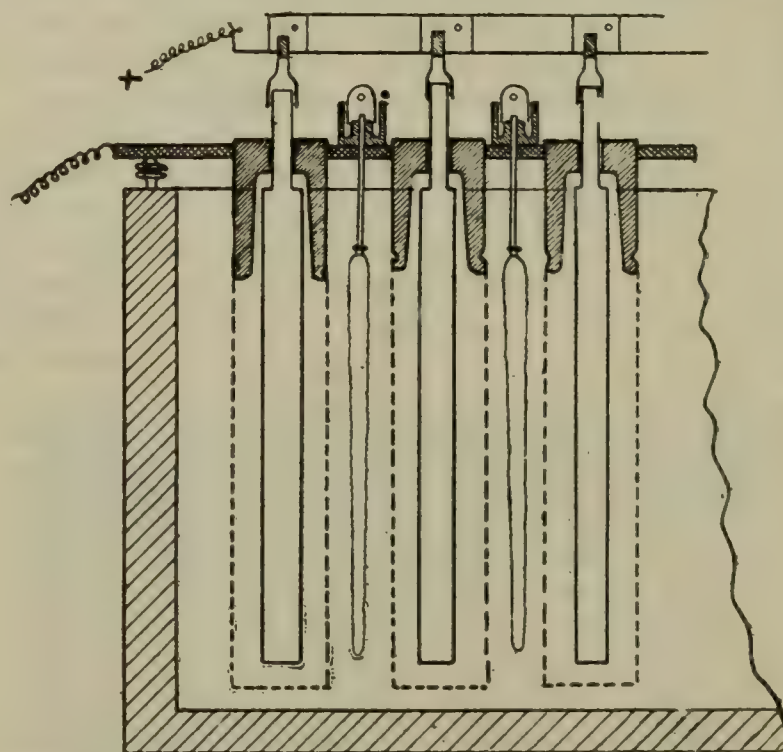


FIG. 20. ANODES AND CATHODE OF BASEL CELL CONNECTED IN PARALLEL

they are in contact with free chlorine. The cathodes and bags are cleaned every six to eight months, since the permeable coatings, especially when employing unpurified chloride solutions, become covered with a thick layer of lime, which lessens the permeability and causes an increase of the voltage. It is unnecessary, however,

to discontinue the working of the cell for cleaning purposes, since each cathode unit and gutter can be lifted out of the containing tank separately, and this can be done also with the single anode bells.

The working of the Basel type of cell is said to be quite simple. The cells are filled up to a certain height with brine, and the electric current is switched on. The propulsive cathodes commence at once their work of circulation, and the caustic alkali solution quickly attains a concentration of 11 to 13 per cent NaOH. A continual supply of fresh brine, corresponding to the quantity of caustic soda solution flowing away, is now fed in at any convenient point; while every propulsive cathode automatically takes the quantity of brine necessary for it, and corresponding to its load of current. The electrolyzers are not heated.

Six electrolytic alkali works in the countries of Central Europe are now employing the Basel type of cell; common salt is being electrolyzed in some of these, and potassium chloride in others.

Electrolytic Alkali and Chlorine Industry in Italy

In Italy, the electrolysis of salt solutions was carried on before the war by three separate companies, two of which employed the Solvay mercury cell, and the third the Outhenin-Chalandre diaphragm cell. The most important undertaking was that located at Caffaro-Falls, and was carried on by the Soc. Elettrochimica del Caffaro. Here the mercury type of cell is employed, with electric power derived from the falls.

The company which operated the diaphragm cell—namely, the Societa Elettrochimica Italiana—has now given up this cell for the Basel type of cell.

The Societa Italiana di Elettrochimica of Rome up to 1918 employed the Outhenin-Chalandre cell, and later a modified form of the Griesheim Elektron cell for its works at Bussi. Owing to the low efficiencies and weak caustic alkali liquors obtained from these types of cell, the company decided early in 1918 to scrap these cells and to adopt the Basel type of electrolyzer.

The new equipment consists of three units of fifty cells, employing a current between 6,000 and 7,000 amp., with an emf. of $3\frac{1}{2}$ to $4\frac{1}{2}$ volts per cell. The new plant is capable of turning out twenty-seven tons of caustic soda per day when the three sets of cells are operated altogether. The consumption of salt is about 1,650 kg. per ton of NaOH, and quadruple-effect evaporators are employed for concentrating the caustic liquors obtained from the cells. The current for each series of cells is provided by a dynamo which generates direct current at 190 to 200 volts. As the waterpower plant at Bussi is capable of generating 6,000 hp., the surplus electric power is at present employed for steam-raising in boilers specially designed for this purpose, and also for the evaporation of the caustic alkali liquors.

The cost of the hp.-yr. at Bussi is stated to be only 55 Italian lire, which at the normal rate of exchange represents \$10.50, whereas coal in Italy today costs from \$20 to \$40 per ton. It is proposed, therefore, to extend the electric heating plant and to employ ultimately 5,000 kw. for these electrically-heated steam-boilers.

The soda solution produced by the cells contains on the average 110 g. NaOH and 200 g. NaCl per liter, with small quantities of chlorate and no hypochlorite. The chlorine contains about 1 per cent CO,

but is fairly concentrated as it issues from the anode compartments of the cell, and therefore it can easily be liquefied in the special plant installed at Bussi for this purpose.

During the war the Societa Italiana di Elettrochimica of Rome was engaged upon the production of poisonous gases and of other materials for military use. The Bussi works, however, is now free from military control, and in addition to manufacturing caustic soda and liquid chlorine the company is producing the following chemicals:

Chlorates of potash and soda; bleaching powder; hydrochloric acid; hypochlorite of soda; compressed hydrogen; tetrachloride of carbon; tetrachloride of tin; magnetite for electrodes; phosphorus and antimony chlorides; benzylchloride; benzoic acid; barium salts, and finally, several electric-furnace products.

Power is obtained from the two rivers Pescara and Tirino, and 50,000 hp. can be developed at this spot when the necessity for further extensions of the works occurs.

Electrolytic Alkali and Chlorine Industry in Switzerland, Italy, Russia and Belgium

The following is a summary of the position of the electrolytic alkali and chlorine industry in Switzerland, Russia and Belgium before the war:

SWITZERLAND

Switzerland possessed two works of this character; that of the Soc. pour l'Industrie Chimique de Bâle at Monthey being the oldest and most important. Here the Basel type of diaphragm cell, which has been described above, was developed and used; and the output of caustic soda, which was only 1,000 tons in 1913, has been increased to over 2,500 tons per annum.

The other works is that of the Soc. Anon. Suisse de l'Industrie Electrochimique Volta, and is located at Chevres, where electric power from the Geneva Municipal Council's generating plant is employed, with the Outhenin-Chalandre type of cell.

RUSSIA

As regards Russia, several electrolytic alkali and chlorine works had been established there before the war by German electrical engineering firms interested in the production and sale of the plant and machinery. The Griesheim Elektron cell and the Solvay mercury cell were the type employed in these Russian works, which were located at Donetz, at Zabkowsice and at Slaviansk, and in all three cases they were operated by steam power.

BELGIUM

Reference may be made to the works of the Belgian Solvay Co., at Jemeppe-sur-Sambre. This works was established in 1898 for operation of the Castner-Kellner mercury cell, and it was here that the improved type of cell which has now been adopted by the English company at Weston-Point was first operated.

The works at Jemeppe before the war operated twenty-three cells of the large type with 1,500 hp. (steam), but since 1914 it has been closed down. In a letter dated February of the present year (1920), from the head office of the company, in Brussels, the managing director of the firm of Solvay et Cie. states that the works at Jemeppe is not yet restarted.

Operating Details of Electric Furnaces

Excerpt From a Report of the Electric Furnace Committee of the Association of Iron and Steel Electrical Engineers Based on a Questionnaire Submitted to Steel Manufacturers
Operating Electric Furnaces

By EDWARD T. MOORE

FROM time to time the question arises as to what limit should be set on transformer primary voltage for electric-furnace service. Transformers having a range from 22,000 to 50 volts are common, and from the transformer standpoint there is hardly any reason why the high voltage should not be doubled, tripled or even quadrupled. However, there are other factors that enter into the situation and in this case are the deciding ones.

As soon as we pass 22,000 volts, the type of oil switch necessary for safely rupturing the current changes to a design that is expensive to install and operate in electric furnace service. Accordingly for 44,000 volts and higher, especially in small units, it is desirable to make the first step from the line voltage to 6,600 volts or 2,300 volts, depending upon the circumstances.

AUTOMATIC CONTROL

The task of keeping the power input to an electric furnace constant within reasonable limits by maintaining the position of several electrodes, with their supporting mechanism and flexible conductors, is not an easy one even when all arcing surfaces are comparatively stable, but when half of the arcing surface is made up of numerous pieces of metal constantly changing under the action of the arcs, the difficulties are considerably increased. From the surface of the molten metal there is a continuous spray of small metallic particles which make it easy to establish the arc before the electrode touches the metal, but with solid metal the electrode must practically come in contact before the arc is struck and then it must be drawn away quickly so as to minimize the current surge. This is the condition met in the first part of melting down a charge of cold steel scrap and is a trying time to all parts of the equipment.

Automatic electrode regulators have been in use commercially in Europe for twenty-five years, and in this country about fifteen years, in both places demonstrating to the user their value in effecting better results and conditions generally.

Compared to the inefficient human machine we have a small relay that follows the impulses continuously and the automatic regulator throws a switch as soon as the change takes place in the circuit, the electrode moving almost instantly to meet the new conditions.

In operating an electric furnace it is desirable to keep all surges within the closest reasonable limits, as these surges have, in practically all cases, a definite bearing on the cost of power, and even when this is not considered, such surges affect other users and frequently cause prejudice against all electric furnaces. Momentary surges are limited by electrical characteristics of the furnace circuit, while the duration of the sustained surge is determined by the electrode control.

A sustained surge tends to carry the current density far above the normal carrying capacity of the electrodes, electrode holders and conductors. As the heating varies directly with the square of the current, a current increase of 50 per cent will increase the heating 125 per cent above normal and accordingly shorten the life of any current-carrying member, especially contact surfaces. The electrode consumption is also increased when the power is permitted to vary over wide ranges and surges tend to cause overheating at weak spots in the electrode with consequent deterioration.

In addition to the important consideration given above there are others of almost equal importance, such as the effect on the quality of the product due to widely varying temperatures at the surface of the metal, effect on the equipment, especially the transformers, due to surge strains, etc.

ARRANGEMENT OF ELECTRICAL APPARATUS

With several notable exceptions, practically all furnace equipments are installed in a straight line—that is, the transformers are located directly behind the furnace and the direction of motion during tilting is directly away from the transformers (Fig. 1). While this method of installation requires somewhat longer flexible leads, there are no side strains to the electrode masts and it is comparatively simple to install apparatus in buildings that were designed for other purposes. As opposed to this arrangement we have the design where the furnace tilts at right angles to the line from the transformers to the furnace (Fig. 2), this arrangement requiring considerably shorter flexible leads but giving considerable side strains to the electrode masts.

Where one polyphase transformer furnishes power to the furnace, the busbar layout is comparatively simple, but with three transformers it becomes much more

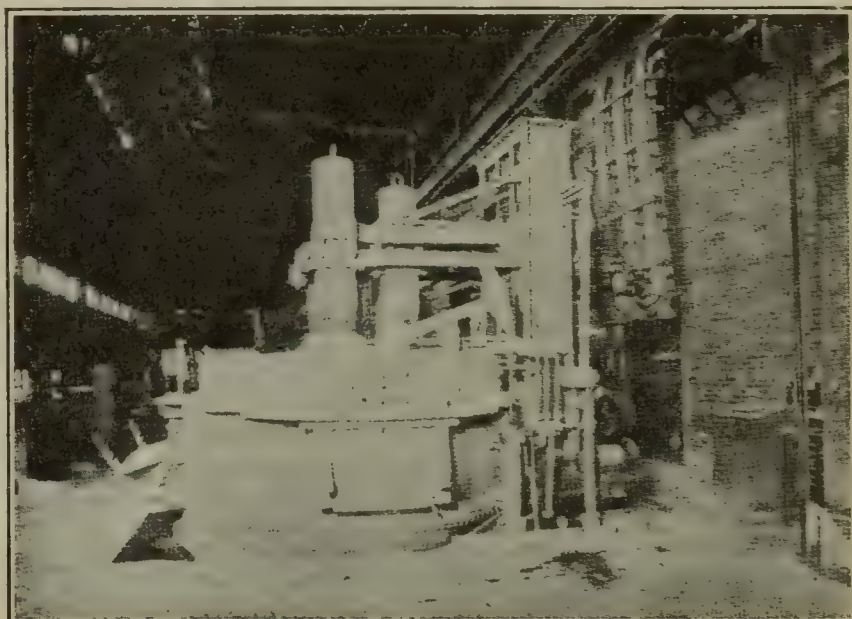


FIG. 1. USUAL ARRANGEMENT OF FURNACE EQUIPMENT

complicated. In this connection come the question of using interleaved buses to point where the delta or Y is formed and the flexible leads taken to the transformer, or whether this connection will be made at the transformers and the added inherent reactance accepted as a necessary evil.

The furnace conductors should be so disposed as to avoid unnecessary eddy current losses which increase the reactance and may cause trouble through distortion of the iron work. Care should also be taken that the panels are kept outside of any magnetic loops or fields, as the instruments may be unfavorably affected.

Busbars are usually self-cooled, but an unusual exception is found on two 10-ton furnaces at Buffalo, where the connections from the cables to the electrode holders

chosen for melting that will give the best results for this so-called heavy duty work, while a corresponding value can be chosen for the refining which will give the best results during that important period.

In one installation the greatest power input that could be obtained during the melting down period was 1,800 kw. at 100 volts, while with practically the same furnace design the power input was increased to 3,200 kw. by a moderate voltage increase.

There is a well-defined belief that the high rate of melting obtained by high voltage is detrimental to the quality of the product, especially for tool steel, and this should be carefully investigated. Until the arc shows above the metal, there can be no other objection and possibly the same holds true for the quality of the metal.



FIG. 2. ANOTHER ARRANGEMENT OF FURNACE EQUIPMENT

are thick-walled water-cooled copper pipes. These conductors have given good service during several years' operation.

Flexible cables are necessarily used between the transformer and furnace buses, and a form of insurance is the use of welded terminals that absolutely do away with shutdowns caused by failure of soldered or brazed terminals.

The current density is usually somewhat higher in the cables, approximately 900 to 1,000 amp., than in the bars, which usually run 750 to 850 amp. per sq.in.

On account of the height of the electrode masts, in those cases where the conductors are carried over the tops, a saving in bus copper can be effected by raising the transformer on a pedestal so that the top of the low-voltage leads is on a level with the top of the masts.

VARIABLE OR DUAL VOLTAGE CONTROL

An important subject is the use of double voltage operation for arc furnaces, not only from the standpoint of range of voltages to be used but also the possible detrimental effect of increased rate of melting, obtained by the use of such voltages, on the quality of the metal.

With small furnaces up to one or two tons capacity, except in special cases, there seems to be little reason for going to the expense of installing apparatus for double voltage control. In larger furnaces, however, there seems to be a good reason for using a high voltage during part of the melting period and a lower voltage during the refining period. With a furnace taking 1,500 kva. the voltage applied to the electrode must necessarily be a compromise between a value that will not be so high as to damage the roof and side walls during refining or so low as to lose too much time during melting.

By the use of double voltage control a voltage can be

REACTANCE

The amount of reactance to be used with an electric furnace; its disposition on high-voltage or low-voltage side; the amount of inherent reactance in the transformers; the kind of reactor, iron core or air core, depend upon the type of furnace, the service and local conditions. The reactance stabilizes the arc and determines the limit of short circuit current. The resistance of the leads, electrodes and charge, being small compared to the reactance, can be neglected in this connection.

AMOUNT

Power factor and reactance are intimately connected and considerable harm has been done by advocating too high a power factor.

Public reference was recently made to the unsatisfactory operating characteristics of a 3-ton, three-phase, 1,000 kva. furnace taking power from a 11,000-volt 25-cycle circuit. On account of the low reactance of this equipment, it is common occurrence for the oil switch to open several times during a heat, and as this switch is set at six times normal current, a reactance of approximately 16 per cent is indicated, which should give a power factor of over 98 per cent, a figure unnecessarily high.

If the reactance was doubled, the power factor would be still approximately 95 per cent, while the short circuit current would be decreased from 600 per cent to 320 per cent. If the reactance was still further increased to 43.6, the power factor would still have the excellent value of 90 per cent and the short circuit current would be 229 per cent. This seems to be a desirable value, although if still better protection is desired, such as on a small capacity privately owned plant, a reactance value of 53.7 per cent would give a power factor of 85 per cent and a short circuit current of 190 per cent. These figures are based on values that would be obtained with a reactance having a characteristic of the air core type and would necessarily be altered for iron core reactors and reactors of the compounding type, such as saturated reactors.

A 6-ton, three-phase furnace having transformer capacity of 1,500 kva. on a 60-cycle circuit will have approximately 90 per cent power factor, indicating a reactance of 43.6 per cent, of which about 6 per cent will be in the transformers. The remaining 37.6 reactance, which is principally in the secondary leads, would be reduced to 15.7 per cent on a 25-cycle circuit. The 25-cycle transformer would have a reactance of about 7 per cent, which, added to the 15.7 per cent, would give a total of 22.7 per cent, indicating a power

factor of 97.4 per cent with a corresponding short circuit current of 440 per cent. This indicates that to give the smooth operation of a 90 per cent power factor furnace a 20 per cent reactance should be added to a furnace that normally requires no exterior reactance on a 60-cycle circuit.

Fig. 3 illustrates graphically the relation between reactance and power factor in a circuit. As abscissæ are plotted reactance voltages in percentage of the supply voltage, while the ordinates represent the power factor of the circuit in per cent. Incidentally, the ordinates of this curve also indicate the voltage drop due to resistance in the circuit, or, neglecting the resistance in the transformer and furnace leads, the actual voltage which is obtained across the furnace electrodes in per cent of the supply voltage.

PRIMARY OR SECONDARY

Except on small furnaces, or very high-voltage circuits, the use of external reactance is practically confined to the high-voltage side. In this location it gives additional protection to the transformer against exterior surges and is easier to install on account of the general arrangement of apparatus.

TRANSFORMER REACTANCE

The inherent reactance of a transformer with normal design is from 4 to 7 per cent and this can be increased without much difficulty up to 20 per cent. If additional reactance is to be installed and it comes within this

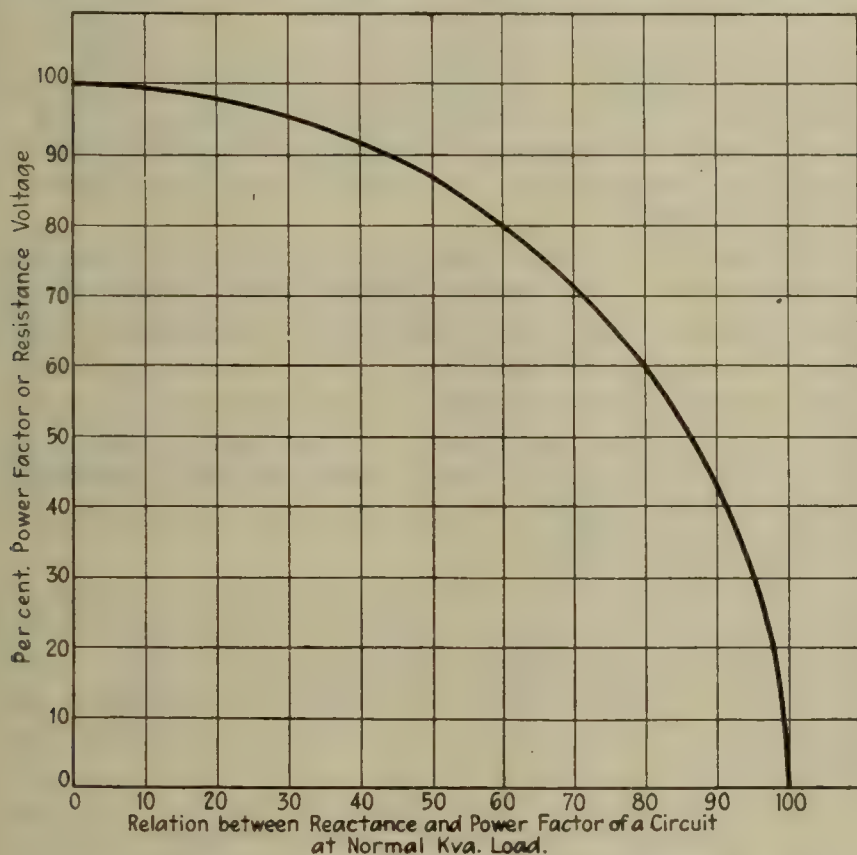


FIG. 3. RELATION BETWEEN REACTANCE AND POWER FACTOR

value, it appears to be a mistake to keep down the transformer reactance and then increase the installation cost by adding external reactance. This is not necessarily the case, as the equipment will be considerably more flexible if the inherent or uncontrollable reactance is reduced to a minimum and desirable characteristics are obtained by the use of external or controllable reactance. This is especially true in installations using variable voltage control, as the amount of reactance necessary to produce the best results at the high voltage would be excessive and produce undesirable characteristics at the low voltage.

Under ordinary circumstances the choice of reactor lies between the iron core type and the air core type, in some cases there being little to choose from the standpoint of price alone.

The iron core reactor is chiefly used in circuits carrying currents of less than about 50 amp., when a reactance of more than 4 or 5 per cent is required. Under such conditions an air core reactor would require a very large number of turns to give the desired reactance, and the iron core design is considerably more economical.

ELECTRODES

The function of the electrode is to conduct electric energy into the furnace and assist in the production of a proper atmosphere for refining of the metal. Since the cost of electrodes will form approximately 9 per cent

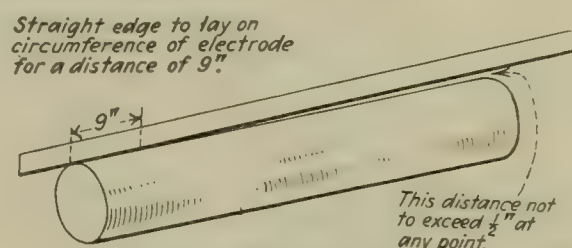


FIG. 4. ELECTRODE

of the total operating expense of a furnace, it will be appreciated that this subject is an important one. This expense will be further increased if excessive breakage is experienced and from the questionnaire below it will be noted this item amounted to an average of 7.7 per cent for carbon electrodes. In addition to this, delays on the furnace due to electrode breakage are costly items and may become prohibitive.

It is believed if more attention was directed toward the proper handling of electrodes by furnace users that excessive breakage would be eliminated and higher economy secured per ton of metal produced. The average consumption of carbon electrodes taken from our questionnaire is 39.9 lb. per ton of metal produced, although there are a number of cases where 30 lb. per ton of metal is an ordinary everyday performance. It would seem as though much improvement could be made toward better electrode economy by better methods of handling and storage of this important material.

One of the large electrode manufacturers has recently published a booklet containing many valuable suggestions for the handling and use of electrodes which we trust will be given wide circulation. With proper handling by the consumer, electrodes should give better service than the average records indicate, for better electrodes are now being made.

Electrodes furnished under this specification are to be amorphous carbon of 14 in. and 17 in. diameter.

Tolerances

Electrodes shall not vary at any point in their diameter over 2 per cent plus or minus from the diameter specified, throughout their entire length, and to be within the following limits:

Nominal Diam., In.	Maximum Diam., In.	Minimum Diam., In.
14	14.28	13.72
17	17.34	16.66

The outside surface of all electrodes to be free of flat spots, bulges, cracks or other irregularities which would interfere with satisfactory operation when placed in the electrode holder of the furnace.

Length

All electrodes furnished hereunder are to be 72 in. long and shall be as straight as possible throughout their length.

No curvature shall exceed $\frac{1}{2}$ in. as determined by using a straight edge which shall engage the electrode for a distance of 9 in. from either end of the electrode. The distance between straight edge and any point on the circumference of the electrode between the 9 in. area and the opposite end shall not exceed the specified variation. See Fig. 4.

Ends

The ends of the electrodes are to be straight and square with the face—that is, a straight edge laid on the end of the electrode would be 90 deg. from a straight edge laid on the face of the electrode for a distance of 9 in. from the end referred to. See Fig. 5.

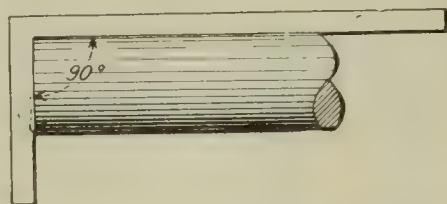


FIG. 5. END OF ELECTRODE

Threading of Electrodes

Electrodes are to be threaded at each end and symmetrical. The center of the threaded portion is to coincide with the center of the electrode so that when two electrodes are jointed together their edges will not project beyond each other.

Screw Plugs

The screw plugs or nipples are to be made preferably of a material different from the electrode in order that greater tensile strength may be secured.

The threads will be machined to fit "free" so that no binding will take place. They shall not be so "free," however, as to allow end play when the nipple is pulled or pushed while in position, but should be tight enough for good electrical contact and not so tight as to cause vertical cracks in the threads of the electrodes or actual breakage at the ends of the electrodes.

Electrical Resistivity

All electrodes are to have an average specific resistance per inch cube at 20 deg. C. of not more than 0.002 ohm and with no single electrode above 0.0025 ohm.

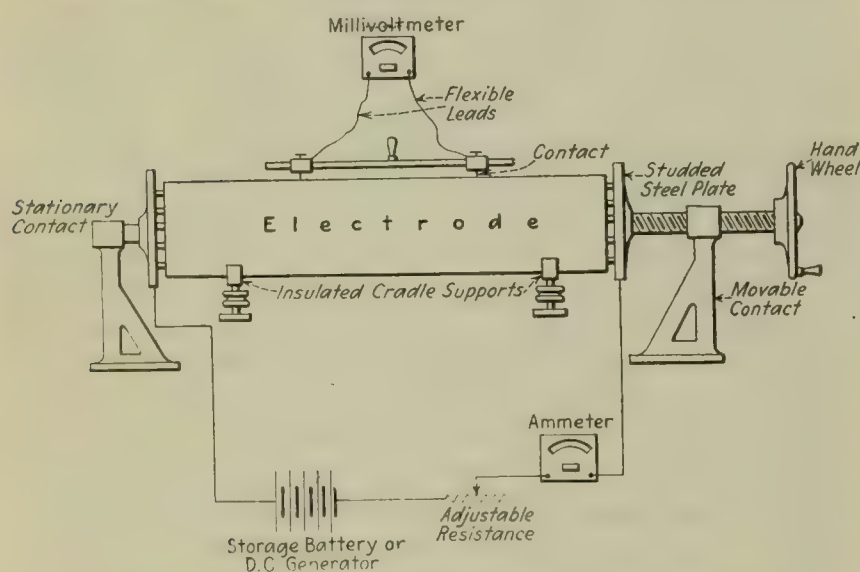


FIG. 6. APPARATUS TO MEASURE ELECTRICAL RESISTIVITY

The value of the test current to be 300 amp. These measurements may be secured by an apparatus similar to that shown in Fig. 6, although in place of the studded plate contacts, ordinary copper bands may be used. The contact frame connected to the flexible leads of the millivoltmeter should be pressed firmly against electrode and readings taken at various positions along the length and laterally. The average of all readings to be taken as the basis for acceptance or rejection.

Round Electrodes¹

Dia., In.	Area, Sq. In.	Av. Wt. per 60 in. Length, Lb.	Est. Max. Current, Amp.
6	28	99.5	1200
8	50	171.4	2000
10	79	251.4	3000
12	113	359.9	4500
14	154	479.8	6000
16	201	670.0	7000
17	227	687.9	7500
20	314	966.4	1,000
24	452	1508.0	13,500

¹ National Carbon Co.

The figures given for maximum current are approximate and are such as to allow the electrode to operate "black hot." These figures depend on furnace conditions and may vary widely.

Some manufacturers do not believe that electrical resistivity tests of the electrodes is of primary importance to the user, although we feel that the above specification should include such resistivity tests in order to provide data for future discussion.

Tolerance for graphite electrodes should be as follows:

Graphite Electrodes²

Size of Electrode, In.	Tolerance in Diameter, In.	Tolerance in Bowing, In.	Size of Nipple	Threads, per In.
2		$\frac{1}{8}$ on 24 length	$1\frac{1}{2} \times 3$	6
$2\frac{1}{2}$		$\frac{3}{32}$ on 30 length	$1\frac{7}{8} \times 4$	4
3		$\frac{1}{4}$ on 40 length	$1\frac{1}{2} \times 5$	4
4		$\frac{1}{4}$ on 40 length	2×7	4
$5\frac{1}{8}$		$\frac{1}{4}$ on 40 length	2×8	4
6		$\frac{1}{4}$ on 48 length	3×9	3
7	$\frac{1}{8}$ under $\frac{1}{4}$ over	$\frac{1}{4}$ on 48 length	4×9	5
8	$\frac{1}{8}$ under $\frac{1}{4}$ over	$\frac{1}{4}$ on 48 length		
9	$\frac{1}{8}$ under $\frac{1}{4}$ over	$\frac{1}{4}$ on 60 length	$4\frac{1}{2} \times 10$	3
10 x 60	$\frac{1}{8}$ under $\frac{1}{4}$ over	$\frac{1}{4}$ on 60 length	$5\frac{1}{2} \times 11$	3
12 x 60	$\frac{1}{8}$ under $\frac{1}{4}$ over	$\frac{1}{4}$ on 60 length	6×12	2
14 x 60	$\frac{1}{8}$ under $\frac{1}{4}$ over	$\frac{1}{4}$ on 60 length	$7\frac{1}{2} \times 12$	2
		$\frac{1}{4}$ on 60 length	$8\frac{1}{2} \times 14$	2

Bowing to be measured across the concave side from straight edge to electrode at middle. The same method for measuring curvature of carbon electrodes may also be used for graphite, with modifications for the smaller diameters.

Resistivity

The average electrical resistivity of graphite electrodes should be 0.00036 ohm per inch cube, or 0.000914 ohm per cm. cube.

Roof Cooling Rings

As a means of securing better electrode economy more attention should be given to roof cooling rings for the purpose of reducing "spindling" and "wasping." At least one of the members of the committee has experimented extensively with rings of various design, but with no very great improvement in results. Several months ago a new type of roof cooling ring was placed on the market and from investigations made on actual installations very great improvement seems to be indicated.

The gases generated in an electric furnace during operation are only combustible at high temperatures, which means that if they escape to the atmosphere, they are hot enough to burn and in doing so burn up part of the electrode itself and also have a very objectionable effect on the electrode holder. Consequently, nearly all the present-day cooling rings have for their principal object the cooling of the electrode and the cooling of the port holes of the roof.

In the cooling ring under discussion there is obtained the desirable feature of keeping the roof port holes cool, keeping the electrode reasonably cool, and go still further by cooling down the gases, as they leave the furnace, to a temperature at which they will no longer burn when they meet the oxygen of the atmosphere.

While these gases are inside the furnace they are under reducing conditions and have, therefore, only their own sensible heat and no heat generated by the oxidation of combustible constituents. These gases pass, first of all, in between the electrode and the port hole of the roof and then pass through clearance A, Fig. 7, in the cooling ring and into a relatively larger chamber B, which causes the expansion of the gases and thereby giving up a large amount of sensible heat in the gases. This heat is absorbed by the water in the cooling ring. From chamber B they are once more contracted through the small clearance C and are passing to a very large chamber D for a second and much larger expansion. This chamber is surrounded, in the case of graphite electrodes, by a thin inclosed cover E, which in actual

² Acheson Graphite Co.

practice has been found quite sufficient to dissipate the heat given up by these gases, and when they finally pass through the clearance *F*, they are no longer at a temperature sufficiently high to cause them to burn in the atmosphere.

The fact that graphite electrodes can be machined allows the use of a very small clearance at the points *A*, *C* and *F*, which in turn allows a much larger relative expansion into the chambers *B* and *D*, and at one installation, where these cooling rings have been under our close supervision, we have found that even during the periods when carbon is being thrown on to the slag for the purpose of deoxidation, there is not the slightest sign of flames being emitted at the point *F*, and the electrodes themselves do not show the slightest trace of reduction in diameter.

When such economizers are to be used on amorphous carbon electrodes, and especially of the larger sizes and

distance *J* can be altered to suit working conditions. This is desirable from the fact that certain types of electrodes may have a greater variation than others and it may be necessary to increase the capacity of the chamber *D*, whereas for the best type of electrode this distance can be kept down to a minimum and thereby not affect the maximum travel of the electrode jib.

The use of this electrode economizer considerably decreases the amount of electrode consumption, and the port holes in the roof also appear to stand up very much better. This is probably due to the blanketing effect and to the fact that the flames do not rush out through the roof. We have also noticed that there is a much less tendency of the electrodes to taper off and they burn square right down to the point of the arc. This means that the electrode always has the correct carrying capacity at its extremity.

In cases where this type of cooling ring are not used, the air coming in through the furnace doors strikes the white hot electrode and the roof openings act as a chimney, the electrode burning away and penciling off. When the tip of the electrode is thus reduced, it has often to carry very much more current than it has been designed for, and the consequences are that the electrode heats up unduly throughout its length and breakages of electrodes and connecting nipples frequently occur.

Experience so far, while limited, seems to indicate that the above objections are very largely prevented by the use of these economizers.

REFRACTORIES

Silica.—Silica bricks are used as an electric-furnace refractory more than other material for the reason that the melting temperature is very high, being approximately that of platinum, or 1,750 deg. C., and stand up remarkably well up to approximately 1,700 deg. C. They are especially satisfactory for roof brick, as they have an expansion when heated of about 0.25 in. per ft., which permits of maintaining a very flat roof. The bricks are made from quartzite with 95 to 99 per cent silica (SiO_2) and when furnished should contain at least 95 per cent silica in order to stand up.

Silica bricks should be laid in a siliceous mud for mortar—in fact, all refractory bricks should be laid in mortar of the same composition as the brick, to avoid fluxing.

Magnesite.—Magnesite bricks are finding an increasingly large use for those parts of the furnace in direct contact with the charge and for parts exposed to extremely high temperature. The finely powdered magnesite is burned so thoroughly that it is sintered and then forced into shape by the use of very high hydraulic pressure. As it shrinks greatly when heated it is again burned before use and can then be kept in storage without fear of spoiling, for it is not so sensitive to moisture.

Basic mortar must be used with magnesite bricks and the courses should be laid as close as possible, so that even with expansion of the mortar the joints may remain tight and expose very small surfaces of attack to harmful influences. It should be noted that under the influence of other materials at high temperatures certain refractories quickly break down. The following rule must be strictly observed: In the presence of basic influence use basic materials, and with acid influences, use acid materials.

Particular attention should be directed to the building

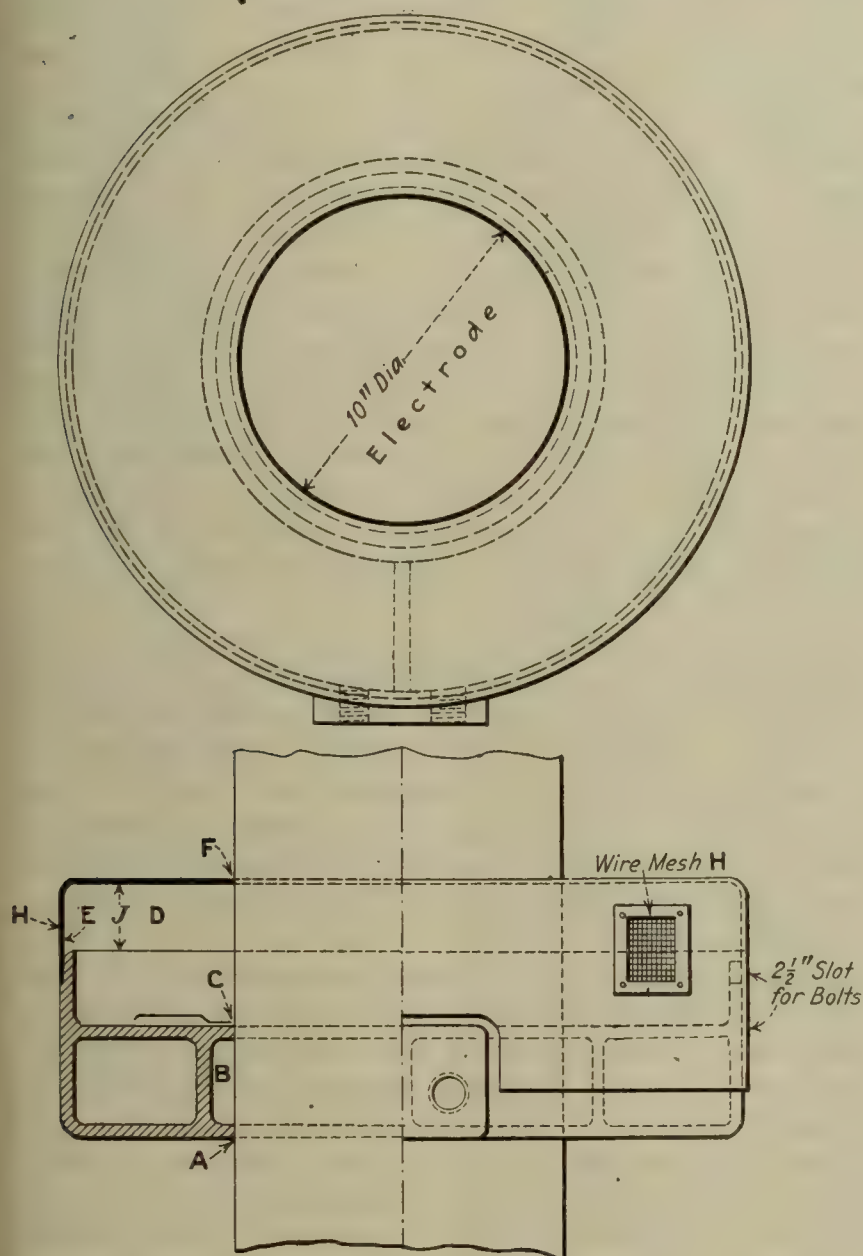


FIG. 7. COOLING RING

of the makes where the diameters do not run to any regularity, a change is made in the chamber *D* of the economizer. The gases there, instead of being all allowed to pass through the clearance *F*, pass through perforated plates *H* on the outer wall of the cover *E*, and by keeping these perforations as small as practical, the plates *H* will act on the principle of the metallic gauze used in Davy miners' lamps, in which it is well known that the heated gases of combustion from the lamp are cooled to such an extent that the lamp can be very safely used in the dangerous explosive gases of coal mines.

The cover *E* will be made adjustable, so that the

of the side walls in a furnace so as not to have them too steep, else it will be very difficult to repair or patch up disintegrated portions.

Very great success has been secured with dolomite in making bottoms for furnaces. It is a limestone containing a considerable proportion of magnesite and when burned forms a valuable refractory, but should be mixed with pitch or tar before ramming into the furnace and used as soon as possible, because of its lime content ($\text{CaCO}_3\text{MgCO}_3$) it readily absorbs moisture from the air and falls to powder.

BRASS FURNACES

The reason for the rapid increase in the use of the electric furnace in the conservative brass industry and for melting other non-ferrous metals and alloys is the production of a uniform metal by eliminating or minimizing operators' errors under the trying conditions of fumes and high temperatures met while handling crucibles, eliminating contamination from furnace gases, preventing loss of volatile constituents through uneven heating and, in general, making a uniform product by superior heat control. Also as we are mixing two or more metals having different specific gravities and melting points, it is necessary to have efficient stirring, and this is accomplished both electrically and mechanically.

Furnaces may be broadly divided into those in which the heat is generated in the metal, those in which the heat is generated at the surface of the metal and those in which the heat is generated externally to the metal and radiated or otherwise transferred to it.

In the first group we have the induction furnace for normal frequencies as exploited by the Ajax Metals Co., of which there are many in successful operation. These furnaces are very efficient and are best adapted to large plants where one or more furnaces can be used continuously on the same class of metal. In small plants, or where several heats are to be made of one alloy and then another composition is required, this type of furnace is at a serious disadvantage, as they are usually started with a charge of molten metal. Intermittent operation of this furnace also has a detrimental effect on the lining and it is practically limited to continuous operation.

Another type that is passing through the experimental stage operates on the induction principle and is designed to take power at 9,000 cycles or higher. The equipment is very simple from all standpoints except the power equipment, which has been the chief obstacle in the development of equipments of commercial capacity. This furnace can melt or heat any metal to any reasonable temperature and should be of great value when fully developed.

In the second group we have furnaces where the current passes from the electrode to the metal, and it is necessary in this case to reduce the voltage drop between the electrode and the metal to such a value as will practically eliminate arcing. This is necessary on account of the intense heat developed by an arc in the surface of the metal, causing tremendous vaporizing losses which could not be tolerated.

The third class includes arc furnaces where the heat is generated above the metal and radiated to it and the refractory walls. By oscillating or rotating the furnace shell, the metal is mechanically stirred and absorbs heat from the refractories, thus tending to keep them at practically uniform temperature.

Other types of furnaces using exterior heating are resistance furnaces where the heat is generated in resistors and radiated or conducted to the metal. The latter types have neither electrical nor mechanical stirring and must depend upon mechanical rabbling together with slight stirring due to heating effect through the lining. Various other types are under development, but they are not of sufficient commercial importance to warrant consideration here.

The consumption of electric energy varies from a reported figure of 174 kw.-hr. per ton in continuous operation on induction furnaces up to 240-500 kw.-hr. for intermittent operation on arc and resistance types.

CONCLUSION

The data secured from the questionnaire indicate very conclusively that the greatest need at present is for better electrode economy, which means watching closely the handling, storing in a warm dry location and proper joining of electrodes. The improvement of the present largely used roof cooling ring will have a big effect on electrode consumption.

Lack of tensile strength seems to be one of the difficulties of electrode trouble caused by the lines of cleavage of the calcined anthracite coal being in a vertical as well as horizontal direction, it being impossible at present to build an electrode where all the cleavage lines are horizontal. Recently some amorphous carbon electrodes have been made with a hard bonding material which increases the density very materially. While their use has been over a period of only six months, preliminary reports indicate a greatly reduced breakage. If some method of placing the material of electrodes in a position to present its lines of cleavage at the best advantage were devised, no doubt practically all breakage could be eliminated.

One of the chief sources of difficulty in furnace operation is delays due to handling material to and from the furnace. This difficulty increases as the number of installed furnaces becomes larger. The practice of bringing the scrap on the surface floor from the rear and adjacent to the furnace in small cars on tracks and using traveling cranes entirely for handling the steel from the furnace is certainly desirable and conducive to reduced delays.

The present method of charging scrap into a furnace by shoveling and peeling means a delay of at least one-half hour. Using an automatic charging machine will reduce the time of charging materially, but it will not be able to place the scrap as uniformly as may be done by hand; therefore, during melting the power fluctuations will be greater. With hand charging, the scrap can be placed uniformly and a greater tonnage treated.

Although considerable work has been done toward perfecting the electric furnace and its accessories, there is opportunity yet for very extensive research, and we believe the necessary results will be forthcoming in the very near future.

Changes in Regulation 60 on Alcohol

A supplement to Regulation 60 relative to dealing in, transportation and use of tax-paid industrial alcohol in original stamped packages only has recently been issued from the Office of Commissioner of Internal Revenue.

Federal prohibition directors and others concerned may obtain the detailed information by writing to the Treasury Department, Office of Commissioner of Internal Revenue, Washington, D. C.

Ternary Brasses

AS LONG ago as 1905, Léon Guillet published¹ some investigations on special brasses, in which he was led to the conception of "fictitious compositions" in an attempt to systematize the results. Thus when adding various percentages of tin to a 60:40 brass, he found that the microscopic appearance of three brasses when slowly cooled were quite similar and consisted of light secondary crystals of γ in a dark matrix of β . These were² 54:40:6, 60:30:10, and 46:54. Up to 10 per cent, tin evidently entered into solid solution, and acted like zinc, but with a potency several times as great. In other words, both of these tin-brasses might be thought of as having a "fictitious" composition of 46 Cu, 54 Zn. From the standpoint of the equilibrium diagram, Fig. 1, tin apparently moves points a_1 , b_1 and c_1 to the left.

Similarly, when studying the ordinary physical properties, tin additions up to 2.2 per cent increase the strength and hardness of 60:40 brass. Ductility and

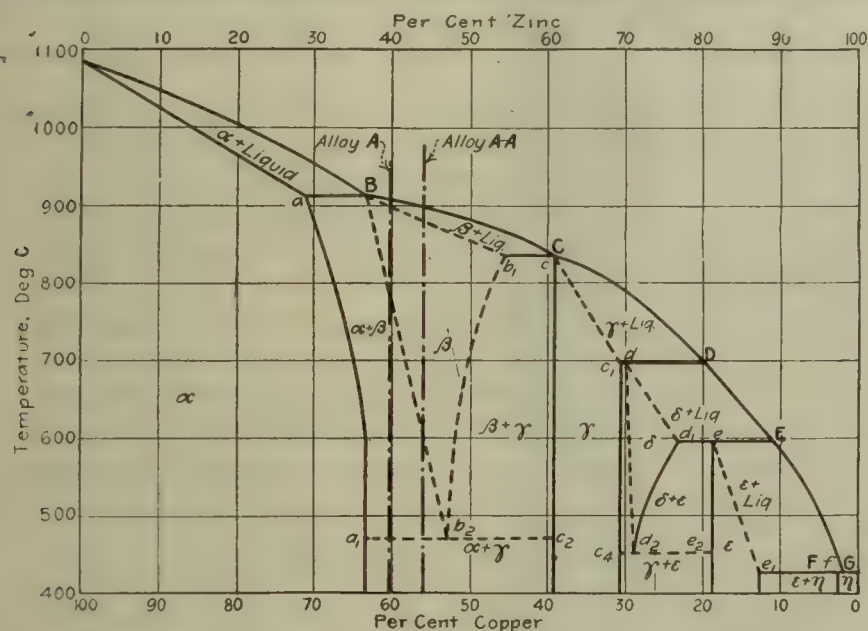


FIG. 1. EQUILIBRIUM DIAGRAM FOR COPPER-ZINC ALLOYS
After Gulliver, "Metallic Alloys," p. 267

shock strength is badly affected when tin is above 1 per cent. All of these changes are in the same direction as they occur when the copper content of the brass is lowered.

Further detailed studies along these lines were published in the following year,³ paying especial attention to the effect of aluminum, which appears to be especially powerful in displacing sidewise the properties vs. composition curves. As many as nine other metals have been studied as to their effect on brass. Guillet states the general conclusions that on the introduction of a small amount of third metal to a Cu:Zn alloy it enters into solution with the normal constituents up to saturation, but by so doing it brings the ternary alloy into a state microscopically equivalent to a binary Cu:Zn alloy of fictitious composition, and physically more nearly like the latter than the brass containing Cu:Zn in the ratio actually present. Physical properties of the fictitious binary brass, when compared to the same properties of an actual brass of the same composition, are of course modified by the inherent properties of the third element. Beyond the saturation point a special constituent appears, and the above generalization no longer holds.

For example, if a 70:30 brass has 2 per cent aluminum substituted for 2 per cent zinc, the actual composition would analyze 70:28:2. Now suppose 1 per cent Al plays the same rôle as 6 per cent Zn. The proportions of copper and equivalent zinc may then be stated as 70 parts copper and 40 parts zinc, which figured to 100 gives an analysis of 63.6 per cent Cu and 36.4 per cent Zn, the "fictitious composition" for a 70:28:2 aluminum brass.

MATHEMATICAL STATEMENT

Such a relation may be stated mathematically: "A body added to a brass possesses a coefficient of equivalence t when 1 per cent of this body will enter solid solution and replace t per cent of zinc, the proportions thus obtained being figured to 100."

In symbols, let A be the real percentage of copper, B the real percentage of zinc and q the real percentage of the third element.

Then

$$A + B + q = 100$$

Also let A' be the fictitious percentage of copper, B' the fictitious percentage of zinc and t the coefficient of equivalence.

Then

$$A' + B' = 100$$

and

$$B' = \frac{B + tq}{A + (B + tq)} = 100$$

Figuring explicit functions for A' , q and t from these expressions one gets

$$A' = \frac{100 A}{100 + q(t - 1)} \quad \text{for figuring the fictitious composition of a given ternary brass.}$$

$$q = \frac{100}{t - 1} \left(\frac{A - A'}{A'} \right) \quad \text{for figuring the quantity of third metal to be added to A brass to approximate the properties of A' brass.}$$

$$t = 1 + \frac{100}{q} \left(\frac{A - A'}{A'} \right) \quad \text{for figuring the coefficient of equivalence of a metal of which } q \text{ per cent changes alloy A to approximately that of A'.$$

DETAILED STUDY OF ALUMINUM BRASSES

As noted above, the second publication gives the details of an extensive study on aluminum brasses to illustrate and verify the general ideas thus expressed. In the first place the coefficient of equivalence was determined approximately, then verified by synthesis of a typical brass, and finally the mechanical properties were studied—tensile strength, Frémont impact, Brinell hardness, and forgeability.

Varying amounts of aluminum were added to a 60:40 brass, the resulting alloy analyzed chemically, and examined micrographically. From such data t can be calculated. Some results follow:

Chemical Analysis		Microscopic Analysis	t
Copper	Aluminum	Copper ⁴	Calculated
59.6	0.3	59	6.1
59.9	0.8	57.5	6.2
59.6	2.9	50.5 to 54.75	7.2 to 4.1
Average about.....			6.0

Given this value of t , it was verified by trying to pro-

¹Revue de Métallurgie, 1905, vol. 2, p. 97.

²Compositions give percentage of copper first, then zinc, and lastly of the third metal.

³"General Study of Ternary Brasses," by L. Guillet, Revue de Métallurgie, 1906, vol. 3, p. 243.

⁴The microscopic appearance of the ternary alloy approximated to within plus or minus $\frac{1}{2}$ per cent the appearance of a binary alloy with copper as indicated. In other words, this table might be headed A' .

duce ternary alloys whose compositions were equivalent to certain well defined microscopic appearances. Thus:

Given Copper	Figured Al	Required A'	
70	2.22	63	β constituent first appears
60	1.92	54.75	Traces of α constituent
60	3.76	50.5	A little γ is seen

As the result of many trials the following data were determined by chemical and micrographical analysis:

A	q	A'	t Calculated
70.3	2.3	63	6.04
59.8	1.65	55	6.27
60.4	4.7	50	5.42

Average..... 5.91

which was regarded as checking the round number 6.0 sufficiently well.

Higher aluminum alloys were also analyzed:

A	q	A'	Calculated t
68.47	4.50	56.0	5.94
68.49	5.60	53.0	6.21
78.73	7.14	57.0	6.33

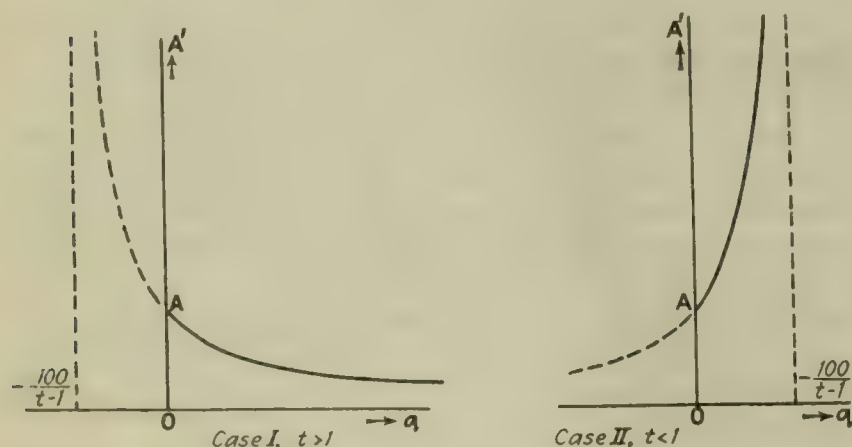
A third series of tests varied the amount of copper in an attempt to retain the same structure.

Aimed at			Analyzed			
A	q	A'	A	q	A' Found	A' Calculated ⁵
70	4.4	57.3	69.6	4.95	56	55.7
65	2.7	57.3	66.4	3.0	58	57.7
60	0.95	57.3	59.9	1.17	56.5	56.5

A great many test-bars were broken in an attempt to correlate and systematize the observed data. From these results the following trio are typical.

Cu	Al	Fictitious Cu	Ultimate	Elastic Limit	Elonga- tion	Contraction	Impact Strength	Hard- ness
64.73	1.64	58.8	51,200	17,600	38.0	40.7	10	69
57.96	.....	.....	50,600	9,400	44.0	49.9	13	73
64.7	.....	.....	30,300	5,700	55.0	53.8	17	39

Evidently the physical properties of the ternary brass are more nearly those of the simple brass of fictitious composition than that with the same percentage of copper. From all these tests it is plain that in industrial



FIGS. 2 AND 3. GRAPH SHOWING RELATIONSHIP BETWEEN AMOUNT OF THIRD METAL AND FICTITIOUS COMPOSITION

brasses (with greater than 55 per cent copper) aluminum increases the breaking strength and elastic limit, but if added even in small quantities to 58 per cent copper brasses it may render the product worthless by bringing in the brittle γ solution.

⁵On the basis that $t = 6.0$.

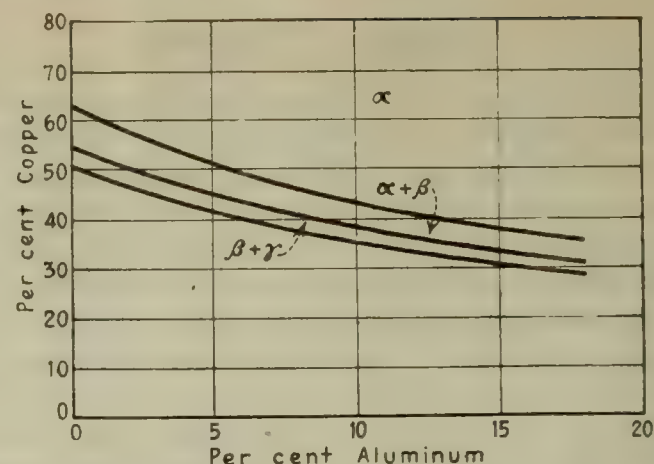


FIG. 4. TERNARY DIAGRAM FOR ALUMINUM BRASSES

GRAPHIC REPRESENTATION

Equation $A' = \frac{100A}{100 + q(t-1)}$ if plotted in A' and q will assume the form of an equilateral hyperbola asymptotic to horizontal axis (q) and a parallel to the A' axis at $q = -\frac{100}{t-1}$. There are two cases, of course, as shown in Figs. 2 and 3, the first where t is greater than 1, and the second where it is less than 1. If $q = 0$, $A' = A$, and in the former case as q increases A' becomes less than the real copper analysis. If t is less than 1 it is evidently useless to add a greater quantity of the third element than $-\frac{100}{t-1}$; however, one or more special constituents due to supersaturation would ordinarily intervene long before.

A ternary diagram for aluminum sketched on these principles is given in Fig. 4. The asymptote is at -20 .

RESULTS IN VARIOUS ALLOYS

Similar detailed studies were made by the author on many addition metals; the details can be consulted in *Revue de Métallurgie*, 1906, vol. 3, p. 243. It must suffice here to tabulate the results obtained, together with notes as to the limits of usefulness of Guillet's generalization—that is, the analysis where a special constituent appears in the alloy. Nickel brasses have further been studied in great detail, and have been briefly reported in 1913⁶ and more fully in 1920. Extensive summaries of these papers will be presented in subsequent issues of *CHEMICAL & METALLURGICAL ENGINEERING*.

TABLE OF RESULTS

Element		Special Constituent Appears =
Al.....	6.0	7.1% in 69% Cu
Mn.....	0.5	8% in 60% Cu
Fe.....	0.9	?
Sn.....	2.0	0.7 up to 63% Cu, 9% at pure Cu
Pb.....	1.0	0.9% in all brasses
Si.....	10.0	1.4% up to 63%, 2.0% @ 90%
Mg.....	2.0	0.25%
Sb.....	?	0.4%
Cd.....	1.0	0.9% (much like lead)
Ni ⁶	1.3	None
Co.....	Variable ⁷	4.3

Such studies should simplify the ideas covering special brasses, and make their fabrication the more dependent upon reason—especially for the forgeable alloys. Required physical properties may therefore be reached by simple analyses, replacing highly expensive and delicately worked alloys of high complexity.

⁶*Revue de Métallurgie*, 1913, vol. 10, p. 1130.

⁷*Revue de Métallurgie*, 1920, p. 494.

H. Foster Bain Becomes Director, Bureau of Mines

IN ASSUMING the directorship of the Bureau of Mines left vacant by the resignation of Dr. Cottrell to become chairman of the Division of Chemistry and Chemical Technology of the National Research Council, H. Foster Bain brings to his new duties a full realization of the importance of the chemical work of the bureau. As a matter of fact, one of the first big questions which came before him was in regard to this phase of the bureau's activities. The Committee on Appropriations had just reported out the sundry civil bill, omitting the items which had been requested by the bureau for extended work in the interest of the chemical industry. That made it necessary to lay plans immediately for renewed efforts in behalf of the industry which has taken on such increased importance since the outbreak of the war.

Mr. Bain was born at Seymour, Ind. After his graduation from Moore's Hill College, Indiana, in 1890, he spent two years at Johns Hopkins University and later received his doctor's degree from the University of Chicago. He was educated and trained as a geologist and mining engineer. He was one of Herbert Hoover's assistants in London on the Belgian relief work during the war. From 1909 to 1915 he was the editor of the *Mining and Scientific Press* of San Francisco, Cal., and later the editor of the *Mining Magazine* of London, England. He made some important mining investigations in south and central Africa and later undertook similar investigations in China. At one time he was a mine operator in Colorado and once was connected with the U. S. Geological Survey. Subsequently, he was the first director of the Geological Survey of Illinois.

In addition to Mr. Bain's contact with British mining affairs, during his residence in England as editor of the *Mining Magazine*, he has been engaged in consulting work in the Rand, the Belgian Kongo and other mining regions of Africa. He also has had considerable experience in the Far East. During the two-year trip from which he has just returned he made mining examinations in ten Oriental countries.

While Mr. Bain is more widely known for his work in geology and as a mining engineer, he has given far more attention to chemistry than has the average consulting mining engineer. While at Johns Hopkins University he received special training in chemistry under Prof. H. N. Morse in addition to the chemical work connected with the regular courses in metallurgy. At Cripple

Creek in 1901 he conducted a series of experiments on the cyanidation of Cripple Creek ores. He was among the first to attempt the heating of solutions. This practice has since developed some importance in connection with certain ores. At a later date he did extensive work on South Dakota ores in connection with the controversies which have arisen over patents covering cyanidation and concentration. Mr. Bain points to these early efforts as an indication of the relatively larger amount of duplication which took place before the work of the Federal Government provided a clearing house which enables all concerned to have the benefits of current developments, thereby speeding the perfection of improved processes. In connection with Mr. Bain's South Dakota work, it later developed that practically the same problems were being worked out at the Homestake Mine.

Just at present Mr. Bain is carefully considering the question of the character of research which should be undertaken by the Bureau of Mines. He is weighing the arguments advanced by manufacturers that the Government's research too frequently encroaches upon a field which properly belongs to private industry and believes that a definite line can be drawn where there will be no such encroachment. His study of the subject, however, has not reached the point where he is prepared to make an announcement of the bureau's future policy in that regard.

An incident in Mr. Bain's earlier experience brought home the fact that human relations as well as applied science are involved in every engineering project. After receiving his doctor's degree he sought employment as a shift boss in a mine with the idea of gaining first-hand experience in that phase of practical operation. He took charge of a gold-silver operation known as the Franklin mine in Clearcreek County, Colorado. The mine labor employed was Italian. Some friction had arisen as to the selection of a night shift boss, the first Sunday after Mr. Bain's arrival. The affair had given rise to a serious fistic encounter which kept Mr. Bain busy during his day of rest in negotiations with the keeper of the jail and the physician in charge of the hospital. This was followed a few days later by another phase of the feud in which work on the property was stopped by a concealed rifleman who amused himself by making the mine mouth his target. Finally, however, Mr. Bain got things running smoothly as far as open hostilities were concerned, but he learned that mining involves a great deal more than a knowledge of engineering and geology. In fact his first task on that job was to teach the men to use hammer drills, which were just coming into use at that time.



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H. FOSTER BAIN

Current Events

in the Chemical and Metallurgical Industries

Dyes and Coal-Tar Chemicals in 1919

The Census of Dyes and Coal-Tar Chemicals for 1919, which has been issued recently by the Tariff Commission as Tariff Information Series 22, is indeed a report of progress in these essential industries.¹ Outstanding features of the census have been given in the preliminary summary by Dr. Grinnell Jones, published in *CHEM. & MET.*, vol. 23, p. 661, Oct. 6, 1920.

INTERMEDIATES

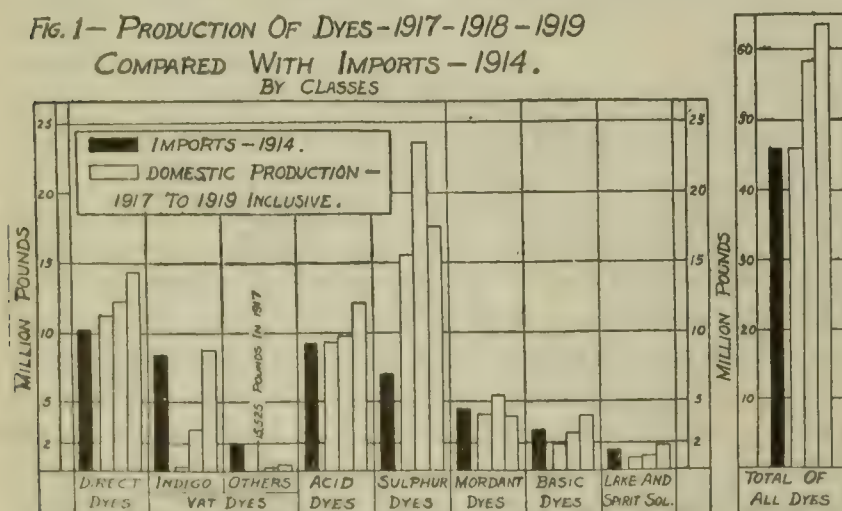
The decrease in the production of intermediates from 357,662,251 lb. in 1918 to 177,362,426 lb. in 1919 can be traced almost entirely to the diminished demand for products used primarily for explosives. The most spectacular case is that of phenol, which dropped from 106,794,277 lb. in 1918 to 1,543,659 lb. in 1919. In this report intermediates are grouped as benzene, toluene, xylene, naphthalene, anthracene and carbazole compounds, each group being subdivided whenever possible into classes of derivatives, such as halogen, nitro, amino, sulphonic acid, hydroxyl, etc. It is interesting to note that the production of anthraquinone in 1919 (294,260 lb.) exceeded the production of anthracene (purity of 25 per cent or over) in 1918 (225,552 lb.). The corresponding figure for anthracene in 1919 is 1,381,944 lb.

Another helpful innovation in this section is a list of intermediates used in the production of developed or coupled dyes directly on the fiber and in printing. Many of these compounds were sold before the war under trade names, such as Developer J and Reserve Salt O, and this list gives the chemical name corresponding to the trade name in the hope that customers will be able to obtain the materials more reasonably and that it will also help intermediate makers to supply those not yet made in this country.

DYES

Besides the itemized table showing a production of 63,402,194 lb. of dyes, valued at \$67,598,855, there is

FIG. 1—PRODUCTION OF DYES—1917—1918—1919
COMPARED WITH IMPORTS—1914.
BY CLASSES



included a comparison of 1914 imports with the production of dyes by classes in 1917-1919 inclusive. This is shown graphically in Fig. 1. It will be noted that the

classification is based upon the method of application on the fiber.

One hundred and ninety-one firms reported a total of 24,736 employees engaged in the manufacture of coal-tar products, of which 2,605, or 10.5 per cent, were chemists or engineers. This is probably a larger proportion of technically-trained men than will be found in any other important manufacturing industry in the United States. The group of employees receiving \$40 or more per week included 57.4 per cent of the technical men, but only 12.7 per cent of those without technical training. Corresponding figures for \$75 or more are 12.67 and 0.14 per cent respectively.

RESEARCH WORK

Of the total of 214 firms, 65 had separately organized research laboratories for the solution of technical problems in the manufacture of their products and for the discovery of new products. During 1919 the net operating expenses of these research laboratories, together with the cost of research work done in laboratories not separately organized for research, was \$4,274,247. This includes salaries, apparatus and materials, after deducting the value of salable products made in research laboratories. This figure is probably an understatement of the real cost of experimental work, since it does not include in all cases work of this nature done as a part of manufacturing operations and is not shown on the books of the companies as a charge against research.

CONDITIONS IN OTHER COUNTRIES

Beginning with February, 1920, detailed statements of one-quarter of the monthly production of every dye in each German factory were made to Reparations Commission, as required by the peace treaty, Annex VI, Part II. A classified summary of these reports from February to October, 1920, is published in this report by permission of the Department of State. A progressive increase is shown in each succeeding month to a maximum of 3,026,247 lb. in August, which indicates a total output of over 12,000,000 lb. per month. The rate of production from July to October inclusive is only about one-third of Germany's pre-war output.

Conditions in England, Switzerland, France and Japan are also briefly reviewed.

IMPORT STATISTICS

Information as to the importation of individual dyes is given in Part III of the report, which is a census of dyes imported into the United States during the fiscal year 1920. The Schultz and Julius number is given wherever possible, together with the name of the manufacturer. The companies listed include thirteen German, six English, four Swiss, two Dutch, one French and one Belgian. The imports total 3,501,147 lb., with an invoice value of \$4,458,109.

The names of 171 firms which manufactured coal-tar products during 1919 will be found in the appendix to this report. Coke-oven plants and gas houses which reported to the Geological Survey are not included.

¹Copies of this report may be obtained for 20c. from the Superintendent of Documents, Government Printing Office, Washington, D. C.

Chemical Tariff Schedule Under Consideration

Schedule A, that portion of the tariff which includes such chemicals, oils and paints as are not on the free list, was the subject of hearings on Jan. 6, 7 and 8. Judging from the attitude of the committee during those hearings and those which have followed, it seems apparent that the intention is to frame promptly a tariff bill which will provide rather arbitrary rates due to inability to ascertain accurately the costs of production abroad and to the difficulty of forecasting the economic situation either at home or abroad. The bill probably will be enacted with a full understanding that it is to be amended frequently as conditions may change.

DOMESTIC MARKET VALUE CONSIDERED AS BASIS

There is very decided sentiment in favor of ad valorem duties to be based on the market value of the commodity in the United States. Apparently the majority of the committee would like to see this plan tried. It is admitted, however, that many obstacles must be surmounted to make the plan effective. To start with, it will be necessary to scrap the intricate governmental machinery which has been built up through a long period of years for making valuations in foreign countries. There is objection on the ground that it will be unwise to disband such an organization in order to experiment with American valuations. Another difficulty arises in the fact that a large proportion of imports are specialties which are not manufactured in this country and on which it will be difficult to fix a fair American valuation.

DATA ON FOREIGN PRODUCTION COSTS UNRELIABLE

Those who have testified before the committee have had a great deal to say about cost of production abroad and most witnesses, in response to questions from the Democratic side of the committee, have stated that all they want in the way of tariff is a rate which will equalize the costs of production. In the face of cross-examination, it has developed that little accurate information is available as to costs of production abroad. The question is further complicated by the exchange situation and from the fact that currency has one value in foreign exchange and entirely another value when it comes to purchasing labor within the country of issue. Moreover, foreign costs are undergoing violent fluctuations.

FURTHER DEPRESSION MUST BE AVOIDED

Republican members of Congress are outspoken in their desire that great caution be used in framing this tariff law. If excesses are permitted to creep in and the rates are made too high, the effect of the law in increasing prices to consumers in the time of depression will react to the disadvantage of the party and the protective tariff idea. It is recognized that at present there are a large number of influences at work tending toward depression. With a new tariff act in the spot-light, it probably would be blamed for a condition for which it could be only partly responsible.

CONSUMING INTERESTS WELL ORGANIZED

Never before when a tariff bill was in the making have the consuming interests been so well organized. The successful outcome of the fight made by some of the textile interests on the dye bill is an indication of the skill with which opposition to tariff can be brought to play on such commodities as are used by powerful aggregations of consumers.

The consensus of opinion among those who were in attendance at the hearings on the chemical schedule is that the case was splendidly presented to the committee. There is abundant evidence that the committee is particularly sympathetic with the necessity for protecting the chemical industries. It is understood that the chief point of Democratic attack will be on other schedules. It is regarded as practically certain, however, that there will be some material reductions in the rate of duty requested by domestic manufacturers.

STATEMENT OF MANUFACTURING CHEMISTS ASSOCIATION

Henry Howard of the Grasselli Chemical Co. opened the hearings on the chemical schedule with a general statement for the Manufacturing Chemists Association. He pointed out that the manufacturing chemists appearing were confining themselves to articles not covered by the pending dye bill. He pointed out in the beginning of his statement that the problem is not alone one of depreciated foreign currency or of low foreign exchange, but is one of low wages. He said that German labor now costs half what it did before the war. He said that the development of the chemical industry is the best index of the progress of civilization in a country. He called attention to the fact that chemical development is predicated on continued systematic research carried out at great expense by the most highly trained experts obtainable. This sort of work is possible only when the industry is in a prosperous condition, because a number of years usually are required before there is any cash return from the products of research.

SPECIFIC VS. AD VALOREM

Mr. Howard made a plea for specific rates rather than ad valorem rates, where the substitution is possible, so as to simplify the administration of the act. He called attention to the fact, however, that in many cases two or more specific rates should be provided. He used this illustration:

Paragraph 73 of the 1909 act provided: "Sulphide of soda, containing not more than 35 per centum of sulphide of soda, $\frac{3}{4}$ of 1 cent per lb.; sulphide of soda concentrated or containing more than 35 per centum of sulphide of soda, $\frac{3}{4}$ of 1 per cent per lb." In the act of 1913 this dual classification was abandoned and a flat rate of $\frac{1}{4}$ of 1 cent per lb. substituted, with the result that only the concentrated product, 1 lb. of which was equal to 2 lb. of the crystals, was imported at a rate designed for the crystal or unconcentrated variety. This concrete instance is given as being typical of a great many and shows the advisability of providing two or more specific rates in all cases where it is possible to substitute a more concentrated or more valuable product for the one in common use at the time the tariff is written.

NEED FOR ANTI-DUMPING LEGISLATION

Mr. Howard emphasized the necessity for providing anti-dumping legislation. In that connection he said:

The association notes with approval the passage of the Fordney anti-dumping bill H.R. 10918 through the House of Representatives, Sixty-sixth Congress, second session, and the introduction of the Smoot anti-dumping bill in the Senate, as indicative of the intent of Congress to legislate on this most important matter, and most respectfully urges upon the Committee on Ways and Means that the next tariff act contain adequate and complete provisions along the lines of the Fordney and Smoot bills, bearing in mind that in our best judgment, no remedy against dumping will prove adequate unless it operates immediately and automatically at port of entry.

Chairman Fordney for the committee stated that it is the intention to make the anti-dumping bill a part of the tariff act if the Senate does not pass it before the

tariff bill comes before the House. In that connection Mr. Fordney stated that it is the intention to report the tariff bill to the House not later than April 10.

ALUMINUM SULPHATE AND BAUXITE SITUATION

In the course of his testimony on behalf of the makers of heavy chemicals, S. W. Wilder of the Merrimac Chemical Co., Boston, said:

We believe the 1913 duty is inadequate to protect our industry and we have special reasons why we may expect that importation from now on of sulphate of alumina and allied compounds will increase. It is a fact that in Europe the production of sulphuric acid has been greatly increased since the war, and sulphate of alumina is a very natural vehicle for disposing of sulphuric acid, and we feel that this country may become a dumping ground for that product.

Mr. Wilder opposed a duty on bauxite. Due to the quality of imported bauxite, he said it would be a serious matter to put a duty on it. Representative Rainey, a member of the committee, took occasion to interpose the following with regard to the Aluminum Company of America:

That company started out as a \$90,000 corporation a few years ago, and now it is a \$10,000,000 corporation, controlling the production of aluminum in Canada as well as in the United States, and probably also in the world.

SUGGESTIONS ON AMMONIA

Among the recommendations made by William H. Bower of the Henry Bower Manufacturing Co. of Philadelphia was the following:

We would also suggest that aqua ammonia be transferred from the non-enumerated paragraph to a paragraph covering ammonia and its products at a specific rate of 1½c. per lb.; liquid anhydrous ammonia, 5c. per lb. This would show a duty per pound of ammonia in ammoniacal gas liquor of 2c.; of aqua ammonia 5c., and a calculated ad valorem for liquid anhydrous of about 14 to 15 per cent. The ammonia industry is an important one in this country, and serves the refrigerating trade by which our foodstuffs are stored and preserved.

Frederick W. Russe of the Mallinckrodt Chemical Works, St. Louis, declared that low priced chemicals are emanating in great volume from Germany, England, France and Italy. "We do not know," he said, "whether it is due to the cost of production, unloading or dumping. At any rate, they have their catalogues and lists down in South America, and they are taking the business that we and other manufacturers have developed before the war and during the war due to these abnormal conditions that are now existing."

MEDICINALS PRESENT SPECIAL PROBLEMS

In giving reasons why medicinal chemicals should be especially regarded in a tariff bill, Donald McKesson of McKesson & Robbins, New York, said:

Medicinal chemicals, owing to their nature and the care with which they have to be produced, chemicals for internal administration or hypodermic administration, require extreme purity, and therefore they cannot be manufactured on a very large scale. You cannot use the ordinary automatic apparatus which can be used on a large-scale manufacture. The workmen have to be intelligent and skilled, they have to be very closely supervised by high-grade chemists, who are very hard to obtain. Our chemical training in this country is not as high as it is abroad, and we have to require our chemists when we employ them to study further to increase their knowledge before they are really as efficient as they should be.

In reply to a question as to what proportion of his costs is labor, Mr. McKesson said:

I would say the average would be about 40 per cent or more; we went up to 75 per cent on some products. Our manufacture being almost entirely of medicinal chemicals, the cost is higher than suggested by Mr. Rosengarten previously, who also manufactures the heavier chemicals, where the cost of labor is very much lower.

He also testified to the effect that professional men in Germany are in desperate straits and are working for very low salaries. In addition he said:

Another reason for protection, or, rather, another reason why there should be a great endeavor in foreign countries to export to the United States is that it is absolutely necessary for them to establish credits in the United States, even at a sacrifice, and they are going to try and get the goods in here at any price they can get them in.

Germany, since the war, has increased her syndicate system. They are consolidating all of their factories, and they have their pools from yellow-dog funds, and everything they had before they are working in the same way to an intensified extent. That is a situation that we cannot reach on account of the Sherman law.

An example of a question put to numerous witnesses is shown by the following colloquy between Representative Garner of the committee and August Kochs, of the Victory Chemical Works, Chicago:

MR. GARNER. You are willing to take the difference between the cost of production here and abroad and take your chances with the foreigner?

MR. KOCHS. Yes, sir; absolutely, as a matter of business, and I think every manufacturer should be willing to do that.

POSSIBILITY OF RETALIATION IN CASE OF CAMPHOR

An interesting exchange took place between Representative Rainey and Nathan M. Clark, vice-president of the Celluloid Company, and representing the Pyroxylin Manufacturers' Association. It follows:

MR. RAINEY. Did it ever occur to you that Japan might retaliate and put an embargo on this camphor?

MR. CLARK. That might be entirely possible, and we could not ask this committee to help us in that instance, as we can now, with a tariff.

MR. RAINEY. If you put on a tariff high enough to keep her manufactures of camphor out of this country, why cannot she put an embargo against your raw camphor?

MR. CLARK. Yes; but then we would die by her blow and not by a blow from our committees.

MR. RAINEY. Then if we passed a tariff which would keep her manufactures of camphor out this market and she retaliated by putting an embargo on your raw material, you would be out of business entirely?

MR. FREAR. We have heard about those bugaboos before.

MR. RAINEY. It is not a bugaboo; it may actually happen.

MR. CLARK. We believe that is a potentiality, but we feel we would rather meet it the other way first.

By allotting all the way from two to fifteen minutes to each witness, a large number of representatives of the chemical industry were given an opportunity to appear before the committee during the hearing. Each discussed the necessity for protecting the products of his own manufacture.

TARIFF INFORMATION SURVEYS

In connection with the hearing, the United States Tariff Commission has furnished a series of tariff information surveys covering the greater portion of the commodities contained in the tariff act of 1913. The fact that the Tariff Commission was able to assemble and have printed, on such short notice, such comprehensive information has brought forth much favorable comment.

Edgar Fahs Smith, New President of the A. C. S.

Like Robinson Crusoe, Dr. Edgar Fahs Smith, the new president of the American Chemical Society, was born at York, but there the analogy ends. Robinson Crusoe went off by himself. Dr. Smith couldn't do such a thing, because there is no spot on earth so isolated or so distant but that many alumni of Pennsy would surely follow after him and before he had his hut half-way built they would be surrounding him, unhooking their ribs and opening their hearts, seeking advice. He has always been a teacher of chemistry, and while his laboratory methods are in use wherever chemistry has entered industry his whole career and activities have been academic. Born in Pennsylvania, he studied at Pennsylvania State College, where he took his degree as bachelor of science at the age of eighteen. At twenty he had achieved his Ph.D. at Göttingen, and since then he has been decorated nineteen times or more by various universities here and abroad, so that he is a twenty-fold doctor.

AS TEACHER AND AUTHOR

He was instructor in chemistry at the University of Pennsylvania from 1876 to 1881, professor of chemistry at Muhlenberg College 1881-83, at Wittenberg College 1883-1888, and from then on at the University of Pennsylvania again. From 1889 to 1911 he was vice-provost of the same university, and its provost from 1911 until last year. Although administrative duties interfered seriously with research, his contributions to the knowledge of electrochemistry, of electrolytic methods for the separation of metals, and of electrolysis generally have made him a leading authority in respect to these subjects. He is the author of several monumental works on electrochemistry, has translated Richter's inorganic and organic reference books; he has made signal contributions to the chemistry of tungsten and its compounds and has contributed with his advanced students over one hundred original papers to chemical literature. Besides this and more he has written a number of volumes of supreme merit which are biographies of leading American chemists of days that are past. We have spoken before of them. They distinguish the subjects of whom he writes. It is a good thing to give thanks unto the Lord, says the Psalmist, and we venture to add that it is also a good thing to know how to do it. Dr. Smith has this gift of words for tribute, for appeal, and for exposition, but he does not misuse it.

HONORED BY MANY SOCIETIES

Aside from membership in many learned societies, he was president of the American Philosophical Society for four years, from 1902 to 1906, and was once before, in 1898, president of the American Chemical Society. In 1914 he received the Elliot Cresson Medal from the Franklin Institute.

RETAINS HOLD ON ALUMNI

As a teacher Dr. Smith has had, in addition to unusual familiarity with his subject, a remarkably keen and appreciative understanding of his objects—who were his students. He knew his young men, and they knew that he knew them. When a new provost was to be chosen he was practically the unanimous choice of the alumni. He straightway became famous among college presidents by keeping every alumnus of the university posted by fre-



EDGAR FAHS SMITH
President American Chemical Society

quent personal letters as to what the university was doing. He proved himself also a faithful and competent administrator.

AN ADEPT AT EXPOSITION

He has a whimsical sense of humor which he employs in exposition, and he is singularly able to make clear the truth in regard to science and its use in everyday life in a manner at once simple and direct. Thus, while his activities have always been academic, his interests are unbounded and his sense of industry is practical and sane. There is no dilletantism in the questions he asks when he visits a chemical factory. His mind is somewhat of the Franklin type, being at once alive with curiosity, constructive in its working and habit, philosophical in its ordering, and yet always open, and usually with a little leaning toward the homely things of everyday life.

These expressions in regard to Dr. Smith have been gathered after diligent inquiry among the alumni of the University of Pennsylvania and from one of the leading educators of America, who is head of another important institution of learning.

British Columbia Paper Possibilities Interest Capital

A number of influential eastern Canadian pulp manufacturers have been in Victoria conferring with the officials of the British Columbia Government with a view to obtaining certain concessions in connection with the erection of two or three large pulp mills in the province. Provided satisfactory arrangements can be made, it is proposed to build a mill at Prince George which, it is said, will cost in the neighborhood of \$6,000,000.

New Tanning Process for Australian Shrub

A shrub growing principally in the gold fields of Australia has been found to possess properties suitable for tanning purposes, according to the *World Salesman*. Leather tanned by the extracts from this shrub is adjudged equal to the best, being especially useful in lining hats. Some excellent samples of fast dyes have also been extracted from this shrub. An extensive area has been granted a new enterprise by the West Australian minister for mines, over which the company will strip the bush to feed a tanning and extracting works.

The Woodpile and Its Relation to the Paper Industry

The Connecticut Valley branch of the Cost Association of the Paper Industry held its regular monthly meeting on Jan. 10 at the Hotel Nonotuck, Holyoke, Mass. Dr. Hugh P. Baker, secretary and treasurer of the American Pulp and Paper Association, was the principal speaker, and had for his subject "The Woodpile and Its Relation to the Paper Industry."

Dr. Baker reviewed the history of the forests in this country, particularly in New England, and pointed out that at first the forests were believed to be inexhaustible and that at times timber was cut down and burned up that the settlers might get at the land. To illustrate what the price of woodland was not long ago, the speaker told of exchanging in his early boyhood forty acres of timber for a bicycle, and said that he got the better of the bargain, taking into consideration that plenty of good woodland could be had at that time for 50c. an acre. It is only within the last two or three decades that forestry has been put on a scientific basis.

It has been claimed that the paper manufacturers have been using up the forests, but statistics show that only 8 per cent of the forests are being used for paper pulp purposes. Ten years ago the person who spoke of the need of reforestation would have been regarded as a theorist, but today the paper manufacturers realize that their industry is dependent upon forestry, as only 2 per cent of the paper made in the U. S. is of all rag stock.

A number of pulp manufacturers in the East have been forced to go into Canada for timber lands, and paper manufacturers are now importing wood pulp from Finland and Scandinavia. This would not have been necessary had we had a proper reforestation policy. The state of New York spent \$140,000,000 for lumber last year and 85 per cent of it came from the South and other states. Only 32 per cent of the land of New England is being farmed. There is enough idle land east of the Ohio River alone which, if properly reforested, would not only provide in time all the lumber that we need, but provide an export supply.

Reforestation in the case of hardwood is not so urgent, as there are large stands of these at present, but the shortage of rapid-growing evergreens for pulp-wood purposes is becoming acute. Reforested lands are about four times as prolific as virgin land and a cutting for pulp purposes could be made in about sixty to seventy-two years. To illustrate that reforestation could be made a profitable business venture, Dr. Baker said that in Germany before the war tenant farmers were being made to vacate the lands, as the owners could make more on their investments by planting forests.

He spoke of the Snell forestry bill now before Congress and said that bill, he hoped, would be passed at the next session and would form the charter of reforestation for this country and mark the first definite

step of the United States for forestation. "Not an industry can get along without our forests," he said, "and I hope to see these New England states great forest states through reforestation of tracts now idle."

Industrial Relations Conference

A large number of manufacturers, industrial relations managers and business executives attended a conference of the Industrial Relations Association of America on Jan. 7 at the Hotel Kimball, Springfield, Mass., at which was advocated a more intimate relationship between employer and employee in all connections, for the sake of more harmonious relations and consequent greater production. The meeting was held as a district convention of the association in co-operation with the Employment Managers Association and the Chamber of Commerce of Springfield.

Colonel B. A. Franklin, vice-president of the Strathmore Paper Co., West Springfield, Mass., was one of the principal speakers at the morning session. In order to obtain lower labor costs, he advised maintaining the best working conditions possible, and stated that adequate lighting of plant, maintenance of health and correct mental attitude of all employees were important factors making for the most pleasant places to work.

An informal discussion followed the afternoon session, at which presidents of the associations in different cities spoke. C. V. Derrick, employment manager of the American Bosch Magneto Corporation, Springfield, Mass., expressed a wish that the higher managers of the factory attend conferences of foremen and of other employees. F. M. Marsh of Boston noted the development of leaders among the employees as a growing function of the industrial relations manager. Mr. Ching of the United States Rubber Co. and Mrs. Jane Williams spoke on "What Readjustments Are Needed in Personnel, Service and Employment Work Under Present Conditions." C. J. Yeomans of New York spoke on "What Does Personnel, Service and Employment Work Mean to the Management?" Howard Cheney of the Cheney Silk Mills, South Manchester, Conn., discussed "New Problems in Industry and How to Meet Them."

Among the practices advocated by the several speakers as sound business were: Make the employee feel you are telling him the truth in all matters; work on the golden rule; a square-deal basis for all concerned; courtesy in meeting all men who apply for work, whether there is work or not; make it possible for foremen to handle labor problems within their own walls.

Nichols Medal Awarded to Dr. G. N. Lewis

The conferring of the Nichols Medal upon Dr. Gilbert N. Lewis of the University of California, by the New York Section of the A. C. S., which was to take place at the Chemists' Club, New York City, March 11, has been postponed until May 6, 1921.

This medal is awarded for some particularly important article which appears during the year in the *Journal* of the American Chemical Society and is to be bestowed upon Dr. Lewis for his paper entitled "The Third Law of Thermodynamics."

Chemicals Sold as Surplus Property

Chemicals, acids and explosives to the value of \$3,703,586.66 were sold prior to Jan. 1 by the director of sales of the War Department. This does not include chemicals, acids and explosives transferred or sold to Government departments or agencies.

Production of Camphor in the United States

Two of the largest consumers of camphor in the United States, E. I. du Pont de Nemours & Co. and the American Celluloid Co., have essayed to defeat, at least in part, the monopoly which the Japanese Government maintains on the supply of camphor by growing their own. This fact was brought out Monday evening, Jan. 10, by William R. Webb, assistant superintendent of the chemical plant of the Eastman Kodak Co., in his talk on "Camphor, Natural and Synthetic" before the Rochester Section of the American Chemical Society.

In 1910 the American Celluloid Co. set out a camphor-tree grove of 3,000 acres in Florida, and five years later the du Pont company began a much larger camphor-tree farm in the same state. The trees are pruned each year and the clippings distilled. From them nearly 2 per cent of their weight in camphor is obtained. When the trees stop growing rapidly they are cut down and the whole tree is distilled for camphor. In the meantime younger trees are kept ready to take the places of the older ones.

The Japanese Government controls the harvesting, reforesting and distilling of its camphor trees. At one time it produced practically all of the camphor used in the world, which is variously estimated at 10,000,000 lb. a year. To overcome this monopoly Germany and France began competing with the natural product through artificial camphor produced in their chemical plants from turpentine. The war stopped the production of this synthetic camphor, so that today the groves in Florida are the most formidable competitor of the Japanese monopoly.

January Meeting of the Indiana Section, A.C.S.

At the January meeting of the Indiana Section of the American Chemical Society at Indianapolis on Friday evening, Jan. 14, Dr. F. O. Andereg of Purdue University gave a talk on "Activated Nitrogen, Hydrogen and Oxygen." It was pointed out that these elements are in very stable molecular form, oxygen being the least inert of the three. Nitrogen is extremely inactive and hydrogen is between the others in activity. If some way can be found to activate these gases, then many reactions which do not occur under ordinary conditions can be brought out. The simplest way to activate most substances is to raise the temperature. Another very important method of activation is to use a catalyst. That subject is so great, however, that it was not discussed further, but the time was devoted to the description of several other methods.

In many chemical reactions where these elements are set free a certain proportion of the atoms or molecules come off in an activated condition. Thus "nascent" or active hydrogen is given off during the rapid solution of metals by acids, and the amount of activated gas is increased by speeding up the reaction. Sometimes electrolytic hydrogen is also very active. Similarly ozone, the commonest form of activated oxygen, is produced under favorable circumstances when acids act on peroxides, during electrolysis and during the slow oxidation of phosphorus or arsenic by moist air. There is always produced in nitrogen from the decomposition of ammonium nitrite some activated form which in contact with an alkali yields nitrates. The suggestion is made that this is initially the result of activated nitrogen.

Another method of activating substances is by ionic bombardment in the electric discharge. This, of course, is the common method of ozone manufacture and can be extended to other gases as well. Nitrogen synthesis by both the arc and silent discharge processes should be included here, and also the so-called synthesis of gasoline as covered by the Cherry patents. A very interesting activated nitrogen is that extensively studied by R. J. Strutt in England. This was produced by a condensed discharge at reduced pressure in pure nitrogen and has many interesting chemical effects. Certain Germans thought that the effects observed were due to the presence of oxygen and the discussion waxed hot and heavy until they all got together in London just before the war broke out and Strutt's claim of the production of the active form from pure nitrogen was vindicated. It was also found that a trace of many foreign gases greatly

accelerated the activation. Recently at the University of Chicago Dr. Wendt and Dr. Grubb have produced and studied a still more active form of nitrogen in the silent discharge. It is hoped that the study of activated gases will aid in the understanding of the structure of atoms, which is today a most fundamental problem.

Dr. I. H. Derby, director of the chemical division of the Republic Creosoting Co., spoke very ably supporting "a movement to establish the co-operative relation between science and the industries in Indiana." Dr. Mahin of Purdue University acknowledged the benefits to both the state industries and the universities of such a proposal and described the present status of the question at Purdue.

T.A.P.P.I. Prepares for Annual Meeting

The executive committee of the Technical Association of the Pulp and Paper Industry met in New York last week and completed preliminary arrangements for the annual meeting and banquet of the association, to be held in conjunction with the annual meeting of the American Pulp and Paper Association at the Waldorf-Astoria and the Hotel Astor, New York, during the week of April 11 to 15, 1921.

The convention will open with informal meetings of the executive committee and the chairmen of standing committees on Monday, April 11. The first general session of the association will convene in one of the meeting rooms of the Waldorf-Astoria at 10 a.m., Tuesday, April 12. The second general session in the afternoon will be devoted to the reading and discussion of scientific papers.

On the evening of Tuesday, April 12, at the Hotel Astor, the annual banquet will be given, at which Judge Charles F. Moore will be toastmaster.

The third general session of the annual convention of T.A.P.P.I. on Wednesday will feature symposiums on pulverized fuel and steam economy, conducted by Howard S. Taylor, chairman of the committee on light, heat and power; and new methods of grinding wood, conducted by the committee on groundwood, of which W. E. Munro is chairman.

Other symposiums, discussions and special papers for Wednesday and Thursday afternoons will be announced later.

Changes Considered in Methods of Industrial Alcohol Distribution

Whether or not changes in the present procedure in distributing industrial alcohol are advisable is being considered by a committee representing industrial alcohol producers. The appointment of the committee was the outgrowth of a meeting Jan. 19 with Prohibition Commissioner John F. Kramer. Mr. Kramer is anxious to know if illegal uses of this alcohol can be safeguarded further. The committee having the matter under consideration is made up as follows: Chairman, Henry J. Kaltenbach, New York, vice-president T. Fleischmann Co.; F. M. Harrison, United States Industrial Alcohol Co.; G. M. MacDowell, National Cereal Beverage Association; Charles Bacharach, Jefferson Distilling & Denaturing Co.; Albert H. Selling, David Berg Industrial Alcohol Co.; V. M. O'Shaughnessy, Rossville Distilling Co.; H. M. Gaylord, Kentucky Distilleries & Warehouse Co.; G. F. Dieterle, Federal Products Co.

Discussion of Western Metallurgical Problems

Dorsey A. Lyon, supervisor of stations, and other Bureau of Mines general officers, the superintendents of the Western experiment stations, Messrs. Van Barneveld, Duschak, Lind, Ralston and Varley, and the deans of co-operating mining colleges, Messrs. Butler, Probert, Lincoln, Merrill and Roberts, met in Berkeley, Cal., during the week of Jan. 24 for discussion of the work in hand and that contemplated by the bureau. Careful consideration was given to all phases of co-operative work of the bureau, colleges and industry, particularly any action designed to stimulate investigational work and the maintenance of close contact. "Flotation" was discussed by Dr. S. C. Lind, "A New Source of Alumina" by O. C. Ralston, and "Production of Sponge Iron" by the round table.

Status of the Nitrogen Corporation Bill in the House

Passage by the Senate of the nitrogen corporation bill removes none of the obstacles which face the bill in the lower house. On receiving the bill from the Senate, the House referred it to the Committee on Military Affairs, which has been considering the House bill on that subject. Representative Kahn, chairman of the committee, states that the bill will not be reported to the House until hearings have been held. Since the Military Affairs Committee has other matters before it which must be disposed of first, no effort has been made to fix a date for these hearings. Some are of the opinion that the bill will die in committee, but apparently the advocates of the bill are in the majority. The ranking Democrat is Representative Dent, of Alabama. Representative Anthony, of Kansas, ranks next to the chairman, and several other influential members are from agricultural sections which are advocating the passage of this legislation. A very influential member of the committee is Representative Fisher, of Tennessee. While there is much doubt as to the outcome of the struggle certain to take place in committee, it is apparent that the pigeonholing of the bill is by no means a foregone conclusion.

It is believed very generally that the bill can be passed in the House if it is brought to a vote. With the exception of Representative Mann, of Illinois, the Republican leaders in the House are understood to be opposed to the measure. With the end of the session approaching, however, the friends of the bill are in a position to exert great pressure on these leaders. If the bill is taken up in the House, it is believed it will be amended in several important particulars. One amendment doubtless will be the relief of the corporation from that provision of the Senate bill which requires it to make a profit from its inception. Another amendment doubtless will be to override the Senate in the matter of precluding Army officers from serving on the board. Undoubtedly the proponents of the legislation would predominate among the conferees, with the probability that the Senate conferees would recede on the more important of the House amendments. By the time the conference report is submitted, it is certain to be late in the present session, thereby offering a splendid opportunity for conducting a successful filibuster against the adoption of the conference report.

The bill, as passed by the Senate, has been put under the microscope during the past week by both its friends and its enemies. Due to the extensive way in which the bill was amended, it now is somewhat disjointed and contains a number of minor errors and conflicts, which, however, can be straightened out in the House and in conference. It is admitted that the provision of the bill making it necessary to pay 5 per cent interest on a sum equivalent to one-half of the original cost of the property cannot be complied with, especially during the first year of the corporation's existence. It was pointed out that it would be unfair to make the corporation pay interest on that considerable portion of the plant which would not be used by it.

It will be recalled that the Ordnance Department has been interested only in having the plant operated. Every effort was made to lease it to private interests. Arthur Glasgow spent six months of intensive effort to obtain a lessee, and at one time it appeared as though the United States Steel Corporation would lease the plant. Then came the suggestion that the Government operate the plant and with it was coupled later the agitation for the sale of the product as fertilizer. Whether or not the nitrogen corporation bill becomes a law, the Ordnance Department expects to redesign and reconstruct one of the units of No. 1 plant for experiments with the Haber process. Ordnance officials do not accept the frequently repeated statement made on the floor of the Senate that the cyanamide process has become obsolete. They point out that the cyanamide process continues in active use at thirty plants in eight countries, while the Haber process is in use nowhere outside of Germany. It is regarded as significant that the favorably located cyanamide plants in Germany are continuing to operate.

The amendment providing that no Army officers shall serve

on the board of the nitrogen corporation is criticized on the ground that each side in the controversy has recognized that the only excuse for the corporation is the fact that it would be in the interest of national defense. Even those who are most interested in obtaining fertilizer at the lowest possible cost admit that the principal purpose of the plant is to enable the country to secure nitrogen for war uses. Under those conditions to bar Army officers from the board is held to be on a par with another amendment to the bill which cut out the research laboratory provision. The laboratory would be essential to the full utilization of the plant for the advancement of knowledge as to the military aspects of nitrogen fixation.

There seems to be no objection in War Department circles to the provision of the bill which limits to 150,000 tons the amount of the nitrate reserve which may be sold. In this connection, it must be noted that it is 150,000 long tons, while current prices usually are quoted in short tons. With sterling exchange rising, and with other indications that Chilean nitrate will advance in price, some figure that \$9,000,000 is the probable realization which could be obtained from this 150,000 long tons of Chilean nitrate. Since the corporation would not need all of its money at once, the sale of the reserve could be spread out over a considerable period, so as not to demoralize or seriously affect the market. There has been considerable controversy over the Army's estimates made in connection with the nitrogen corporation project. The officers who made them call attention to the fact that sight is being lost of the prices and factors which prevailed at the time they were made.

Personal

Dr. MILO C. BURT, formerly of the ribbon factory of the Remington Typewriter Co. and of the Aetna Explosives Corporation, and WALTER R. HIBBARD, formerly of the U. M. C. Works of the Remington Arms Co., Inc., have opened a consulting and research laboratory in the McMahon-Wren Building, Bridgeport, Conn., under the name of Burt & Hibbard, Inc.

Dr. CARL J. ENGELDER, formerly chief chemist for the Pennsylvania Gasoline Co., is now assistant professor of analytical chemistry at the University of Pittsburgh, Pittsburgh, Pa.

Dr. COLIN G. FINK of the Chile Exploration Co., New York, will speak before the Pittsburgh Section of the American Electrochemical Society on "Modern Developments in Metallurgical Research," on Friday, Jan. 28. The meeting is to be held at the Mellon Institute, and will be preceded by a dinner at the University Club of Pittsburgh.

A. F. GREAVES-WALKER, production manager of the American Refractories Co., Pittsburgh, Pa., has been appointed chairman of the Refractories Division of the American Ceramic Society to take the place vacated by the resignation of A. V. Bleining.

Dr. OTTO KRESS, chairman of the committee on dyestuffs, Technical Association of the Pulp and Paper Industry, who has been in charge of the section of pulp and paper at the Forest Products Laboratory, Madison, Wis., for several years past, will resign from the service soon to accept a responsible position with the Consolidated Water Power & Paper Co., Wisconsin Rapids, Wis.

Dr. S. A. MAHOOD, who was in charge of research on wood cellulose and essential oils at the U. S. Forest Products Laboratory, Madison, Wis., has resigned to become associate professor in charge of organic chemistry at Tulane University, New Orleans, La.

Dr. E. E. MARBAKER, formerly chief engineer of Alexander Bros., Philadelphia, has accepted the position of chemist to the Cleveland Wire Division of the National Lamp Works of the General Electric Co.

HOMER F. STALEY, of the ceramic department of the Bureau of Standards at Washington, has resigned to be-

come affiliated with the Metal & Thermit Corporation, 120 Broadway, New York City, as ceramic engineer.

Dr. S. A. VONSOCHOCKY, general technical director of the Radium Luminous Material Corporation and the Radio Chemical Corporation, both of New York, has been elected president of the former company.

F. R. WADLEIGH, who has been export sales manager for Weston, Dodson & Co., Inc., has entered private practice as a consulting engineer. He is prepared to act in an advisory capacity on matters pertaining to the production, market and use of coal.

Dr. E. W. WASHBURN, director of ceramics at the University of Illinois, Urbana, Ill., has been appointed editor of the *Journal of the American Ceramic Society* beginning with the current year.

Obituary

EDWARD T. MCHUGH, for many years president of the McHugh Foundry Co. of Holyoke, died on Jan. 9, at the age of seventy-nine. Mr. McHugh's first important work was undertaken for the Government during the Civil War when he was stationed at Chattanooga, Tenn., in charge of reconstruction of railroads destroyed by the Confederates.

FERDINAND SCHLESINGER, head of the Newport Chemical Co., Milwaukee, Wis., died suddenly at Albuquerque, N. M., at the age of seventy. He was on his way to Pasadena, Cal., accompanied by his wife and son. Mr. Schlesinger was chairman of the board of directors of the Milwaukee Coke & Gas Co. and the Steel Tube Co. of America.

Current Market Reports

The Chemical and Allied Industrial Markets

New York, Jan. 24, 1921.

Actual trading in heavy chemicals during the past week has been very slow. However, there continued to be signs of a renewal of live interest. Improvement was noted in the extent of inquiries for miscellaneous chemicals. The slow but steady absorption of resale stocks has placed the market in a distinctly stronger position. The continued increasing strength of the alkalis is one of the most hopeful signs, and leading interests in the trade believe that this strength will soon spread throughout the general list of heavies.

The unceasing request from domestic consumers has forced manufacturers of *caustic soda* and *soda ash* to reduce prices on contracts. It is stated that the revision is not warranted by any lessened cost of production, but leading makers are willing to step in line with the general trend of affairs in an effort to stimulate business for forward shipments. The open quotation for *solid caustic soda* is now \$3.60 per 100 lb., basis 60 per cent, f.o.b. works, while 3½c. per lb. is the inside figure for round lots over the balance of the year. This cut represents a minimum of 15c. and a maximum decline of 25c. per 100 lb. *Light soda ash* is offered on contract at \$1.72½ per 100 lb. in single bags, basis 48 per cent, f.o.b. works, against a former figure of \$1.82½. Both chemicals on the spot market displayed a stronger tendency. Resale *caustic soda* is still obtainable below producers' prices, owing to the accumulated stocks in the hands of dealers, while the scarcity of *light ash* in second hands has forced the market to about the same level as that named by producers.

The demand for additional quantities of *white arsenic* has not been very active of late. Moderate offerings are obtainable at prices ranging from 11c. to 11½c. per lb. for domes-

tic material, while as low as 10½c. could probably be had on limited offerings of foreign. Resale lots of *formaldehyde* are in the market at prices ranging from 18c. to 19c. per lb., although most dealers are not eager to quote under 18½c. Producers quoted contracts at 20c. Manufacturers named 6½c. per lb. as the inside figure for standard *copper sulphate*, 99 per cent, in car lots. Outside makes occasionally reached the market at a trifle under this price, but there does not appear to be a great deal of material around. The inquiry is rather quiet at present and somewhat below that of recent years at this time.

Prominent sellers of *copperas* reported sales of prime goods on a basis of \$25 per ton f.o.b. works. It is doubtful whether any round lots could be purchased on the spot market under 1¼@2c. per lb. Sales of *yellow prussiate of soda* were reported at 17½c. per lb. and a few odd lots down to 17c. The tone of the market is firmer, however, and resale offerings are not as free as noted at the beginning of the month. Producers are asking 18c. for contracts, but admit that the inquiry for future shipments is rather quiet at the present time. Resale offerings of *caustic potash*, 88-92 per cent, are in the market at prices ranging from 14c. to 16c. per lb. Producers are quoting considerably above this figure, but admit that the demand is very light and confined solely to contract deliveries. There are sellers of foreign material for prompt shipment from Germany on a basis of 10c. per lb.

Sales of imported *tartaric acid* were reported at 33c. per lb., spot, duty paid, for the crystal variety. The powdered is quoted higher and sellers are asking 35@37c. per lb. Demand has not shown much activity of late and the feeling is still irregular regarding the future course of prices. Fused 60-62 per cent *sodium sulphide* is quoted by dealers at 5½@5¾c. per lb. for resale goods. The broken grade is considerably higher, and it is doubtful if much material could be obtained under 7c. per lb. The single strength crystals are now offered freely and the market remained more or less unchanged at 3½c. Sales of *sal ammoniac*, white, granular, 99 per cent, were reported down to 8½c. per lb. on spot. At the close of the week there were sellers at 8¼@9c. per lb. The demand has not been of any considerable volume so far and sellers were able to get business only by granting considerable price concessions.

COAL-TAR MARKET

Considering the increase in both inquiries and orders from different quarters of the market during the past week, many are led to believe that a period of improvement is ahead, and broader trading can be expected. Producers of various materials are holding to their views on prices and practically no reductions are announced. Most factors expect to see prices forced higher by the increasing activity among textile mills. While business in the woolen trade has not as yet shown much activity, it is expected that a better buying movement will be noted upon the naming of new prices by the American Woolen Co.

Trading in *dimethylaniline* was confined to a light volume. Producers are firm in their views on prices at 65@75c. per lb. Second hand lots are not being offered in any liberal quantities. The market in *dinitrotoluene* still holds to routine trading in small lots. There has been very little change in price on this item for some time. Quotations range from 27c. to 30c. per lb., depending on seller. Supplies of *H acid* are reported available in more quarters than recently noted and figures vary depending on sellers. In one direction \$1.30 was asked for a limited quantity, while leading producers named \$1.60. The demand for spot goods remained quiet and there was little talk on futures.

While the volume of trading in the market on *aniline oil* is still confined to small lots, the general tendency is toward a higher level of prices and where heretofore 23c. was readily done, the price is said to be harder to locate and 26@28c. per lb. was more generally quoted. The lack of any demand for *diphenylamine* seems to persist and with a fair volume of goods available, the market looked weak with quotations at 65@70c. per lb. The *anthracene* market attracted a little more attention during the past week in both offerings and inquiries. Domestic producers are not

thought to be in any better position on supplies and prices on the 80 per cent are quoted at 85c.@\$1 per lb.

There is very little change noted on *beta naphthol* of late and offerings are again noted at prices that show shading on producers' quotations and range from 35@40c. per lb. Prices on *paranitraniline* were named by producers from \$1 to \$1.05 per lb. for prompt delivery, with \$1.10 named on contract. Spot lots are around the market from second hands at figures well below manufacturers. The general quotation ranged from 90c. to 95c. per lb.

No change in *benzene* has been noted in the market. Prices in producers' hands remain around 30@35c. per gal. in drums and 28@32c. per gal. for the 90 per cent grade. Buying has been very limited on account of the slowness in consuming industries. *Naphthalene* producers are holding 9c. per lb. as the standard contract price over the year. There are lots to be had from dealers as low as 8c. per lb. for prime white goods, but it is understood that lots at these figures are being held more firmly and that in many cases holders have advanced their ideas to 8½@8¾c. per lb. No further imports have been noted, but stocks of foreign and domestic are still heavy in many quarters. The former price of 9c. per lb. on *phenol* is becoming increasingly hard to do, as stocks on spot are being cleaned up. Offers generally are made around 9½@10c. per lb., with more at the higher than at the lower figure.

The Chicago Market

Chicago, Jan. 21, 1921.

Heavy chemical prices in general have remained firm, the most notable exception being *blue vitriol*, which has been weakened by the low price prevailing in the copper market. Spot sales are recorded at 6¼c. per lb. for large crystals, and ½c. less for the small. Demand for small quantities is constant. All of the soda products have remained firm in price, all indications pointing to the practical elimination of second hand stocks. *Soda ash* on immediate delivery is quoted at \$2.20 per 100 lb. Contracts are reported at \$1.82½ per 100 lb. for 48 per cent f.o.b. works. *Caustic soda* has changed hands on the spot at as high as 4½c. per lb., but 4¼c. is probably more near the average market. Contracts are offered at \$3.75 per 100 lb. f.o.b. producing point. *Sal soda* is in poor demand, with price unchanged at \$2@ \$2.25 per 100 lb. Current demand for *bleaching powder* seems well covered by contracts which range around 3½c. per lb. Spots are offered somewhat lower, but little interest is shown.

Formaldehyde is easier and is reported as offered at 22c. per lb. in cars f.o.b. factory. Resale stock is offered at considerably below the market. *Alcohol*, *ethyl* grade, remains unchanged at \$5.10 per gal. for 190 proof, but *methyl* grade and *denatured* are both sharply off. Light demand on *denatured* has forced the price down to 68@72c. per gal. *Methyl*, 97 per cent, is down to \$1.35 per gal. Production is being sharply cut as large stocks are said to be in the hands of both producers and second hands. *Glycerine* remains quiet, as offers remain firm at 20c. per lb. for c.p. grade. *Quicksilver* remains weak, \$45 per flask representing the top of the market.

Chlorate of potash is on an uncertain price basis, the domestic being quoted at 16½@17c. per lb. for the crystals, and ½c. less for the powdered. *Caustic potash* is quoted all the way from 15c. to 20c. per lb. for domestic goods, with but few sales being closed. Imported goods are offered at much lower prices. *Carbonate of potash*, calcined, is offered at 14@17c. per lb., with little business resulting. *Chlorine*, liquid gas, is being bought in limited quantities only, and is quoted unchanged at 9@10c. per lb. *Salt cake* is in limited supply and price for immediate delivery ranges around \$53 per ton. *Sulphuric acid*, 60 deg., is quoted at \$15 per ton, but demand on this, as on other heavy acids, is light on the market.

VEGETABLE OILS

There is little doing in oils, as consuming factors have reduced operations to a minimum, operation being quoted as running below 25 per cent in most lines. *Linseed oil*

remains at 94c. per gal. in 1 to 5 bbl. lots from jobbers' stock and is quoted at around 80c. in carlots in cooperage. Actual sales of *coconut oil* in quantity have been made at 10½c. per lb. and Coast quotation is 9¼c. for Manila, in sellers' tanks. Demand is better than has been noted for some time. *Corn oil*, offered at 6½@6¾c. per lb. f.o.b. works, attracts no attention, and the same is true of *cottonseed oil* at 5¼@6c. for crude f.o.b. Texas points. Partial resumption of the textile industry holds some promise of better business in *red oil*, but no current market is in evidence.

NAVAL STORES

Contrary to general expectation, the advent of the new year failed to bring any renewal of activity in naval stores. Rosin and turpentine are equally quiet, the utter lack of export trade causing stocks to accumulate all along the line. *Turpentine* is quoted by jobbers in less than 5-bbl. lots at 96c. per gal.

COAL-TAR PRODUCTS

Business is utterly quiet, but prices are held firm, apparently because there is no hope of inducing business even through the medium of price cutting. *Naphthalene* is almost a drug on the market, quantities of imported material being available at 7½@8c. per lb. for the flakes and 9@9½c. for balls. Domestic is not so plentiful, and commands 1@1½c. per lb. higher price. Second hand holdings are confined principally to imported goods. *Toluene* at 35@37c. per gal. is in demand in routine quantities only and *benzene* seems a little more desired at 36c. than was the case a few weeks ago. Practically the entire line of intermediates may be covered in one phrase—no business. Prices are being held firmly, but it is probable that real money would secure radical concessions. The one exception is *aniline oil*, which is meeting fair demand at 25c. per lb.

The St. Louis Market

St. Louis, Jan. 21, 1921.

While there has been no startling increase in activity in the St. Louis market during the past two weeks an optimistic feeling is still very much in evidence. Quotations in practically no instances are showing any signs of weakness, though there has not been a very great demand. Producers give two reasons for this condition, one being a lowered production of some items and a resultant decreased stock. The other reason is the confidence that when demand does begin it will be concerted and prove more than equal to the stocks on hand.

Shipments on contracts have improved recently but are still slightly under normal. Contract renewals at current prices continue to be frequent but spot business has not recovered from its coma.

Shipments of the 98 deg. *sulphuric acid* have bettered and the quotation is holding firmly at \$24 per ton f.o.b. works. There is a lively market for the 66 deg. *sulphuric acid*, more sales being recorded for this strength than for any of the others. Producers are quoting \$20@\$21 per ton and 1¼c. per lb. in carboys, both prices at plant in St. Louis. The demand for the 60 deg. *sulphuric acid* has become quiet again but prices are being held at \$16 per ton and 1¼c. per lb. in carboys. There have been a number of inquiries for *oleum*, but as far as a real demand is concerned the market is quiet. The current quotation is \$28.50 per ton.

Muriatic acid is in fairly good demand, with supplies on hand continuing low. Producers are asking 1¼@2c. per lb. in carboys and \$25 per ton in bulk lots.

Quietness is the prevailing note in the *sodium bisulphate* market, with a flash of activity interspersed occasionally. Shipments have been quiet also. The current price is \$7@\$8 per ton.

Nitric acid has been very quiet, with quotations unchanging. The accepted prices are \$7 per 100 lb. for the 36 deg. test and \$10 per 100 lb. for 42 deg. *Standard mixed acid* is quoted at 1¼c. per lb. of sulphuric content and 11¼c. per lb. of nitric acid content.

Zinc chloride is slow at \$4.15 per 100 lb. for the 50 per cent test. U. S. Government supplies of *phenol* are being offered by a St. Louis producer at 12¼c. per lb.

The Iron and Steel Market

Pittsburgh, Pa., Jan. 21, 1921.

Demand for steel has not increased, either in the open market or against contracts. Generally speaking there is a decrease, making comparison with the average of December.

While the double market in steel products ended with 1920 by the independents coming down to the Steel Corporation level in prices, the Steel Corporation and the independents are in totally different positions. The independents seem to have expected a redistribution or leveling up process to occur, whereby they and the Steel Corporation would be in much the same position. Instead, there is a wide divergence. The independents are operating at about one-fourth of capacity on an average, while the Steel Corporation is operating at about 92 per cent, and even as to a continuance of the present rates of operation the Steel Corporation has the better outlook.

There is more or less similarity in the predictions as to future of the iron and steel market—that there will be no very material improvement in demand before the second half or third quarter of the year.

PRICES

There are reports of price cutting on the part of independents, but the really important point in the market is that there is not enough business being offered to induce general price cutting if the willingness to cut prices were complete. The real test is not being furnished. A sale of blue annealed sheets at \$3 a ton under the regular market of 3.55c., base, is reported, but that was 1,000 tons to the Standard Oil Co., on a very attractive specification. Orders so attractive are not common even in an active market, hence it seems to be a case of the exception that tests the rule. If \$3 is the limit of concession in such cases, an ordinary order would hardly bring out any shading.

Again, it is reported that mills in the Chicago district are shading prices on certain commodities by various amounts up to \$4 a ton, but in this case again it is a matter of the "Pittsburgh basing," the nominal market at Chicago being the Pittsburgh price plus freight, which is \$7.60, so that the Chicago mill would still be getting several dollars a ton more than the Pittsburgh price, and in a weak market the Pittsburgh basing is not expected to stand.

Regular prices remain as follows: Bars, 2.35c.; shapes, 2.45c.; plates, 2.65c.; grooved steel skelp, 2.45c.; universal mill skelp, 3.55c.; sheared skelp, 2.65c.; standard steel pipe, 57½ per cent basing discount; plain wire, 3.25c.; wire nails, \$3.25; blue annealed sheets, 10-gage, 3.55c.; black sheets, 28 gage, 4.35c.; galvanized sheets, 28-gage, 5.70c.; tin plate, \$7 per base box, 100 lb.; hoops, 3.05c.; hot-rolled strip, 3.30c.; cold-rolled strip, 6.25c. Standard railroad spikes are 3.65c.; cold-finished steel bars 3.60c., chain 7.25c. base, structural rivets 4c. and boiler rivets 4.10c. Rivets have come down somewhat in the past week, the other prices having been in force for several weeks.

PIG IRON

Bessemer and basic have been wholly inactive, and remain quotable at \$32 and \$30 respectively, valley furnaces, the levels to which they declined at the beginning of the year. Several sales of foundry iron in lots of about 500 tons each have established the quotable market at \$31.50 valley, a decline of \$1.50 in the week. Pig iron in the valley market has now declined nearly \$20 a ton since the high point of last August, and in proportion to the drop that has occurred the market has relatively little room for further decline. The greatly advanced freight rates represent several dollars per ton of pig iron by which pre-war prices could not be attained, and there are high wages in the Connellsville coke region, probably impossible of much reduction while the present high mining scale obtains in the union bituminous coal regions. The independents in the Lake Superior ore region are reducing wages by 15 per cent, but that does not indicate any close approach to pre-war prices for ore. The extreme estimate is that pig iron may get down to \$25 within the next six or nine months.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride.....	lb.	—	\$0.55 - \$0.60
Acetone.....	lb.	\$0.13 - \$0.13	.13 - .14
Acid, acetic, 28 per cent.....	100 lbs.	3.00 - 3.25	3.50 - 3.75
Acetic, 56 per cent.....	100 lbs.	6.00 - 6.25	6.50 - 6.75
Acetic, glacial, 99½ per cent, carboys.....	100 lbs.	10.50 - 11.00	11.25 - 11.50
Boric, crystals.....	lb.	.14 - .15	.15 - .16
Boric, powder.....	lb.	.15 - .16	.17 - .18
Citric.....	lb.	—	.46 - .48
Hydrochloric.....	100 lb.	1.60 - 1.75	1.85 - 2.25
Hydrofluoric, 52 per cent.....	lb.	.15 - .16	.16 - .18
Lactic, 44 per cent tech.....	lb.	.10 - .11	.11 - .12
Lactic, 22 per cent tech.....	lb.	.04 - .05	.06 - .07
Molybdic, C. P.....	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....	—	—	—
Nitric, 40 deg.....	lb.	.07 - .07	.08 - .08
Nitric, 42 deg.....	lb.	.08 - .09	.09 - .10
Oxalic, crystals.....	lb.	.18 - .18	.19 - .20
Phosphoric, Ortho, 50 per cent solution.....	lb.	.18 - .18	.18 - .19
Picric.....	lb.	.30 - .32	.35 - .40
Pyrogallol, resublimed.....	lb.	—	2.30 - 2.40
Sulphuric, 60 deg., tank cars.....	ton	—	14.00 - 15.00
Sulphuric, 60 deg., drums.....	ton	—	—
Sulphuric, 66 deg., tank cars.....	ton	18.00 - 19.00	—
Sulphuric, 66 deg., drums.....	ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....	ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars.....	ton	23.00 - 24.00	—
Sulphuric, fuming, 20 per cent (oleum) drums.....	ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....	ton	32.00 - 35.00	40.00 - 42.50
Tannic, U. S. P.....	lb.	—	1.15 - 1.25
Tannic (tech.).....	lb.	.45 - .47	.48 - .50
Tartaric, crystals.....	lb.	—	.33 - .35
Tungstic, per lb. of WO.....	lb.	—	1.20 - 1.40
Alcohol, Ethyl.....	gal.	—	5.10 - 5.50
Alcohol, Methyl (see methanol).....	—	—	—
Alcohol, denatur ed, 188 proof.....	gal.	—	.66 - .70
Alcohol, denatur ed, 190 proof.....	gal.	—	.71 - .75
Alum, ammonia lump.....	lb.	.04 - .04	.05 - .05
Alum, potash lump.....	lb.	.05 - .06	.06 - .07
Alum, chrome lump.....	lb.	.13 - .13	.14 - .14
Aluminum sulphate, commercial.....	lb.	.02 - .02	.03 - .03
Aluminum sulphate, iron free.....	lb.	.03 - .03	.04 - .04
Aqua ammonia, 26 deg., drums (750 lb.).....	lb.	.06 - .07	.07 - .08
Ammonia, anhydrous, cyl. (100-150 lb.).....	lb.	.30 - .32	.33 - .35
Ammonium carbonate, powder.....	lb.	.12 - .12	.13 - .13
Ammonium chloride, granular (white salamoniac) (nominal).....	lb.	.08 - .09	.09 - .09
Ammonium chloride, granular (gray sal-ammoniac).....	lb.	.08 - .08	.09 - .09
Ammonium nitrate.....	lb.	.09 - .09	.10 - .10
Ammonium sulphate.....	lb.	.03 - .03	.04 - .04
Amylacetate.....	gal.	—	4.25 - 4.50
Amylacetate tech.....	gal.	—	3.50 - 3.75
Arsenic oxide, (white arsenic).....	lb.	.10 - .11	.11 - .11
Arsenic, sulphide, powdered (red arsenic).....	lb.	.15 - .15	.15 - .16
Barium chloride.....	ton	75.00 - 80.00	85.00 - 90.00
Barium dioxide (peroxide).....	lb.	.24 - .25	.26 - .27
Barium nitrate.....	lb.	.10 - .10	.10 - .11
Barium sulphate (precip.) (blanc fixe).....	lb.	.04 - .05	.05 - .06
Bleaching powder (see calc. hypochlorite).....	—	—	—
Blue vitriol (see copper sulphate).....	—	—	—
Borax (see sodium borate).....	—	—	—
Brimstone (see sulphur, roll).....	—	—	—
Bromine.....	lb.	.50 - .52	.54 - .56
Calcium acetate.....	100 lbs.	2.00 - 2.05	—
Calcium carbide.....	lb.	.04 - .04	.04 - .05
Calcium chloride, fused, lump.....	ton	27.00 - 29.00	30.00 - 32.00
Calcium chloride, granulated.....	lb.	.02 - .02	.02 - .03
Calcium hypochlorite (bleach'g powder).....	lb.	.02 - .02	.03 - .03
Calcium peroxide.....	lb.	—	1.25 - 1.30
Calcium phosphate, monobasic.....	lb.	—	.16 - .18
Calcium sulphate, pure.....	lb.	—	.05 - .06
Camphor.....	lb.	—	.85 - .90
Carbon bisulphide.....	lb.	.08 - .08	.09 - .09
Carbon tetrachloride, drums.....	lb.	.11 - .11	.11 - .12
Carbonyl chloride (phosgene).....	lb.	—	.60 - .75
Caustic potash (see potassium hydroxide).....	—	—	—
Caustic soda (see sodium hydroxide).....	—	—	—
Chlorine, gas, liquid-cylinders (100 lb.).....	lb.	.09 - .09	.10 - .10
Chloroform.....	lb.	—	.43 - .50
Cobalt oxide.....	lb.	—	3.70 - 3.80
Copper as (see iron sulphate).....	—	—	—
Copper carbonate, green precipitate.....	lb.	.22 - .22	.24 - .25
Copper cyanide.....	lb.	—	.40 - .50
Copper sulphate, crystals.....	lb.	.06 - .06	.06 - .07
Cream of tartar (see potassium bitartrate).....	—	—	—
Epsom salt (see magnesium sulphate).....	—	—	—
Ethyl Acetate Com. 85%.....	gal.	—	1.05 - 1.10
Ethyl Acetate pure (acetic ether 98% to 100%).....	—	—	—
Formaldehyde, 40 per cent.....	lb.	.18 - .18	.19 - .20
Fusel oil, ref.....	gal.	—	3.50 - 3.60
Fusel oil, crude.....	gal.	—	2.75 - 3.00
Glauber's salt (see sodium sulphate).....	—	—	—
Glycerine, C. P. drums extra.....	lb.	—	.20 - .21
Iodine, resublimed.....	lb.	—	3.85 - 4.00
Iron oxide, red.....	lb.	—	.10 - .20
Iron sulphate (copperas).....	100 lb.	1.75 - 2.00	2.25 - 2.50
Lead acetate, normal.....	lb.	—	.14 - .16
Lead arsenate (paste).....	lb.	.13 - .14	.14 - .15
Lead nitrate, crystals.....	lb.	—	.90 - 1.00
Litharge.....	lb.	.09 - .09	.09 - .10
Lithium carbonate.....	lb.	—	1.50 - 1.50
Magnesium carbonate, technical.....	lb.	.10 - .11	.11 - .12
Magnesium sulphate, U. S. P.....	100 lb.	2.50 - 3.00	—
Magnesium sulphate, commercial.....	100 lb.	—	1.50 - 1.75
Methanol, 95%.....	gal.	—	1.30 - 1.40
Methanol, pure.....	gal.	—	1.50 - 1.70
Nickel salt, double.....	lb.	—	.12 - .12
Nickel salt, single.....	lb.	—	.13 - .13
Phosgene (see carbonyl chloride).....	—	—	—
Phosphorus, red.....	lb.	.45 - .46	.47 - .50
Phosphorus, yellow.....	lb.	—	.35 - .37
Potassium bichromate.....	lb.	.15 - .16	.16 - .16

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)....	lb.	\$.35 — .40	\$0.33 — \$0.35
Potassium bromide, granular.....	lb.	.35 — .40	.25 — .40
Potassium carbonate, U. S. P.....	lb.	.11 — .11½	.11 — .12
Potassium carbonate, crude.....	lb.	.10 — .11	.12 — .18
Potassium chlorate, crystals.....	lb.	.14 — .14½	.65 — .70
Potassium cyanide.....	lb.	.14 — .14½	.15 — .16
Potassium hydroxide (caustic potash)....	ton	75.00 — 80.00	
Potassium iodide.....	lb.	.11 — .12	3.00 — 3.20
Potassium nitrate.....	lb.	.55 — .60	.12½ — .13
Potassium permanganate.....	lb.	.50 — .52	.65 — .70
Potassium prussiate, red.....	lb.	.31 — .31½	.53 — .55
Potassium prussiate, yellow.....	lb.	.31 — .31½	.32 — .33
Potassium sulphate (powdered).....	ton	\$225.00 — 230.00	
Rochelle salts (see sodium potas. tartrate)			
Salammoniac (see ammonium chloride)....			
Sal soda (see sodium carbonate).....			
Salt cake.....	ton		33.00 — 35.00
Silver cyanide.....	oz.		1.25 — .45
Silver nitrate.....	oz.		.44 — .45
Soda ash, light.....	100 lb.	2.15 — 2.20	2.30 — 2.60
Soda ash, dense.....	100 lb.	2.60 — 2.75	3.00 — 3.25
Sodium acetate.....	lb.	.05½ — .05¾	.06 — .06½
Sodium bicarbonate.....	100 lb.	2.40 — 2.50	2.60 — 2.90
Sodium bichromate.....	lb.	.08½ — .09	.09½ — .09¾
Sodium bisulphate (nitre cake).....	ton	7.00 — 7.50	8.00 — 11.00
Sodium bisulphate powdered, U.S.P.....	lb.	.06½ — .07	.07½ — .08
Sodium borate (borax).....	lb.	.07 — .07½	.07½ — .08
Sodium carbonate (sal soda).....	100 lb.	2.00 — 2.25	2.50 — 2.75
Sodium chl. rate.....	lb.	.10 — .10½	.10½ — .11
Sodium cyanide, 96-98 per cent.....	lb.	.21 — .23	.24 — .30
Sodium fluoride.....	lb.	.17 — .17½	.17½ — .18½
Sodium hydroxide (caustic soda).....	100 lb.	3.90 — 4.00	4.10 — 4.60
Sodium hyposulphite.....			.04 — .04½
Sodium nitrate.....		2.85 — .	3.00 — .
Sodium nitrite.....	lb.	.06 — .06½	.06½ — .07
Sodium peroxide, powdered.....	lb.	.30 — .31	.32 — .34
Sodium phosphate, dibasic.....	lb.	.03½ — .04½	.04½ — .05
Sodium potassium tartrate (Rochelle salts)	lb.	.17 — .17½	.17½ — .18
Sodium prussiate, yellow.....	lb.	.01½ — .01¾	.02 — .02½
Sodium silicate, solution (40 deg.).....	lb.	.03 — .03½	.03½ — .04
Sodium silicate, solution (60 deg.).....	lb.	.075 — 2.00	2.25 — 2.50
Sodium sulphate, crystals (Glauber's salt) 100 lbs.		.05½ — .05¾	.06 — .06½
Sodium sulphide, crystal, 60-62 per cent (conc.) lb.		.04 — .04½	.04½ — .05
Sodium sulphite, crystals.....	lb.	.20 — .20½	.21 — .22
Strontium nitrate, powdered.....	lb.	.08 — .09	.10 — .10½
Sulphur chl. ride, red.....	ton	16.00 — 20.00	
Sulphur, crude.....	lb.	.09 — .	.10 — .12
Sulphur dioxide, liquid, cylinders.....	100 lb.		3.70 — 4.35
Sulphur (sublimed), flour.....	100 lb.		3.40 — 3.90
Sulphur, roll (brimstone).....	100 lb.		
Tin bichloride, 50 per cent.....	lb.	.18 — .19	
Tin oxide.....	lb.	.16 — .18	.48 — .50
Zinc carbonate, precipitate.....	lb.	.11½ — .12	.19 — .20
Zinc chloride, gran.....	lb.	.45 — .49	.50 — .60
Zinc cyanide.....	lb.	.12 — .13	.13½ — .14
Zinc dust.....	lb.	.10 — .10½	.11 — .11½
Zinc oxide, XX.....	lb.	.03½ — .03¾	.04 — .06
Zinc sulphate.....	lb.		

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude.....	lb.	\$1.10 — \$1.15
Alpha-naphthol, refined.....	lb.	1.45 — 1.50
Alpha-naphthylamine.....	lb.	.40 — .44
Aniline oil, drums extra.....	lb.	.26 — .28
Aniline salts.....	lb.	.27 — .30
Anthracene, 80% in drums (100 lb.).....	lb.	.85 — 1.00
Benzaldehyde (f.f.c.).....	lb.	2.00 — 2.10
Benzidine, base.....	lb.	1.00 — 1.10
Benzidine sulphate.....	lb.	.85 — .90
Benzoic acid, U.S.P.....	lb.	.70 — .75
Benzoate of soda, U.S.P.....	lb.	.75 — .85
Benzene, pure, water-white, in drums (100 gal.)	gal.	.30 — .35
Benzene, 90%, in drums (100 gal.).....	gal.	.28 — .32
Benzyl chloride, 95-97%, refined.....	lb.	.30 — .35
Benzyl chloride, tech.....	lb.	.25 — .30
Beta-naphthol benzoate.....	lb.	3.50 — 4.00
Beta-naphthol, sublimed.....	lb.	.75 — .80
Beta-naphthol, tech (nominal).....	lb.	.35 — .40
Beta-naphthylamine, sublimed.....	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.).....	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.).....	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal.	.95 — 1.00
Cresylic acid, 95-97%, dark, in drums.....	gal.	.90 — .95
Cresylic acid, 50%, first quality, drums.....	gal.	.65 — .75
Dichlorobenzene.....	lb.	.06 — .09
Diethylaniline.....	lb.	1.25 — 1.30
Dimethylaniline.....	lb.	.65 — .75
Dinitrobenzene.....	lb.	.30 — .32
Dinitrochlorobenzene.....	lb.	.25 — .30
Dinitronaphthalene.....	lb.	.35 — .40
Dinitrophenol.....	lb.	.40 — .45
Dinitrotoluene.....	lb.	.27 — .30
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 — .40
Diphenylamine.....	lb.	.65 — .70
H-acid.....	lb.	1.40 — 1.55
Meta-phenylenediamine.....	lb.	1.25 — 1.30
Monochlorobenzene.....	lb.	.14 — .16
Monoethylaniline.....	lb.	1.75 — 2.25
Naphthalene crushed, in bbls. (250 lb.).....	lb.	.08 — .08½
Naphthalene, flake.....	lb.	.08 — .08½
Naphthalene, balls.....	lb.	.09 — .09½
Naphthionic acid, crude.....	lb.	.70 — .75
Nitrobenzene.....	lb.	.12 — .15
Nitro-naphthalene.....	lb.	.40 — .50
Nitro-toluene.....	lb.	.18 — .25
Ortho-amidophenol.....	lb.	3.20 — 3.75
Ortho-dichlor-benzene.....	lb.	.15 — .20
Ortho-nitro-phenol.....	lb.	.75 — .80
Ortho-nitro-toluene.....	lb.	.20 — .28
Ortho-toluidine.....	lb.	.25 — .30
Para-amidophenol, base.....	lb.	1.90 — 2.00
Para-amidophenol, HCl.....	lb.	2.20 — 2.25

Para-dichlorobenzene.....	lb.	.15 — .25
Paranitroaniline.....	lb.	.93 — 1.00
Para-nitrotoluene.....	lb.	1.05 — 1.15
Para-phenylenediamine.....	lb.	2.20 — 2.35
Para-toluidine.....	lb.	1.50 — 1.60
Phthalic anhydride.....	lb.	.55 — .60
Phenol, U. S. P., drums (dest.), (240 lb.).....	lb.	.10 — .12
Pyridine.....	gal.	2.00 — 3.50
Resorcinol, technical.....	lb.	2.25 — 2.50
Resorcinol, pure.....	lb.	3.60 — 3.80
Salicylic acid, tech., in bbls. (110 lb.).....	lb.	.25 — .28
Salicylic acid, U. S. P.....	lb.	.29 — .35
Salol.....	lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.28 — .32
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.16 — .18
Sulphanilic acid, crude.....	lb.	.30 — .35
Tolidine.....	lb.	1.45 — 1.60
Toluidine, mixed.....	lb.	.40 — .45
Toluene, in tank cars.....	gal.	.30 — .32
Toluene, in drums.....	gal.	.33 — .35
Xylidines, drums, 100 gal.....	lb.	.45 — .50
Xylene, pure, in drums.....	gal.	.42 — .45
Xylene, pure, in tank cars.....	gal.	.45 — .50
Xylene, commercial, in drums, 100 gal.....	gal.	.33 — .35
Xylene, commercial, in tank cars.....	gal.	.30 — .35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark.....	lb.	\$0.24 — \$0.26
Beeswax, refined, light.....	lb.	.27 — .28
Beeswax, white pure.....	lb.	.35 — .40
Carnauba, No. 1.....	lb.	.85 — .90
Carnauba, No. 2, North Country.....	lb.	.35 — .40
Carnauba, No. 3, North Country.....	lb.	.19 — .20
Japan.....	lb.	.19 — .20
Montan, crude.....	lb.	.07 — .08
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.05 — .05½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.04½ — .05
Paraffine waxes, refined, 118-120 m.p.	lb.	.06½ — .06¾
Paraffine waxes, refined, 125 m.p.	lb.	.07 — .07½
Paraffine waxes, refined, 128-130 m.p.	lb.	.07 — .08
Paraffine waxes, refined, 133-135 m.p.	lb.	.09½ — .09¾
Paraffine waxes, refined, 135-137 m.p.	lb.	.10½ — .11
Stearic acid, single pressed.....	lb.	.13 — .13½
Stearic acid, double pressed.....	lb.	.13½ — .14
Stearic acid, triple pressed.....	lb.	.14½ — .14¾

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940.....	gal.	\$1.70
Pine oil, pure, dest. dist.....	gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035.....	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990.....	gal.	.75
Pine tar, ref., thin, sp.gr. 1.080-1.960.....	gal.	.36
Turpentine, crude, sp. gr. 0.900-0.970.....	gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990.....	gal.	.37
Pinewood creosote, ref.....	gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl.....	280 lb.	\$8.75 — .
Rosin E-I.....	280 lb.	8.75 — .
Rosin K-N.....	280 lb.	8.75 — .
Rosin W. G.-W. W.....	280 lb.	9.00 — .
Wood rosin, bbl.....	280 lb.	9.00 — .
Spirits of turpentine.....	gal.	.76 — .
Wood turpentine steam dist.....	gal.	.72 — .
Wood turpentine, dest. dist.....	gal.	.71 — .
Pine tar pitch, bbl.....	200 lb.	— 8.50
Tar, kiln burned, bbl. (500 lb.).....	bbl.	— 15.00
Retort tar, bbl.....	500 lb.	15.00 — 15.50
Rosin oil, first run.....	gal.	.52 — .
Rosin oil, second run.....	gal.	.54 — .
Rosin oil, third run.....	gal.	.62 — .

Solvents

73-76 deg., steel bbls. (85 lb.).....	gal.	\$0.41
70-72 deg., steel bbls. (85 lb.).....	gal.	.39
68-70 deg., steel bbls. (85 lb.).....	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.).....	gal.	.30

Crude Rubber

Para-Upriver fine.....	lb.	\$0.18½ — \$0.19
Upriver coarse.....	lb.	.14 — .14½
Upriver caucho ball.....	lb.	.14½ — .14¾
Plantation—First latex crepe.....	lb.	.21 — .
Ribbed smoked sheets.....	lb.	.20 — .
Brown crepe, thin, clean.....	lb.	.18 — .
Amber crepe No. 1.....	lb.	.20 — .

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.....	lb.	\$0.09½ — \$0.10
Castor oil, AA, in bbls.....	lb.	.11 — .11½
China wood oil, in bbls. (f.o.b. Pac. coast).....	lb.	.08½ — .09
Cocoonut oil, Ceylon grade, in bbls.....	lb.	.12½ — .13
Cocoonut oil, Cochín grade, in bbls.....	lb.	.12½ — .13
Corn oil, crude, in bbls.....	lb.	.08½ — .09½
Cottonseed oil, crude (f. o. b. mill).....	lb.	.06 — .07
Cottonseed oil, summer yellow.....	lb.	.09 — .09½
Cottonseed oil, winter yellow.....	lb.	.09½ — .09¾
Linseed oil, raw, car lots (domestic).....	gal.	.76 — .77
Linseed oil, raw, tank cars (domestic).....	gal.	.69 — .70
Linseed oil, boiled, car lots (domestic).....	gal.	.78 — .79

Olive oil, commercial.....	gal.	\$2 50	—	\$2 60
Palm, Lagos.....	lb.	.07 $\frac{1}{2}$	—	.08
Palm, Niger.....	lb.	.07	—	.07 $\frac{1}{2}$
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.07	—	.07 $\frac{1}{2}$
Peanut oil, refined, in bbls.....	lb.	.13	—	.13 $\frac{1}{2}$
Rapeseed oil, refined in bbls.....	gal.	1 10	—	1 15
Rapeseed oil, blown, in bbls.....	gal.	1 20	—	1 25
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.08 $\frac{1}{2}$	—	.09
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.05 $\frac{3}{4}$	—	.06

FISH

Light pressed menhaden.....	gal.	\$0 53	—	\$0 55
Yellow bleached menhaden.....	gal.	.55	—	.58
White bleached menhaden.....	gal.	.57	—	.60
Blown menhaden.....	gal.	1.00	—	—

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	—
Blanc fixe, dry.....	lb.	.05	—	.05 $\frac{1}{2}$
Blanc fixe, pulp.....	net ton	60.00	—	65.00
Casein.....	lb.	.14	—	.18
Chalk, domestic, extra light.....	lb.	.05	—	.05
Chalk, domestic, light.....	lb.	.04 $\frac{1}{2}$	—	.05 $\frac{1}{2}$
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04 $\frac{1}{2}$	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	25.00	—	35.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. New York.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Fla.....	net ton	25.00	—	—
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	—
Fullers earth, imported, powdered.....	net ton	35.00	—	40.00
Graphite, crucible, 90% carbon, Ashland, Ala.....	lb.	.07	—	.09
Graphite, crucible, 85% carbon, Ashland, Ala.....	lb.	.11	—	.40
Graphite, higher lubricating grades.....	lb.	.04	—	.50
Pumice stone, imported, lump.....	lb.	.06	—	—
Pumice stone, domestic lump.....	lb.	.04	—	.07
Pumice stone, ground.....	lb.	.04	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	—	—	10.00
Quartz (acid tower) 1 $\frac{1}{2}$ @ 2 in., f.o.b. Baltimore.....	net ton	—	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	—	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.80	—	.85
Shellac, orange superfine.....	lb.	.95	—	1.00
Shellac, A. C. garnet.....	lb.	.70	—	.75
Shellac, T. N.....	lb.	.68	—	.70
Soapstone.....	ton	15.00	—	25.00
Sodium chloride.....	long ton	—	—	17.50
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	40.00	—	50.00
Talc, California talcum powder grade.....	ton	20.00	—	45.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	—	—
Chrome brick, f.o.b. Eastern shipping points.....	net ton	100—	110	—
Chrome cement, 40-45% Cr ₂ O ₃	net ton	55—	60	—
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	60—	65	—
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55—	60	—
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45—	50	—
Magnesite brick, 9-in. straight.....	net ton	—	110	—
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	—	121	—
Magnesite brick, soaps and splits.....	net ton	—	134	—
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65—	70	—
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56—	61	—
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	55—	60	—

Ferro-Alloys

All f.o.b. Works

Ferrocobalt-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.16	—	.17
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.17	—	.18
Ferromanganese, 76-80% Mn, domestic.....	gross ton	105.00	—	110.00
Ferromanganese, 76-80% Mn, English.....	gross ton	110.00	—	115.00
Spiegeleisen, 18-22% Mn.....	gross ton	55.00	—	60.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.00	—	2.50
Ferrosilicon, 10-15%.....	gross ton	55.00	—	60.00
Ferrosilicon, 50%.....	gross ton	78.00	—	80.00
Ferrosilicon, 75%.....	gross ton	—	—	150.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.55	—	.60
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	7.00	—	—
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.75	—	6.75

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content, less than 2% Fe ₂ O ₃ , up to 20% silica, not more than H 4% moisture.....	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.60	—	.65
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.55	—	.60
Coke, foundry, f.o.b. ovens.....	net ton	—	—	7.00
Coke, furnace, f.o.b. ovens.....	net ton	—	—	6.00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	21.00	—	22.00
Fluorspar, lump, f.o.b. Tonuco, New Mexico.....	net ton	15.00	—	—
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	—	25.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 $\frac{1}{2}$	—	.01 $\frac{1}{2}$
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.38	—	.40
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.65
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	35.00	—	—
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.12	—	—
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.17	—	—
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	—
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	—	3.50
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.50
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	2.75	—	3.00
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.75	—	3.00
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	—
Zircon, washed, iron free.....	lb.	.05	—	—

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	15.00
Aluminum, 98 to 99 per cent.....	27.50
Antimony, wholesale lots, Chinese and Japanese.....	5.25 @ 5.37 $\frac{1}{2}$
Nickel, ordinary (ingot).....	43.00
Nickel, electrolytic.....	45.00
Monel metal, spot and blocks.....	.35
Monel metal ingots.....	.38
Monel metal, sheet bars.....	.40
Tin, 5-ton lots.....	34.02 $\frac{1}{2}$
Lead, New York, spot.....	5.37 $\frac{1}{2}$
Lead, E. St. Louis, spot.....	6.25
Zinc, spot, New York.....	7.00
Zinc, spot, E. St. Louis.....	6.75

OTHER METALS

Silver (commercial).....	oz.	\$0 66 $\frac{1}{2}$
Cadmium.....	lb.	1.40 @ 1.50
Bismuth (500 lb. lots).....	lb.	2.40
Cobalt.....	lb.	6.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.35
Platinum.....	oz.	75.00
Iridium.....	oz.	350.00 @ 400.00
Palladium.....	oz.	75.00
Mercury.....	75 lb.	50.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per Lb.

Copper sheets, hot rolled.....	21.50
Copper bottoms.....	33.00
Copper rods.....	28.00
High brass wire and sheets.....	19.25
High brass rods.....	17.25
Low brass wire and sheets.....	29.50
Low brass rods.....	18.50
Brazed brass tubing.....	35.25
Brazed bronze tubing.....	40.50
Seamless copper tubing.....	25.00
Seamless high brass tubing.....	24.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	11.50	18.50	10.00	10.50
Copper, heavy and wire.....	11.00	16.50	9.50	10.00
Copper, light and bottoms.....	9.00	14.50	9.00	9.00
Lead, heavy.....	4.00	7.25	4.00	4.00
Lead, tea.....	3.00	5.25	3.00	3.50
Brass, heavy.....	7.00	9.50	7.00	10.00
Brass, light.....	5.50	8.00	5.00	5.50
No. 1 yellow brass turnings.....	6.00	9.50	5.50	5.50
Zinc.....	4.00	5.00	3.00	4.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by $\frac{1}{4}$ in. and larger, and plates $\frac{1}{4}$ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes.....	\$3.58	\$3.80	\$3.47	\$3.58	\$3.37	\$3.58	\$3.47
Soft steel bars.....	3.45	3.70	3.37	3.34	3.27	3.48	3.52
Soft steel bar shapes.....	3.45	3.70	3.37	3.48	3.27	3.48	3.52
Soft steel bands.....	4.18	4.65	4.07	6.25	—	—	—
Plates, $\frac{1}{4}$ to 1 in. thick.....	3.78	4.00	3.67	3.78	3.57	3.78	3.67

Industrial

Financial, Construction and Manufacturers' News

Colorado

GARFIELD—Harrison Petroleum Co., Grand Valley, is having plans prepared for the construction of 1,000 ton shale oil refinery for manufacture of gasoline, lubricating oils and paraffine. Estimated cost \$500,000. H. C. Wolf, Oklahoma City, engr.

Idaho

KELLOGG—Bunker Hill & Sullivan M. & C. Co. plans to build electrolytic zinc refinery, with 25 ton metallic zinc capacity per day. Above project will be in conjunction with lead concentrator and smelter of company, here. Estimated cost \$1,000,000. F. M. Smith, dir.

Iowa

BELLE PLAINE—The Bd. of Educ. is having plans prepared for the construction of a 2 story, 83 x 130 ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$100,000. C. R. Ahrens, Secy. C. A. Dieman & Co., 408 Granby Bldg., Cedar Rapids, archt.

CORYDON—The Bd. of Educ. will receive bids until Feb. 10 for the construction of a 3 story, 67 x 121 ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$160,000. D. T. Sellenberger, Pres. W. Gordon, 319 Hubbell Bldg., Des Moines, Archt. noted Dec. 1.

Kansas

PARSONS—City is having plans prepared for rehabilitation of waterworks plant including installation of filter equipment and machinery for 6,000,000 gal. capacity. Estimated cost \$350,000,000. Burns & McDonnell Engr. Co., Interstate Bldg., Kansas City, Mo., assigning and consulting engs.

Maine

RICHMOND—THE City Waterworks plans to construct a filtration plant. Cost between \$18,000 and \$20,000.

Michigan

BENTON HARBOR—City is having plans prepared for installation of filtration plant. Estimated cost \$100,000. Greeley, Pearse & Hansen, 39 West Adams St., Chicago, engs.

CADILLAC—St. Mary's Hospital will receive bids in the early spring for construction of 3 story hospital. A chemical laboratory will be installed in same. Estimated cost \$250,000. E. Brielmaier Sons, 432 Bway., Milwaukee, archts.

FENTON—The Bd. of Educ., c/o M. B. Smith is having plans prepared for the construction of a 2 story high school. A chemical laboratory will be installed in same. Estimated cost, \$200,000. Van Leyen, Schilling, Keough & Reynolds, 3440 Cass Ave., Detroit, archt.

Minnesota

ALBERT LEA—The Central Fdry. Co., Marshalltown, Ia., plans to construct a 1 story, 100 x 200 ft. factory here. Estimated cost, \$50,000.

EVELETH—City has received bids for construction of a filtration plant, from Lawrence McCann Co., Eveleth, \$178,350; Roberts Mfg. Co., Eveleth, \$179,870; Phelps-Drake Co., 631 Metropolitan Life Bldg., Minneapolis, \$184,730. Noted Sept. 17.

Montana

MILES CITY—Custer Co. Free High School has awarded the contract for construction of 3 story, 152 x 210 ft. high school, to Lease & Liegland, Great Falls. Estimated cost \$195,000. A chemical laboratory will be installed in same. Noted Jan. 12.

Nebraska

NELSON—Bd. of Educ. has plans prepared for the construction of a 2 story high school. A chemical laboratory will be installed in same. Estimated cost, \$90,000. H. D. Pampel, 402 Finance Bldg., Kansas City, Mo., archt.

New York

BROOKLYN—W. Scandon Paper Box Co. will build a 2 story, 40 x 100 ft. factory at 150 Skillman St. Estimated cost, \$35,000.

CARTHAGE—The Northern Development Syndicate plans to construct a commercial size ore reduction plant and electric smelting furnace.

OLEAN—England, Walton & Co., Inc., plans to rebuild its six tannery buildings which were recently destroyed by fire. Estimated cost, \$200,000.

North Dakota

JAMESTOWN—The city plans to improve waterworks system, including reservoir and water softener. Estimated cost, \$60,000. H. H. Hurning, city engr.

Ohio

CLEVELAND—The Frank Dry Cleaning Co., 1361 East 55th St., has awarded the contract for the construction of a 2 story, 44 x 76 ft. factory on East 60th St. and Bonna Ave. Estimated cost, \$50,000. M. H. Merver, mgr.

WEST CARROLLTON—American Envelope Co. is having plans prepared for construction of 2 story, 60 x 110 ft. factory, on Main St. Estimated cost \$50,000. E. J. Mountstephen, 803 U. B. Bldg., Dayton, archts.

YOUNGSTOWN—The Bd. of Educ., 16 West Wood St., will soon award the contract for the construction of a 2 story, 250 x 250 ft. high school on Ohio St. A chemical laboratory will be installed in same. Estimated cost, \$1,000,000. C. F. Owsley, 1301 Mahoning Bank Bldg., archt.

Oregon

PORTLAND—Portland Vegetable Oil Mills Co. plans to build manufacturing plant, to have 100 ton vegetable oil capacity. Estimated cost \$450,000. C. A. Painton, pres.

Pennsylvania

SUGAR NOTCH—City plans to construct a 2 story, 100 x 120 ft. high school. A chemical laboratory will be installed in same.

South Dakota

MISSION—The Bd. of Educ., c/o S. D. Hickey, Co. Supt. of Schools, plans to construct a 2 story consolidated school. A chemical laboratory will be installed in same. Estimated \$125,000. Architect not announced.

SIOUX FALLS—The Bd. of Educ. is having plans prepared for the construction of a 3 or 4 story high school. A chemical laboratory will be installed in same. Estimated cost, \$400,000. Perkins & McWayne, 324 Paulton block, archts. H. S. Hillehoe, supt. of schools.

Texas

EASTLAND—The city has awarded the contract for the construction of storm and sanitary sewers and a sewage disposal plant to include a septic tank, sprinkling filter and sludge bed. Estimated cost, \$185,000. Noted Dec. 8.

FORT WORTH—The Masonic Grand Lodge of Texas, Waco, has awarded the contract for the construction of a 2 story hospital. A chemical laboratory will be installed in same. Estimated cost, \$90,000.

FT. WORTH—The Peden Iron & Steel Co., Main and Daggett Sts., is having plans prepared for the construction of a steel roller mill and fabricating plant. Estimated cost, \$1,000,000. D. R. Luce, Ft. Worth, engr.

RANGER—Chestnut & Smith are having plans prepared for the construction of a casinghead gasoline plant. Estimated cost, \$500,000.

RANGER—The Humble Oil & Refining Co., Goggan Bldg., Houston, is having plans prepared for the construction of a topping plant in connection with its oil refinery. Estimated cost, \$500,000.

Washington

MILLWOOD—The Inland Empire Paper Co. has awarded the contract for the construction of a brick and concrete addition to its paper mill. Estimated cost, \$85,000.

SEATTLE—The Rothert Process Steel Co., 622 Othello St., plans to construct several buildings and install one or two 15-

ton electric steel furnaces and other equipment, for manufacture of ingots, bar steel and high grade steel products from raw materials. E. H. Rothert, pres.

West Virginia

ROUND BOTTOM—H. J. Booth, 1675 Beechwood St., Pittsburgh, Pa., has purchased a site and plans to build a glass plant.

Wyoming

CASPER—E. LeRoy, Sistersville, West Virginia, plans to build plant, here, for manufacture of glass.

Ontario

LONDON—I. O. D. E., c/o Watt & Blackwell, archts., Bank of Toronto Chambers, has awarded the contract for the construction of a 4 story, 110 x 200 ft. children's hospital on Ottaway Ave. A chemical laboratory will be installed in same. Estimated cost, \$200,000.

WINDSOR—The Municipal School Bds. of Windsor and Walkerville plans to construct a 3 story technical school. A chemical laboratory will be installed in same. Estimated cost, \$500,000.

British Columbia

PRINCE RUPERT—Prince Rupert Pulp & Paper Co., Vancouver, plans to erect plant, here, for the manufacture of pulp and paper, to be in conjunction with general lumbering business. Estimated cost \$4,000,000.

Quebec

MONTANE—The Hammermill Paper Co., Erie, Pa., will receive bids the latter part of January for building a pulp and paper mill, here. Estimated cost, \$1,000,000.

MONTREAL—W. R. Cuthbert & Co., 41 Duhe St., plans to build a 3 story brass finishing factory. Estimated cost, with equipment, \$85,000.

ST. ANGELE DE LAVAL—The Brown Pulp & Paper Co. is having plans prepared for the construction of a pulp and paper mill. Estimated cost, \$1,500,000.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its annual meeting Feb. 21 to 24 at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting Feb. 14 to 17 in New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA will hold its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.

NATIONAL PETROLEUM CONGRESS will meet at the Hotel Baltimore, Kansas City, Mo., March 22 to 25.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

THE SEVENTH EXPOSITION OF CHEMICAL INDUSTRIES will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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CHARLES A. BLATCHLEY
Industrial Editors
J. S. NEGRW
Managing Editor

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Number 5

A Question That Will Not Down

SOME time ago we asked, "Who is a chemist?" and the question has not been answered yet. But many have been asking it repeatedly, and some earnest men are rather insistent in the query. The New Jersey Chemical Society, at its October meeting, appointed a committee consisting of F. D. CRANE, G. F. COTTLE and C. P. TITUS to ascertain and report whether or not it appears advisable to form an American Institute of Chemistry. These gentlemen propose that such an institute might:

1. List all persons who wished to be considered chemists in any sense of the word, all chemical products and all chemical industries; the lists to be made without charge and to be public. It would be a kind of "Chemical Who's Who," containing each man's record of himself.

2. Register chemists who furnish definite, accurate information as to education and experience, such information and all other pertinent facts to be subject to independent investigation and to be available to inquirers under reasonable regulations. In other words, the Institute would undertake to check up the records. For registration a moderate fee would be charged.

3. Certify chemists according to their proficiency in the various branches of chemical education and experience after the candidate has passed a definite examination suited to the type of certificate desired. A fee to be charged for such examination.

In addition to the foregoing it is also proposed to urge upon the national and state legislators such legislation as may prove to be desirable or needed, and to maintain communication with all institutions which train chemists, with a view to achieving some measure of harmony in the various courses.

It is very easy to pick to pieces any proposal for something new. At first glance it seems to us that items 1 and 2 should be consolidated, on the ground that a general listing of all claimants would contain a great deal of misinformation. It would also lack many of the best names as well as a great many facts of leading importance. A severe supervision would be better, we think, because otherwise the chemical quacks would get their names in, and then attempt to profit by it. The registration feature appeals to us as the better course. As for the certification feature, it is a great deal to ask of a man in practice to pass an examination, and we doubt if the best and most experienced men would be willing to undergo it.

But these questions are only preliminary. Of course the committee is not tied to any particular course; it is seeking wisdom and we desire to give it all the encouragement we can in the great quest of "Who is a chemist?"

Back of all this seeking, and hastening it a little, is a cloud no bigger than a man's hand perhaps, but a cloud nevertheless. In Chicago, and here in New York

and elsewhere, a number of men engaged in laboratories have formed labor unions and associated themselves with the American Federation of Labor. It is not a pleasant prospect. When a man enters upon a profession he takes upon himself professional obligations. He pays less for his education than it costs. The institution that was endowed to give him his education was not designed primarily to make him rich; it was designed to prepare him to render service. He is a man set apart for special work. When we think of the immense forces still hidden in the secrets of nature which may be available to the next generation, the responsibilities of men of the exact sciences are greater by far than the responsibilities of lawyers and practitioners of medicine.

It may be that men working all day as laboratory helpers or in making color carbons or other routine tests, week in and week out, are underpaid; but they are not working as chemists. Whatever their training and preparation may be, they are no more entitled to the honorable appellation than the prescription man in the drug store. They may be chemists, but they are not practicing chemistry. If they want to join a drug clerks' union or a steel testers' federation, it is their right and privilege, but to call them chemists is a mistake. A real chemist differs from a craftsman in that his mind is trained to meet a multiplicity of problems. He is entitled to the distinction of his calling.

On the other hand, the proposal to license chemists is fraught with difficulties. When this is done by state legislation it prevents the best man who may live somewhere else from rendering his much-needed service. If a national license system is organized it will grow too big to be efficient and if politics creeps in it will create an unbearable situation. Engineers are now licensed in several states and so far as we have learned the system only adds red tape and chokes progress.

Our advice to our New Jersey friends is to drop the idea of a new Institute and to go ahead in New Jersey; to try out some system of listing and registering in that state alone, and when they have the work pretty well along so that they have a census of, say, half the chemists and chemical industries and chemical products of the commonwealth, the state government may come in and complete the job. It may prove to be of great value. New Jersey is important in chemical industry. If information as to men, industries and materials were available it would give the state a distinct and peculiar lead. Other chemical industries would flock there to be near what they need and to be where they know that competent professional men foregather. Then if New Jersey works it out other states may follow. In the process of working it out we may discover who a chemist is.

Power Plant Wastes Contain Recoverable Chemicals

A PRELIMINARY survey of a certain large city steam-generating station indicates the possible recovery of 220 tons of sulphuric acid per day from the waste flue gases. Tests made at the same time reveal the possible recovery of 10,000 lb. of potash (K_2O) per month and the economical production of 19,100 tons of slag cement during the same period.

The estimates were based on the weight of slag and soot for a given number of steaming hours, the total number of steaming hours for one month, samples of flue dust and combustion chamber slag, total coal burned, total refuse for one month and analyses of slag and soot samples, together with sulphur determinations of weekly station ash samples.

It was proposed to recover the acid with Cottrell precipitators, the potash by leaching the various wastes with hot water which was available and to produce the cement by addition of a suitable proportion of limestone to the slag. The gross income from the three products was estimated at \$330,000 per month.

Public utilities enter the oil and mining business these days, and with considerable profit. It is not unlikely they will gain by attention to such chemical products as involve plant and sewage wastes and which come within the field of electrochemistry. A good chemical engineer would be an asset to any large power company.

Stifling Water-Power Development Through Inaction

WITH a keen perception of political values Congress is giving attention to certain phases of legislation of doubtful value. Over the veto of the President it has passed legislation providing for loans to farmers, and with a great show of interest in the public welfare it is considering emergency tariff legislation. At the same time a bill of tremendous import to industrial progress is allowed to rest peacefully in the hands of the select committee of the House of Representatives on water power. Political expediency evidently dictates this course, but the chemical industries, with others that need power for effective development, may well ask why class legislation is crowding out their legitimate needs.

We refer to the bill introduced by Representative ESCH (H.R. 15126) providing slightly enlarged authority for the Federal Power Commission to employ appropriate personnel, either from outside the Government or by transfer from other executive departments. At the present time there is pending before the Power Commission a mass of applications for power development which represents 13,000,000 horsepower in potential energy supply. This is five times as much business as has been handled in over twenty years by all of the executive departments previously in charge of these affairs. And to care for it Congress permits these departments to loan a few members of their staff to the Power Commission to do the work. At the present rate one hundred years will be required to care for the applications already pending, and more arrive every day.

Chemical industry, especially the metallurgical and electrochemical industries, need extensive power developments in all parts of the country so that one of their raw materials, electrical energy, will be available in adequate quantity at reasonable price. They do not ask that the Federal Government go out and spend money on this development. They can reasonably de-

mand, and they do, that the Federal Government permit this commission to do business effectively and promptly, so that the horsepower now going to waste can be put into productive use for the benefit of all. The electrical industry, the prospective customers of that industry, and public officials all agree that the present legislation is adequate for development and safeguarding such investments. Why should we, therefore, stand marking time industrially simply because the federal agency which must handle these matters is tied hand and foot for want of a paltry few thousand dollars and is compelled to work only with borrowed help? We understand that the House rules prevent immediate consideration of this measure; but it seems likely that if the chairman of the Rules Committee were sufficiently impressed with the importance of action at this session of Congress the necessary steps could be taken to insure it. We suggest this procedure to those concerned in early water-power development.

The Language Of Chemistry

THE language of chemistry has never been noted for its beauty. The main thing has been to get the ideas over, and if we have occasionally cracked an ear drum or split a tongue in the process, we haven't bothered about it. We haven't cared much about the style of our speech, and this very neglect has given the single-track humanists an effective club against science as a subject for study. Sometimes in our acceptance of "any old word" to carry a meaning we have wandered over into the field of the ridiculous, as when we adopt the phonetically Latinized word potassium from potash.

Occasionally an effort is made to shorten a word, such as the change from aluminium to aluminum. The late Dr. ROEBER would not have it, and so long as he lived this journal held to aluminium. Of late, so general has the shorter term become that, by some kind of linguistic mass action, it has broken through. And yet, in the names of elements, we hardly see reasons for the beginning of reform. We are not at all anxious to leave the i's out, even though it is a nuisance to dot them; we do not care for barum or cadmum or chromum or helum or magnesum or radum or selenium or any of the shortened forms. They're not enough better to spend the effort in making the changes.

There are, however, words that have served their usefulness, but which should give way to expressions of greater intrinsic merit. There is *specificity*, for instance, that sounds as if it had originated with a snake; it is a hissing noise, and although it finds greater use in biology than in chemistry, we are all guilty of using it occasionally. Whenever we do so we disturb the air and wound the language. Specificness is a better word and less offensive, although as an achievement in phonetics it is not a thing of beauty. The terminations *ition* and *ation*, when used too frequently, are no less than hurdles to good style in English. Those who practice the science of chemistry have the obligation to clothe their thoughts in an acceptable manner. When we say, "After crystallization and filtration the utilization of the filtrate is recommended for lixiviation until saturation is reached," we are clothing our thoughts in a manner of which we have good reason to be ashamed. We should not want to be responsible for such a sentence if it were to be carved in stone for

future generations to read. But, just as we form our habits of speech, so we shall speak. And if we want chemistry to have premerit in the thoughts of men we must use better language than that.

There are two words in everyday use that are no less than stutters, tongue-traps, and so difficult to pronounce that their very awkwardness keeps them out of use where they are most needed. We refer to the words qualitative and quantitative. Ever since the days of ROBERT BOYLE chemists of a philosophical turn of mind have been preaching the gospel of quantitative thinking, which humanity needs today more than ever it did before. But the word has been such a stumbling block that the layman has refused to utter it. And by this negation he has made the thought itself unwelcome. That extra syllable comes from the Latin declension *quantitas*, *quantitatis*, etc., but usage has provided that when a Latin declension stands in the way of good English, English that does its work in the clearest and most direct way, it should be avoided. And there are two words that mean exactly the same, that have been established in the language but allowed to become obsolete by mere neglect, and yet they may be found in dictionaries. These are *qualitive* and *quantitive*. They are more easily said, and are not phonetic offenses, such as their longer synonyms. We suggest the use of the adjectives qualitive and quantitive in the place of qualitative and quantitative. The entire subject is open to our readers for discussion.

Research, a Capital Investment Or an Operating Expense?

PURCHASE of a new machine or construction of a new building as a part of the equipment of any chemical industry represents capital expenditure, and is a physical investment on which earnings are expected and which must be gradually written off as depreciation or obsolescence may require. In public utility valuation there is added to the value of such physical property a certain sum known as "going value" to represent the intangible increase in the proper capitalization of the corporation because it is an active going concern organized and doing business instead of simply a total of machinery, material and structures.

The chemical executive in analyzing research costs can profitably take account of somewhat similar factors. A research organization well conceived and properly developed represents a real investment. The organization and training of the staff, its familiarity with the needs of the industry and its prospective invention or development output are all intangible, but are very genuine matters of value to the concern as a whole. In the present industrial circumstances, while costs must be cut to fit new conditions, it is of greatest importance that the executive should not unwittingly destroy the investment in his research department.

There are certain parts of the work that may perhaps profitably be laid aside for a time. There are doubtless misfits in the personnel which have resulted from the difficulty in getting adequately-trained men during the war period. There may even be some cases where valuable research men have outlived their usefulness to the particular situation in which they are now working. In any of these circumstances careful analysis of the coming year's budgets will justify some retrenchment. On the other hand, there are today available for engagement in new positions a greater number of ex-

perienced and promising research workers than ever before in the history of American chemical industry. It is an ideal time to make a little additional investment of capital in building up the research departments. Any concern which expects to continue to do business for many years to come can well afford to buy, in the present very favorable market, the services of some of these men. Even though the results of their labor may not be apparent for months or perhaps years, the investment can be made now to great advantage. It is unlikely that another season will pass leaving so many of these men who are really worth while open to new engagements. Immediate action will, therefore, be most expedient.

A Fool and His Money

ELSEWHERE we print a true report of the visit of a gentleman to see a demonstration of what was alleged to be a remarkable discovery. We are not allowed to give the name of the so-called "inventor" or the location of the hopeful plant, lest the credulity of certain underwriters be brought to light. We are glad, however, to give it such publicity as we may.

It is surprising how assertions in chemistry affect the lay mind. Analysis is supposed to be a rule-of-thumb procedure; it would almost seem as though the chemist had only to pour some of any substance into his mystic apparatus, and straightway not only every element but every chemical body would proceed under orders to some compartment marked out for it and then ring a bell. Of course if all the elements present go each to its respective cell and the compounds do likewise, it would seem that the compounds might be disturbed in the process, but, as the lay mind would declare, "You can't expect me to know about that," or, what would be more likely, "I haven't the *time* to look up that sort of thing."

Another curious disposition of the lay mind is to hurry in and buy stock before anyone with understanding comes along and condemns it. There was the electric refining of sugar that we remember about thirty-five years ago or more. The happy inventor made just such a demonstration; he put raw sugar into one end of the apparatus on the top floor, started his motors going, and in a few minutes beautiful white refined sugar swished down into a bin on the ground floor. It had the American Sugar Refining Co., which had lately been organized, beaten to a frazzle. The trouble was that after the inventor was called away to parts unknown, it was discovered that the raw sugar was deposited into an unseen bin, while the refined sugar was dumped out of another.

Everyone remembers the Reverend JERGUSON's fortune made by his process to extract gold from sea-water and the abundant proceeds he took away with him. Still another who got away with the money was the inventor of gold from goldfish. He flourished in New York, put his goldfish into an apparatus—and showed beads of gold as the product. Sober, solid business men who knew how to make fortunes and to keep them—until the chemical troubadour came along—closed their eyes and got into the ground waters with the goldfish! Only the other day in Berlin the cheerful Mr. UNRUHE came pretty near to getting a million pounds sterling for developing powerful electric currents from the hidden wires connected up with a central station. The method is monotonous.

British Chemical Industry

FROM OUR LONDON CORRESPONDENT

LONDON, Jan. 12, 1921.

CHEMICAL markets are still stagnant and very little business is passing either for home or export account. There is a nervous tone in both buying and selling, values being merely an indication of prices at which sellers are willing to sell or buyers willing to buy. Until the present abnormal conditions change business is too speculative and will be on a hand-to-mouth basis until the curve of values tends to straighten. Coal is again a disturbing factor on account of the serious effect of the slump in export prices due to incipient overproduction. An increase in the price of industrial and household coal is not improbable on account of the altered conditions in the trade.

CHEMICAL ENGINEERING GROUP PUBLISHES FIRST PROCEEDINGS

The first volume, embodying conferences on power plant and pumping machinery for chemical works, has at last been issued after unfortunate and vexatious delays. In sending out this volume the Group states that the second volume, dealing with labor-saving devices and filtration, may be expected in March and that the record of the meetings of the Group will not in future be published *in extenso* in any periodical other than the Group's *Proceedings*. The first volume is attractive and marks the beginning of regular and undiluted chemical engineering literature in this country. The conferences contemplated during the present year are to deal with plant for the treatment of industrial waste and evaporation and distillation. Recent papers read before the London Section of the Society of Chemical Industry dealt for the first time with the Smith (American) system of low-temperature carbonization and with the absorption of alcohol, ether, acetone, etc., by means of cresol. The last-named process was successfully operated during the war on a large scale by the Bregeat process both in this country and in France, and the results obtained should be of far-reaching importance for peace production of explosives and allied products.

POSITION OF INTERMEDIATES UNDER THE NEW DYESTUFFS BILL

The dyestuffs (import regulation) bill was passed on Dec. 23 and comes into force on Jan. 15. Literally it scraped through Parliament by the skin of its teeth, its supporters in the House of Commons having to fight throughout against time, and on two occasions the bill was nearly lost. The opposition in the House of Lords was even more effective and not of the same obstructive nature in that it was based on technical knowledge. Some of the amendments suggested in the House of Lords could have been embodied in the bill without much detriment, but if the bill had been so amended it would have had to go back to the House of Commons and could not have been passed during the current session. It is understood that one of the amendments proposed to exclude from the operation of the bill all intermediates which were not derived from coal tar and the bill was saved only by the giving of a parliamentary pledge to this effect, which will, of course, have far-reaching results if and when a list of such intermediates is formulated. A further amendment proposed to exclude "synthetic organic products imported mainly for medi-

cal or surgical purposes," and the mere fact of such a proposal being made does not augur well for the prospects of such protection as may ultimately be afforded to the fine chemical industry. It was understood at one time that acetic acid would also come under this bill in order to assist the Canadian synthetic industry, which is at present being strangled partly by the American import duty, but mainly by German competition. The Eastern markets have already been largely captured by the Germans and in view of the pledge referred to above the outlook is serious.

THE FINE CHEMICAL INDUSTRY IN EXTREMIS

When the campaign in favor of dyestuffs was started it was generally understood that provision would at the same time be made for the fine chemical industry, as being closely related and intimately connected with the dyestuffs industry both in regard to the linking up of manufacturing processes and in regard to the secondary object of maintaining an adequate force of trained organic chemists and potential auxiliary arsenals for chemical warfare and munitions manufacture. The last-named object has been greatly exaggerated in order to give emphasis to the movement and as the campaign progressed it was soon found that the opposition to immediate protection of the fine chemical industry would be so great as to endanger the passing of the dyestuffs bill as well. The lesser of two evils was therefore chosen and fine chemicals will now have to wait for protection until they can be included in an "omnibus" key industries bill in the next parliamentary session. Meanwhile the industry is practically stagnant, and when the key industries bill comes up for discussion it is certain to be of such a contentious nature that grave doubts are expressed as to whether the fine chemical industry can be saved unless a separate and non-contentious bill can be introduced for this industry alone. That, of course, requires time and money, which do not seem to be available at present. Perhaps the chief factors which have led to the present critical position of the industry are lack of confidence in the government and the notorious failure of the manufacturers themselves to translate their talk of co-operation and community of interest into actual practice. The question has already been asked of the dye industry whether, having received protection, it will be able to supply the right dyes, and those best qualified to judge are more pessimistic in this connection than in regard to the fine chemical industry, for which there is at present insufficient capital available.

FORMATION OF A BRITISH CHEMICAL PLANT ASSOCIATION

The Association of British Chemical Manufacturers is the sponsor of an association which has for its main object that British chemicals shall be made with British plant. It cannot be said that the members appointed to the positions on the first committee are such as to inspire complete confidence in the attainment of this object, and representatives of the chemical stoneware makers and other important manufacturers are conspicuous by their absence. It is understood that the movement is to some extent bound up with the question of standardization of detail fittings and items of plant, which has at last, after considerable discussion, been set in motion by the formation of a chemical engineering sectional committee of the British Engineering Standards Association.

Chemical Properties and Metallography of Nickel

Data on Solubility and Magnetic Transformation of Pure Nickel—Notes Are Also Given on the Effect of the Common Impurities Such as Carbon, Oxygen, Manganese, Sulphur, Cobalt, Iron and Silicon Upon Various Physical Properties

BY PAUL D. MERICA

Superintendent of Research, International Nickel Co.

NICKEL is not an active element chemically. It is not attacked at ordinary temperatures by air, fresh or sea water or combinations of the two. Organic acids such as acetic, oxalic, tartaric and citric acids attack it appreciably only after long periods of contact. Sulphuric and hydrochloric acids dissolve it slowly; in nitric acid, on the other hand, it is very readily dissolved. Alkalis either in the fused state or in solution in water are without effect upon it, and for this reason, laboratory fusions with these substances are carried out in crucibles of this metal.

SOLUBILITY

At temperatures around 500 deg. C. it becomes oxidized in the air and also decomposes water with formation of hydrogen.

Hale and Foster have measured the dissolution of nickel sheet in various solutions at ordinary tempera-

TABLE I. CORROSION TESTS OF NICKEL

Specimens Immersed in:	Loss of Weight in 7 Days (Solution Renewed Daily), Grams	Loss of Weight in 28 Days (Solution Not Renewed), Grams
HNO ₃ (N/5).....	4.2	2.1
HCl (N/5).....	0.25	0.45
H ₂ SO ₄ (N/5).....	0.25	0.40
MgCl ₂ (N/5).....	0.05	0.10
NaOH (N/5).....	0.00	0.00
CaCl ₂ (N/5).....	0.08	0.05
NaCl (N/5).....	0.00	0.00
NH ₄ OH (N/5).....	0.00	0.00
Na ₂ CO ₃	0.00	0.00

ture¹ and their results expressed in loss of weight per 100 sq.cm. are given in Table I.

Nickel is used for cooking utensils quite extensively in Germany and this has inspired numerous investigators to study the question of the solution of nickel by the liquids used and its absorption by the food, as well as the physiological effect of the amounts thus absorbed.² The results of these investigations have usually been expressed in terms of milligrams of nickel found in 100 g. of the food and varied from 0.01 mg. to a maximum of 64 mg., the high results being obtained by the use of salt and vinegar or food containing both. Vuk³ found losses of from 15 to 65 mg. of nickel per sq.m. of exposed surface after boiling in 5 per cent acetic acid for 2½ hours. These small amounts of nickel thus absorbed by food from nickel utensils have been regarded as being entirely harmless physiologically.

The heats of formation of two of the more important compounds of nickel are given by Richards⁴ as:

NiO61,500 gram-calories
NiS19,500 gram-calories

Sieverts⁵ has determined the solubility of hydrogen in nickel and finds that it forms a homogeneous solid solution. The solubility of hydrogen both in solid and in molten nickel is proportional to the square root of the hydrogen pressure. He found that 100 g. of nickel absorbs, at 760 mm. pressure:

0.16 mg. H at 212 deg. C.
0.39 mg. H at 520 deg. C.
0.98 mg. H at 1,023 deg. C.
1.50 mg. H at 1,400 deg. C.

and that this amount liberates 1.9 mg. hydrogen upon solidification at 1,452 deg. C. in a hydrogen atmosphere of 760 mm. pressure.

METALLOGRAPHY

As far as is known, nickel exists in only one solid modification or phase which is stable at all temperatures up to that of its melting point. It suffers, however, a magnetic transformation, in a manner quite similar to iron, at about 360 deg. C.; below this temperature it is ferromagnetic, above, it is only weakly paramagnetic. Values of the temperature of this transformation varying from 320 to 370 deg. C. have been obtained by different investigators working with nickel of different degrees of purity, and are shown in Table II. There is therefore some uncertainty about the exact temperature of this transformation, and the value accepted above represents the results of those who worked with the purest material. The magnetic transformation of nickel, as in the case of iron, is accompanied by changes in the other physical properties such as density, resistivity and thermo-electromotive force.

As the magnetic transformation of nickel is not accompanied by any determinable alteration in structure

TABLE II. TEMPERATURE OF THE MAGNETIC TRANSFORMATION OF NICKEL

Authority	Chemical Composition				Temp. of Transformation, Deg. C.
	Cu	Fe	Co	Si and C	
Copaux ⁶	Trace	Cobalt-free nickel melted under hydrogen	1.86	.....	340
Guertler and Tammann ⁷	Trace	0.47	1.86	.....	325
Curie.....	.....	.....	.....	.....	320
	0.20	Trace	0.15	0.00	340
	0.80	Trace	Trace	0.20	345
Pechoux ⁸	0.40	0.60	0.10	0.15	340
	Trace	1.50	0.50	0.10	345
Jänecke ⁹.....	.....	.....	.....	.....	335
Werner ¹⁰.....	.....	.....	.....	.....	347-356
Stark-Tatarenko ¹¹.....	.....	.....	.....	.....	352-355
Baikow ¹².....	.....	.....	.....	.....	370
	.....	.....	.....	.....	360

or recrystallization, the microstructure of this material is relatively simple, at least when compared with that of iron and steel. The impurities which are invariably

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¹J. Chem. Soc., 1915, p. 464.

²Ber. pharm. Ges., vol. 24, p. 303 (1914); vol. 23, p. 567 (1913), Engineering, Oct. 23, 1914. Halbmonatschrift für Margarine-Industrie, No. 17 (1913).

³Z. Unterres. Nahr. und Genussmittel, vol. 28, p. 103 (1914).

⁴Metallurgical Calculations, McGraw-Hill Book Co.

⁵Z. physik. Chem., vol. 77, p. 591 (1911).

⁶Ann. chim. phys., vol. 6 (8), p. 508 (1905).

⁷Z. anorg. allgem. Chem., vol. 52, p. 25 (1907).

⁸La Lumiere Elec., vol. 10, p. 232 (1910).

⁹Z. Elektrochem., Jan. 1, 1918, p. 9.

¹⁰Z. anorg. allgem. Chem., vol. 83, p. 275 (1914).

¹¹J. Russ. Met. Soc., vol. 1 (10), p. 221 (1910).

¹²J. Russ. Phys. Chem. Soc., vol. 42, p. 1,380 (1910).

found in commercial nickel are with three exceptions soluble in the solid state in the amounts in which they are usually present—namely, iron, copper, manganese, cobalt and silicon. Nickel oxide, sulphides (of nickel or manganese) and carbon are at times visible as separate constituents in nickel. In addition there may be found in all malleable nickel a small amount of magnesium compounds in the form of small round particles.

Fig. 1 shows the structure of commercial nickel blocks and the appearance of the nickel:nickel oxide eutectic. This is found, of course, only in non-malleable nickel, as it is impossible to work the metal containing it at any temperature. The structure of malleable nickel in the form of hot-rolled rod is shown in Fig. 2; only the grains of nickel and the small particles of magnesium (and possibly manganese) oxides are visible. Carbon is soluble in nickel to about 0.40 per cent and is therefore not ordinarily observed in commercial nickel. Above that percentage, however, it begins to separate out in the form of graphite; Fig. 3 shows the appearance of graphite in rolled nickel.

Nickel is subject to a peculiar type of intercrystal-

solutions appear to give more uniform results than the aqueous solution, in which the metal readily assumes the passive state.

Electrolytic etching is also recommended, an electrolyte of sulphuric acid and hydrogen peroxide being used as follows: 22 per cent sulphuric acid, 12 per cent hydrogen peroxide solution, 66 per cent water.

EFFECT OF IMPURITIES ON THE PROPERTIES OF NICKEL

With reference to the effect which they exert upon the physical properties of nickel the ordinary impurities fall naturally into two classes—i.e., those which are soluble in the solid state in nickel and those which are not. Those of the former class act in general only to increase the hardness and strength of the metal somewhat, and of course to diminish its electrical conductivity. Those of the latter class affect chiefly the hot-but also cold-working properties of the metal.

Carbon.—Carbon is hardly to be looked upon as an impurity in nickel any more than it is to be so regarded in steel; it is an element which is never absent in the metal and its presence is in the present state of the art

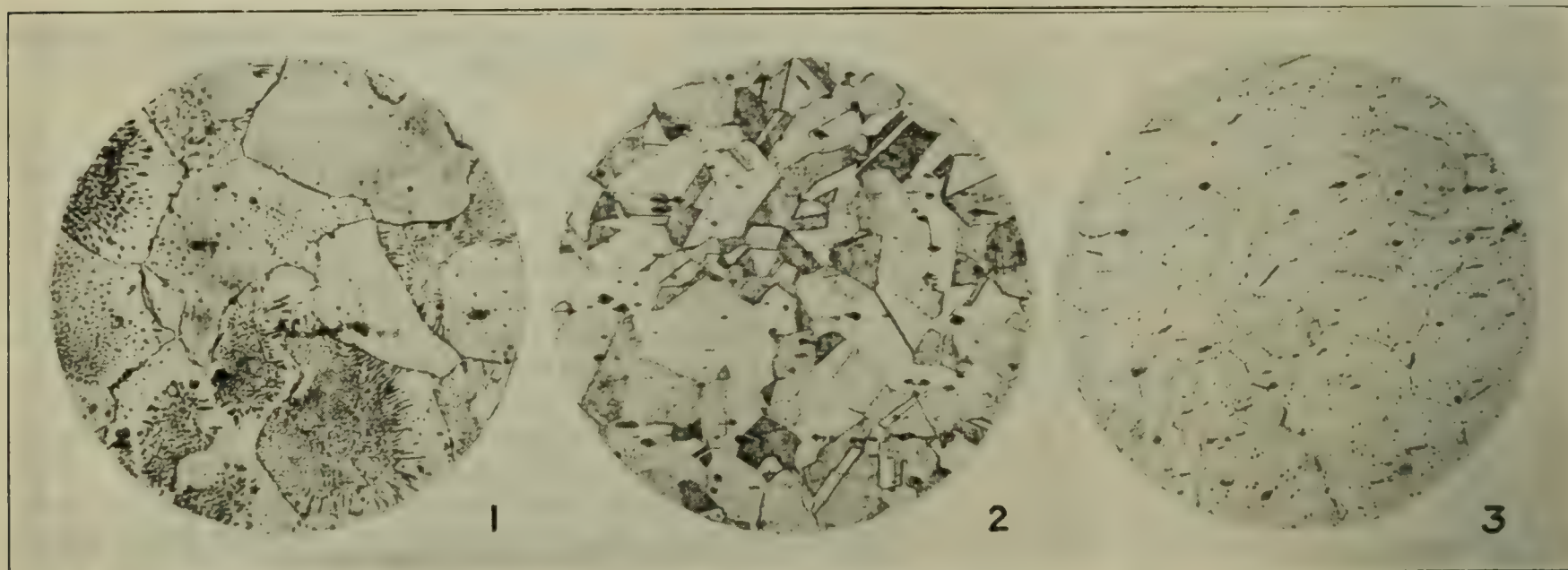


Fig. 1. Microstructure of nickel blocks showing nickel:nickel-oxide eutectic. $\times 100$.

Fig. 2. Microstructure of hot-rolled nickel rod showing oxide inclusions. $\times 100$.

Fig. 3. Microstructure of rolled nickel rod containing precipitated graphite in the form of fine particles. $\times 100$.

line brittleness which has been structurally well described by Rawdon and Krynitzky¹³. When exposed at high temperatures (i.e., from 1,000 to 1,200 deg. C.) to the action of oxidizing or sulphurizing gases the boundaries of the surface grains are attacked, either oxidized or sulphurized, and the cohesion between the grains is destroyed. These surface layers become quite brittle and will not elongate or flow under subsequent drawing or rolling operations, but there is produced a network of fine cracks on the surface under such treatment. The presence of these cracks indicates a faulty heating operation—i.e., either the flame was too oxidizing and “burnt” the metal, or it introduced sulphur into it. Fig. 4 shows the structure of such “heat-checked” nickel sheet.

The best etching agent is nitric acid, and for that purpose a volume concentration from 75 to 100 per cent acid may be used. Somewhat better results may be obtained by using a solution of nitric acid of a volume concentration of from 50 to 75 per cent made up by diluting the concentrated acid with a 50 per cent aqueous solution of glacial acetic acid; these acetic acid

necessary for the commercial production of malleable nickel.

The nickel-carbon equilibrium diagram has received some attention at the hands of investigators, but there are still many gaps in our knowledge of the constitution of this binary system. With increasing carbon content the melting point of pure nickel is progressively lowered from 1,452 deg. C. to 1,311 deg. C., at which temperature nickel forms a eutectic with 2.2 per cent graphitic carbon. The liquidus temperature then rises again with increasing carbon content and at 2,100 deg. C. the metal absorbs 6.42 per cent carbon, apparently in the form of a carbide, Ni_3C^{14} , which is, however, rapidly decomposed at lower temperatures with formation of graphite. The equilibrium below the eutectic temperature has never been satisfactorily worked out. Ruff, Borman and Keilig¹⁵ state from the results of their investigations that the solubility of graphite in nickel in the solid state is not greater than 0.5 per cent at the eutectic temperature, but they give no information about the presumably diminishing solubility at lower tempera-

¹⁴W. Borman, Dissertation, Techn. Hochschule, Danzig, 1915.

¹⁵Z. anorg. allgem. Chem., vol. 88, p. 386 (1914).

tures. Although we do not have the exact knowledge of equilibrium at lower temperatures which would be desirable, it is known that the presence of carbon introduces no transformation such as that which occurs in steel, and with which might be associated the possibility of profoundly altering the physical properties of the alloy by means of a suitable heat-treatment.

Within the limits of composition within which carbon is usually found in nickel it occurs in solid solution and merely increases the hardness and strength of the metal. It increases the ease of hot-working operations by making the metal tougher at these temperatures and less susceptible to edge cracking. On the other hand, it increases the difficulties of cold-working both because with increased carbon the metal is initially harder and also because it hardens more rapidly with progressive cold work. The effect of carbon in increasing the hardness of nickel is illustrated in Table III.

When the percentage of carbon exceeds about 0.40 per cent the separation of graphite may take place, which is accompanied by a loss of malleability. Free graphite should not be present in good quality malleable nickel. The statement that carbon is harmful to malleable nickel

TABLE III. EFFECT OF CARBON ON THE HARDNESS AND TENSILE STRENGTH OF NICKEL

Chemical Composition					Tensile Properties				Hardness		Remarks
C	Mn	Si	S	Fe	Yield Point	Tensile Strength	Elongation in 2 In.	Reduction of Area	Brinell 3000 Kg.	Scler scope	
0.08	...	0.04	0.026	0.63	22,000	69,000	46	50	103	10	Hot-rolled
0.26	0.48	0.13	0.016	0.56	34,000	93,000	40	35	132	17	Hot-rolled
0.19	0.26	0.33	.....	0.68	.....	.....	..	..	131	15	Annealed
0.06	0.21	0.33	.....	0.59	.....	.....	..	..	97	10	Annealed

and that its presence should be avoided is not correct, but applies when the carbon is in form of graphite.

Nickel Oxide (NiO).—This compound cannot be present in malleable nickel and is therefore in a sense not to be regarded as an impurity in it; on the other hand, its potential effect on the properties of the metal make necessary certain procedure in the preparation and de-oxidation of malleable nickel of the utmost importance. It does occur in shot and casting blocks and occasions the complete lack of malleability of these forms of the metal.

The equilibrium of nickel and nickel oxide has not been systematically studied. The only mention of it is by Ruer and Kaneko,¹⁴ who state that the presence of NiO in molten nickel depresses the melting point by about 10 deg. C. and they give a photomicrograph showing the eutectic structure of it in nickel. Apparently nickel dissolves several per cent of nickel oxide in the liquid state, but it is completely insoluble in the solid state and separates out in the form of a eutectic. Fig. 1 shows the appearance of this eutectic in nickel blocks.

As nickel oxide is always found and is probably always formed in refining molten nickel, it is necessary to remove it before pouring the metal into ingots for forging or rolling. This may be done by means of manganese, aluminum or magnesium, but the latter element is by far the best and is most generally used. It is introduced in the form of a 1- to 2-in. rod either into the crucible or the teeming ladle; it must be plunged to the bottom and stirred around briskly in

order that it will not merely float to the surface and burn off. Approximately 1.5 oz. to the hundred pounds of metal is added; more magnesium will do positive harm, making the melted metal thick and sluggish to pour.

Manganese.—Manganese is generally absent from non-malleable nickel, but is added intentionally to malleable metal both because of its effect on its ultimate properties and because of its usefulness in decreasing manufacturing difficulties. It renders the metal less tender just after freezing and thus aids in the production of ingots free from "pulls" and hot cracks. It



Fig. 4. Microstructure of cross-section of heat-checked nickel sheet, showing intercrystalline oxidation of surface layers.

also increases the fluidity of the molten nickel and thus renders easier the production of ingots of good surface.

These advantages are obtained with small additions. Added in larger amounts, it increases the resistance to oxidation and renders it less susceptible to the action of sulphur in the fuels used in hot rolling. Thus it is the C and D grades of nickel, containing from 1.50 to 6 per cent manganese, which are largely used for the spark points of motor ignition systems.

The equilibrium of the system manganese:nickel has been studied by Zemczuzny, Urasow and Rykowskoff,¹⁵ who find that the two metals are soluble in all proportions both in the solid and in the liquid state. This agrees with our rather meager knowledge of the properties of high manganese:nickel alloys. These may be rolled readily up to 10 per cent of manganese and prob-

TABLE IV. EFFECT OF MANGANESE ON THE PHYSICAL PROPERTIES OF HOT-ROLLED NICKEL ROD

No.	Chemical Composition					Tensile Properties					
	C	Mn	Fe	Si	S	Proportional Limit	Yield Point	Tensile Strength	Elongation in 2 In.	Reduction of Area	Electrical Resistivity, Microhm-Cm.
1	0.06	3.00	0.62	0.22	0.018	20,000	23,500	74,100	51	60	14.5
2	0.06	3.58	0.62	0.23	0.018	22,500	23,700	74,400	50	62	14.5
3	0.06	4.40	0.73	0.27	0.021	25,000	27,500	75,500	43	63	17.9
4	0.06	5.06	0.72	0.28	0.020	22,500	26,800	77,500	48	62	19.2
5	0.07	6.78	0.89	0.34	0.020	31,000	30,500	82,000	50	66	23.6
6	0.08	6.84	0.91	0.35	0.020	31,500	31,200	81,300	36	50	24.6
7	0.10	9.18	0.95	0.42	0.021	32,000	32,900	84,100	48	62	29.3
8	0.10	9.24	0.94	0.41	0.020	31,000	32,800	83,800	48	64	29.7

ably beyond, although the 50 per cent alloy is known to be quite brittle. Within these limits the addition of manganese mildly increases the hardness and strength of nickel without materially decreasing the ductility.

¹⁴Metallurgie, vol. 9, p. 419 (1912).

¹⁵Z. anorg. allgem. Chem., vol. 57, p. 263 (1908).

The addition of manganese, however, does decrease the electrical conductivity of nickel markedly;¹⁸ thus the resistivity of nickel, drawn and annealed, was increased from 12.43 microhm-cm. to 28.0 and 51.2 microhm-cm. with the addition of 10 and of 20 per cent respectively of manganese. Table IV shows the effect of manganese on the tensile properties and resistivity of hot-rolled nickel rod.

Sulphur.—The form in which the usual small amounts of sulphur occur in commercial nickel is not known, but it is present presumably as a sulphide of nickel or of manganese. Its presence in amounts above 0.05 per cent decreases the ductility both hot and cold and it should be held as low as possible in nickel intended for malleable ingots.

Judging therefore by its effect on the properties, it is present in the form of a separate constituent, insoluble in the solid state in nickel. Bornemann¹⁹ has investigated the equilibrium of the system nickel: sulphur and finds that a compound is formed, Ni_3S_2 , which is soluble in the liquid state in nickel but which forms a eutectic with it at 21.5 per cent sulphur and 644 deg. C. upon freezing. The solubility of Ni_3S_2 in nickel in the solid state at the eutectic temperature is about 0.5 per cent and rapidly approaches zero at lower temperatures.

Iron.—This element is always present in commercial nickel due both to imperfect removal of the iron originally present in the ores and to the wear and solution of tools used in the roasting and refining furnaces. The amount present is usually less than 1 per cent and has no appreciable effect upon the properties of the metal. The system nickel:iron has been investigated by Guertler and Tammann,²⁰ Ruer and Schuz²¹ and others, who find that the metals form an uninterrupted series of solid solutions, with certain interesting anomalies to be described later in an article in this series entitled "Iron:Nickel Alloys."

Cobalt.—This element in amounts up to 1 per cent and averaging about 0.3 per cent in American nickel is invariably found in nickel and is usually included in the figure given for the nickel content. It is soluble in the nickel in all proportions both in the liquid and in the solid state and in small amounts does not exert any appreciable effect upon the properties of nickel except probably the electrical resistivity.

Silicon.—According to Guertler and Tammann,²² this element forms a compound, Ni_3Si , with nickel which is soluble in molten nickel, but upon solidifying forms a eutectic with it at 10.6 per cent silicon and 1,153 deg. C. The solubility of this compound in the solid state in nickel is equivalent to 6 per cent of silicon at the eutectic temperature, decreasing to 2.5 per cent at 660 deg. C. and approaching lower values as the temperature decreases.

Silicon is always present in furnace-refined nickel in amounts generally under 0.25 per cent and has comparatively little effect. In larger amounts the hardness of the metal is increased and its ductility decreased and with still increasing amounts the malleability, both hot and cold, is diminished and finally destroyed completely. This occurs at a content of about 3 to 5 per cent of silicon.

Oil Refinery at Swansea Near Completion

The new oil refinery of the Anglo-Persian Oil Co. at Swansea is now practically ready to begin operations, reports Consul Cooke. The company states that it expects to begin refining oil in February or March, 1921. The refineries are located at the village of Skewen, about four miles from the port of Swansea, among the hills. The company has leased from the Swansea Harbor Trust on long lease fifty acres of land lying adjacent to the King's Dock, where there have been erected four huge sheet-iron tanks with a capacity of 2,500,000 gal. each. These tanks are connected with the adjacent dock and jetty by underground pipes. It is proposed to use three of these tanks for storing the crude oil as it is piped from the discharging vessel, and from these the oil will be pumped up to the refineries. The fourth tank is to receive the refined oil, which will return from the refineries by gravity and be delivered by pipe to receiving vessels as they lie alongside the jetty.

The initial capacity of the plant is stated to be 12,000 to 15,000 tons of oil per week. The capacity, it is expected, will be doubled within two years. The crude oil will be brought in bulk from the Persian fields and from other sources as they are available.

Every precaution has been taken to facilitate the shipping of oil by vessels whether for bunker or cargo. To this end the company has laid down pipes from the tank to the jetty, thus obviating the necessity of vessels entering the King's Dock. They have only to take berth alongside the jetty, and the oil will be supplied to them through pipes.

While the primary object of the company is to refine for fuel purposes, it plans ultimately to enter the field of high-test refining and to turn out both oil for lighting and gasoline.

Steel From Japanese Iron Oxide Sand

A method whereby iron may be smelted from the volcanic iron oxide sand of Japan, heretofore regarded as wholly refractory, is said to have been discovered by scientific experimenters working for the War Department of that country. While the discovery cannot be employed as yet commercially, the cost of the iron so obtained being too high to compete with iron smelted from ore, the value, from a military standpoint, of the process to Japan, which, like every other volcanic country, is rich in deposits of iron oxides, is regarded as being great, inasmuch as it may place that country in an independent position so far as its supply of steel for military and naval uses, where cost is not the deciding factor, is concerned.

A statement made by the War Office on Oct. 18 said, with regard to the process, which is being guarded as a military secret: "Iron sand is so general throughout the entire length and breadth of the empire that it has long been plain that if some method were discovered of smelting the iron from it, Japan would never suffer from want of steel. On the strength of the above, the necessary investigations were started as early as September last year by a special committee, with experimental offices established in the Aomori Prefecture, and with Dr. Kishi as chief engineer. The experiments of a year have now been crowned with tolerable success, and the process has been experimented with on a practical scale at the Penchihi works under the control of the Okura firm with very satisfactory results."—*The Engineer*, Dec. 24, 1920.

¹⁸Hunter and Sebast; *J. Am. Inst. Metals*, vol. 11, p. 115 (1917).

¹⁹*Metallurgie*, vol. 7, pp. 667, 740 (1910).

²⁰*Z. anorg. allgem. Chem.*, vol. 45, p. 211 (1905).

²¹*Metallurgie*, vol. 6, p. 679; vol. 7, p. 415 (1909, 1910).

²²*Z. anorg. allgem. Chem.*, vol. 49, p. 93 (1906).

Salt Manufacture in Michigan

Description and Technology of the Salt Deposits of Michigan—Preliminary Treatment, Storage and Settling Tanks—Salt Grainer and Vacuum Pan Operation—Mechanical Crystal Handling Devices—Types of Crystals Produced

By W. L. BADGER

VERY little has been published on the engineering features of salt manufacture. The few articles that have been published are mainly in publications not usually consulted by engineers.¹ One well known handbook has a description that gives an entirely false impression of the present state of the industry. This paper describes present practice as it is found in the eastern district of Michigan, which is now the principal salt-producing field of the United States.

SALT DEPOSITS

The geology of salt deposits in Michigan has been reported in several places.² The lower peninsula of Michigan is a syncline or basin. There are several salt-bearing strata, but the most important one is the Salina. This is at a depth of 700 to 1,200 ft. in the neighborhood of Detroit and dips rapidly to the north and west. It is found at a depth of about 1,600 ft. in the vicinity of St. Clair, sixty miles north of Detroit. In the center of the state it is too deep to work, but it reappears in the northwest corner of the lower peninsula in the vicinity of Ludington and Manistee. Here it is at a depth of 1,900 to 2,200 ft. The salt varies in thickness. Sometimes there are several thin seams, some more or less impure. In other places, especially along the Detroit and St. Clair Rivers, the main bed is from 100 to 400 ft. thick and very pure, although there are thin seams of impure salt above it. In the Saginaw Valley, on the other hand, the source of salt is natural brine. This is found in the Parma and Napoleon formations. The Parma is just below the coal horizon in Michigan, and the Napoleon a little lower. Brine is met at a depth of only 700 to

850 ft., but it is more impure than the salt of the Salina deposit. It is high in calcium and magnesium chlorides, and contains enough bromides to be the basis of the most important bromine-producing district in the United States.

Salt production in Michigan can be divided, then, into three quite distinct districts: the Detroit and St. Clair River District; the Saginaw Valley district; and the Ludington-Manistee district. This paper is concerned mainly with the present practice in the first of these districts.

SOURCE OF BRINE AND PRELIMINARY TREATMENT

The main bed of the Salina formation is usually pure enough to work up into high-grade salt with little preliminary treatment. Since the deposit is rock salt, an artificial brine has to be made by pumping down river water. A typical log of a well is shown in Fig. 1. This well is at the plant of the Worcester Salt Co. at Ecorse, just south of Detroit. The outer casing is continuous to the top of the first bed of salt worked. From this point the well is 6 in. in diameter, uncased, to the bottom of salt. A central line of tubing goes to the bottom of the well. Practice is not uniform as to pumping; wells are usually supplied with water through the annular space and the brine flows up through the central tubing. Perhaps the less common case is where water is supplied to the bottom of the well through the central tube.

If the cavity at the bottom of the well is closed, no air need be used; and the pump which delivers water furnishes pressure for raising brine. In some cases two or more wells become connected at the bottom. In this case water may be pumped in one well and brine obtained from the other; or each may be pumped by air lifts. At one of the older plants an estimate was made of the size of the cavity. Assuming that water pumped down was distributed uniformly over the cavity and worked down to the outlet uniformly, the time elapsed between pumping in water and getting out the same water as brine was about three years.

When several beds are worked as in Fig. 1, at intervals the shale strata between the salt strata cave in and block the well so that the wells have to be redrilled occasionally. Where the wells work only one thick bed, they seldom need any attention for long periods.

This method of working gives a fully saturated brine. Brine is usually reported in salinometer degrees—i.e., on a scale where 100 deg. is a completely saturated brine. No plant in the Detroit district expects to work on less than a 99 deg. brine, and it is usually 100 deg.

These brines are so pure that the usual preliminary treatment is merely settling. There is a plain odor of hydrogen sulphide in the brine as it comes from the wells. There is usually little or no iron present—so little in most cases that direct tests without concentration usually fail to show iron.

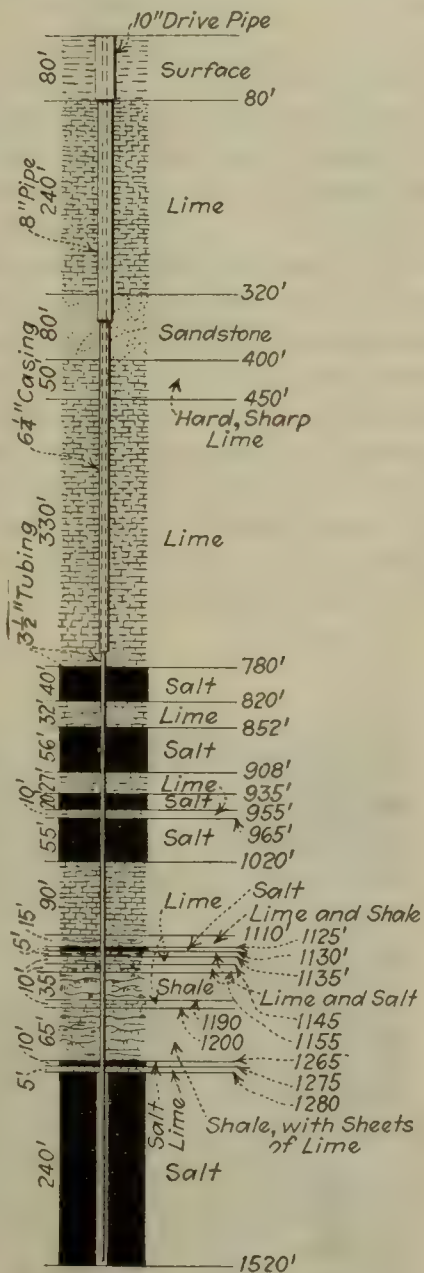


FIG. 1. LOG OF WELL

¹Exceptions to this statement are: "Technology of Salt Making in the U. S.," W. C. Phalen, Bu. Mines Bull. 146 (1917). "Salt Manufacture," G. B. Willcox, *Trans., Am. Soc. Mech. Eng.*, 1908, p. 1065.

²"Salt Resources of the U. S.," W. C. Phalen, Bull. 669, U. S. Geological Survey, 1919. "The Brine and Salt Deposits of Michigan," C. W. Cook, Michigan Geological and Biological Survey, Publication 15, Geological Series 12 (1914).

The following analyses of artificial brines from the Detroit district are taken from Cook³ (recalculations to salts by the author). All figures are grams per liter:

	A	B	C	D
K	trace	trace	trace	trace
Na	114.5	119.2	120.6	121.3
Ca	0.6	1.4	0.8	0.6
Mg	1.0	0.4	trace	trace
Cl	175.0	185.0	183.8	185.2
SO ₃	2.2	2.8	4.4	3.4
CaSO ₄	2.2	4.8	2.7	2.0
MgCl ₂	3.9	1.6	trace	trace
Na ₂ SO ₄	1.8	0.0	5.0	3.9
NaCl	284.1	303.6	303.6	305.9

A—Delray Salt Co., Delray, Mich.

B—Michigan Alkali Co., Wyandotte, Mich.

C—Diamond Crystal Salt Co., St. Clair, Mich.

D—Worcester Salt Co., Ecorse, Mich.

SETTLING TANKS AND GRAINERS

The old-time salt maker used to say that good salt could not be made from brine less than twenty-one days old. It is difficult to

place the reason for this superstition. Some plants still think they can get better salt by settling the brine, but in most cases the settling tanks are merely to give storage capacity; and, if necessary, brine goes from the wells directly to evaporators or grainers with no apparent lowering of the quality of the salt made. Very few plants in the eastern Michigan district have capacity for more than

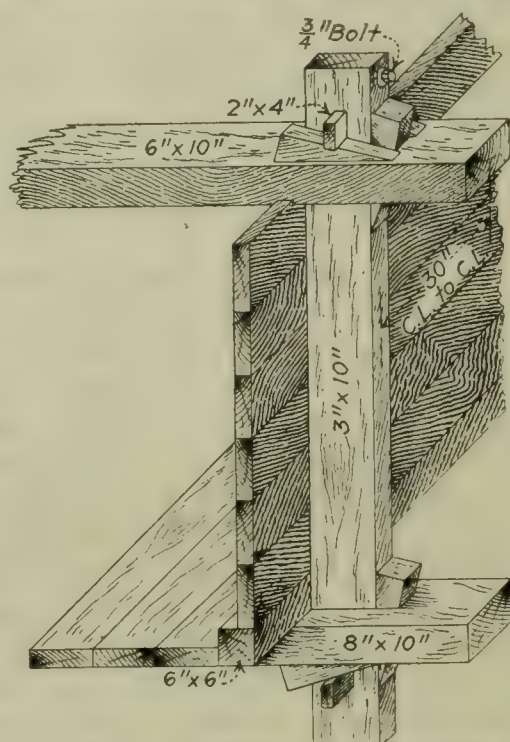


FIG. 2. TIMBER TANK CONSTRUCTION

twelve or eighteen hours' supply of brine. One of the most characteristic features of salt plants in this district is the old wood settling tank. Most of these plants were built long enough ago so that timber construction was the cheapest for settlers. Also, complete avoidance of iron made it easier to get a good-colored product. The method of bracing and tying these storage tanks, without the use of any iron, is very interesting. Buckstaves 3 x 10 in. on about 30-in. centers pass through mortises in 8 x 10-in. sills below and 6 x 10-in. ties above. By means of a pin and wedges the tank is tied crosswise and the side planks are drawn down. The planks are not tongued. A diagrammatic sketch appears in Fig. 2, and photographs of this style of construction are shown in Figs. 3 and 4.

These tanks are usually about 150 ft. long, 15 ft. wide and 6 ft. deep. They are divided by cross-bulkheads into individual sections about 50 ft. long. The commonest construction is to build sets of two tiers with two long tanks in each tier. Brine from the wells is discharged into launders running over the tanks. If the brine is to be limed, hydrated lime is made into a thin milk and scattered over the surface of the brine after the tank is filled. Some plants use no lime at all, others very little. Probably the maximum amount used in this district is 50 lb. hydrated lime for one tank 50 x 15 x 6

ft. This amount is considered excessive at other plants. The grainer is a typical Michigan institution. It developed in the early days of the salt industry when salt was almost wholly a byproduct made by waste steam which was generated from saw-mill refuse. It is an inefficient and crude device; but it makes a characteristic grade of salt for which



FIG. 3. TIMBER SETTLING TANKS

there is a definite demand. The usual form of grainer is a steel trough, 150 ft. long, 12 to 15 ft. wide and 22 in. deep. In it are hung steam pipes, and brine is evaporated without boiling. Grainers are usually of 1/4-in. plate, single lap riveted. Due to rapid corrosion of iron exposed to salt and air (iron completely immersed in brine corrodes much more slowly), all parts of a salt plant are made as simple and cheap as possible. The grainer shell rarely has a flange or stays, and coil hangers and similar parts are very simple.

In the old days grainers were made of wood, but there are comparatively few wood grainers now in existence. Willcox⁴ has described the construction of concrete grainers. These have proved entirely satisfactory in other districts but very few have been built along the Detroit and St. Clair Rivers.

Coils are of 3 1/2 or 4-in. pipe, and there are nine to thirteen passes in each grainer. In some grainers the pipes are in parallel from one header. In other cases they are arranged in two or three parallel coils. There

⁴G. B. Willcox, *loc. cit.*



FIG. 4. TIMBER SETTLING TANKS

³Loc. cit.

are occasional grainers in which all the turns of the heating surface are in series in one coil. Probably series-parallel arrangement is the commonest. The objection to straight parallel arrangement is that different pipes do not discharge their condensed water uniformly from a common header. One is apt to be water-bound while another is discharging, and this condition oscillates across the coils so that expansion and contraction strains are excessive. The coils are usually hung from crossbars which are either loose and resting across the edges of the grainer or riveted to the grainer walls.

Originally the salt was removed by hand. Now, mechanically raked grainers are universal. The rake used in practically all grainer plants is made by the Willcox Engineering Co. of Saginaw and is described briefly in the paper mentioned above. It consists of

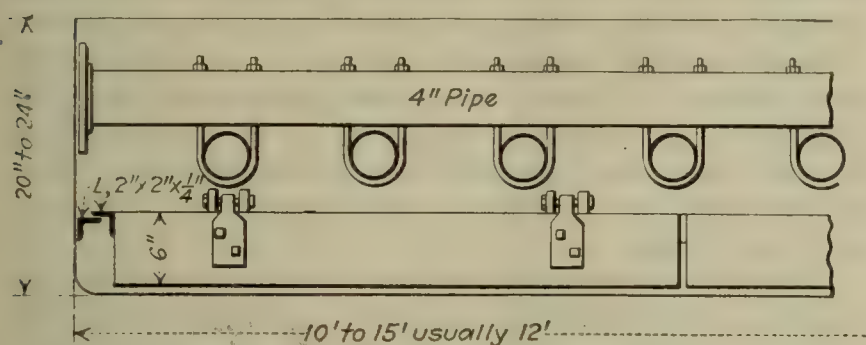


FIG. 5. CROSS-SECTION OF GRAINER

a framework of angle iron submerged in the brine and worked back and forth by a hydraulic piston. Scrapers pass the salt to one end of the grainer, work it up on a drain board and over into the conveyor. Figs. 5, 6, 7 and 8 show this construction. The main frame of the rake is of 2 x 2 x 1/4-in. angle irons, in panels about 8 ft. long, with diagonal braces to each panel. On the transverse member of each panel are fastened scrapers of 1/4 x 6-in. plate, hung with cast iron hinges, as shown in Fig. 6.

This allows the scrapers to "feather" over the salt on the back stroke, and to engage the salt on the forward stroke. In Fig. 8 may be seen the scrapers with their diagonal braces. A 10-ft. stroke results in a progressive motion of the salt. Fig. 5 shows a cross-section of a grainer in which the coils are hung from cross-pipes riveted to the grainer walls. The rakes slide on short angles fastened at intervals along the grainer sides. Power for the rakes is furnished by a hydraulic cylinder. This is usually about 8-in. bore, and is supplied with water at from 60 to 100 lb. Reversal is accomplished by a trip rod, operated by a striker attached to the rake frame, actuating a linkage which throws a hydraulic reversing valve. Figs. 9 and 10 show the linkage used by the Willcox Engineering Co. in its installations. A trip rod from the grainer rake (3) has a yoke with rollers (5) bearing on the lever (1). At the end of a stroke of the rake, a striker on the grainer rake frame engages a collar on the trip rod and

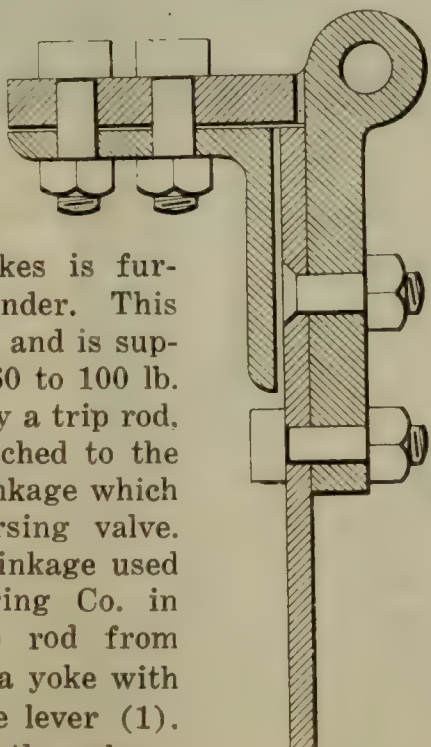
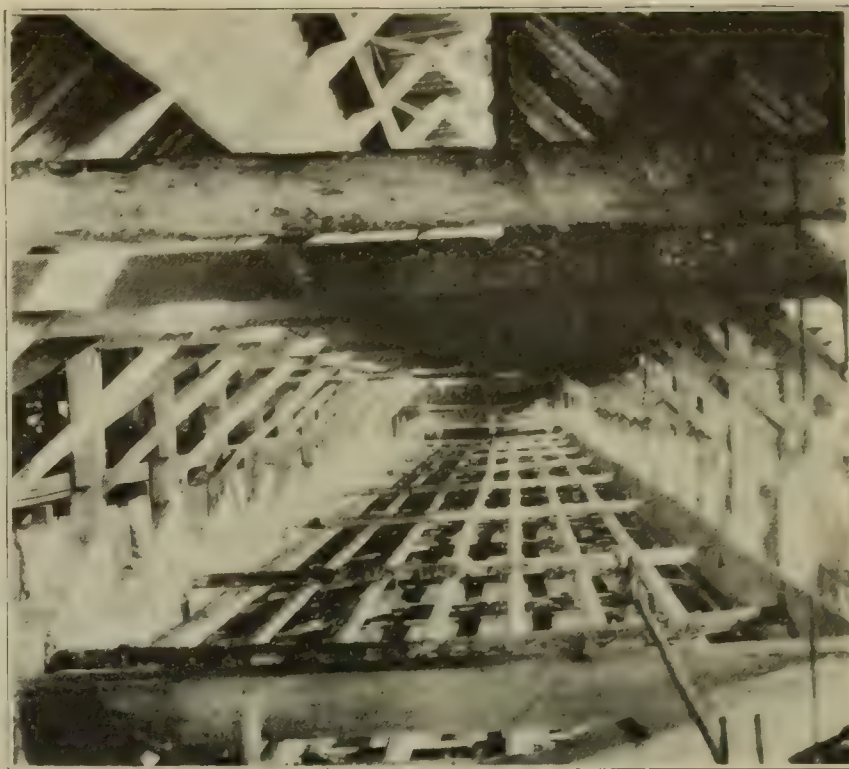
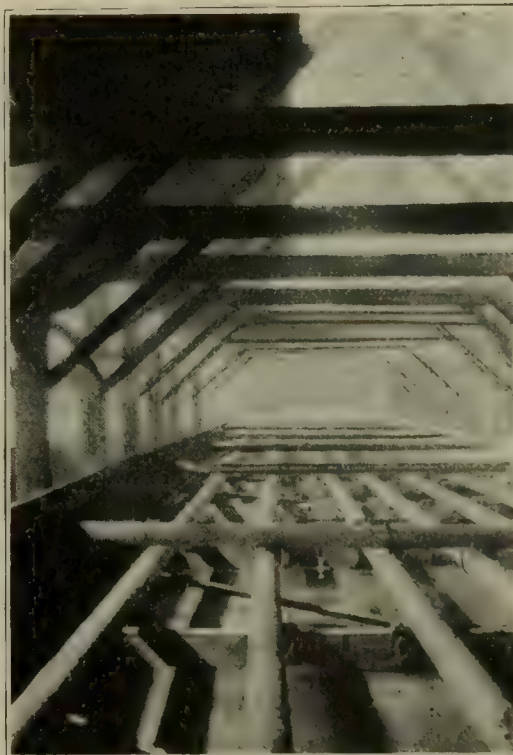
FIG. 6.
GRAINER RAKE
AND SCRAPER

FIG. 7. EMPTY GRAINER

pulls the lever (1) over into the position shown by the dotted lines, thus throwing the hydraulic reversing valve whose stem is connected to (2). The valve, piping and trip mechanism are shown in Fig. 10.

Another linkage used in the plant of the Worcester Salt Co. is shown in Figs. 11 and 12. In Fig. 11 (5)

FIG. 8. GRAINER SHOWING
DETAILS OF RAKE

is the trip rod from the rake, and the stem of the hydraulic reversing valve is attached to the pin G. As the rake reaches the end of a stroke, it moves the trip rod (5) to the left, which rotates bar (2) around A and lifts the counterweight on rod (4). When pins D, E, A and B are in line the linkage is on a dead center, but the valve has not been moved because of the slot in bar (6). As pin E moves beyond this line the toggle is upset, the weight on bar (4)

falls and pulls the linkage into the position shown by the dotted lines, and the resulting motion of pin G operates the reversing valve.

The delivery end of the grainer is sloped up at an angle of about 30 deg. and the end panel of the rake is hinged so that salt is shoved up on this sloping drain board. The end scraper does not go to the edge of the drain board at the end of its stroke, but leaves enough space between the end of its stroke and the discharge to store several scraper-loads of salt. Thus the salt drains for some minutes before being pushed off into the conveyor below.

The speed of the rakes varies with the rate of evaporation in the grainer. When working near to capacity about one complete double stroke in two

the purity of the brine and the rate of operation. Few producers have any standard for purity of the salt, and hence have no standard for the concentration of impurities which may accumulate in the bittern before discarding. A table of analyses of grainer discard bitterns in Cook⁵ shows the following extreme cases, with the rest distributed anywhere between:

	Grams per Liter			Grams per Liter	
K	0.1	2.0	Mg	0.2	2.7
Na	121.1	104.6	Cl	187.5	194.6
Ca	1.9	13.8	SO ₃	3.4	0.6

Where calcium chloride is to be manufactured from the bitterns, a further evaporation removes most of the sodium chloride and gives a highly concentrated bittern to go to the calcium chloride evaporators proper. Sodium chloride is almost insoluble in strong solutions of calcium-magnesium chloride mixtures.

The capacity of a grainer is quite variable. It depends on the temperature and humidity of air circulating over the grainer, and on the wind or other conditions affecting air supply. The number of coils, steam pressure, amount of scale, and temperature of brine fed, all affect the capacity. A clean grainer and 40 lb. steam will result in about 140 to 150 bbl. of salt for one 12 x 150-ft. grainer per twenty-four hours. Atmospheric steam will give as low as 50 bbl. A fair average is 80 to 100 bbl. per day.

Grainer salt is almost never dried. It is usually conveyed to a storage building and allowed to stand in stock piles for varying lengths of time. Under the old state law for salt inspection, salt was not to be packed until it was twenty days old. This length of time is not now maintained, and salt is packed or shipped as soon as the moisture content is low enough. As there are almost never accurate specifications, this means that grainer salt is packed after a storage that depends on the relation between the amount in stock and the amount being sold. If it can be sold as fast as made, it is packed after the least storage—possibly less than a week—that will give salt dry enough to satisfy the buyer.

Salt is sold in standard barrels of 280 lb. net. Grainer salt may be packed in barrels or sold in bulk. It is rarely sold in packages smaller than a barrel.

One characteristic of sodium chloride, when formed by slow evaporation, is that it forms hopper-shaped crystals. These hoppers are composed of true cubes of the regular system united at their corners to form a hollow pyramid. Fig. 13 shows a characteristic hopper crystal, though the crystal photographed was ac-

tually KClO₃. These pyramids form at the surface of the brine in the grainer and float for some time. Chance drafts and disturbances send them to the bottom before they get very large. In rare instances they may be obtained as much as $\frac{1}{4}$ in. across. This slow surface evaporation, combined with the habit of sodium chloride to form crystal aggregates rather than large compact crystals, gives grainer salt its peculiar open structure which is the only reason for its existence. Photo-micrographs of grainer salt are given in Figs. 14 and 15. Grainer salt will dissolve faster than vacuum pan salt of the same grain size. Due to its open structure, it carries much mother liquor with it which is not drained out, but dries on the crystals. Hence it is never as pure as vacuum pan salt. Standards for color are not as rigid as for vacuum pan salt.

Grainer salt goes to various markets. Some is used for salting hides, though crushed rock salt is generally preferred for this. Some grainer salt goes for dairy purposes, some for ice cream manufacture. Much is sold to jobbers for miscellaneous uses, some jobbers drying it and packing it as a low-grade table salt for the cheaper trade. Undoubtedly much grainer salt is used for purposes where pan salt would be equally good, the demand for grainer salt being only a trade tradition.

VACUUM PAN PROCESS

The first single effect vacuum pans in Michigan were built about 1888 or 1889, and the first double effect pans in 1895. When this is contrasted with the sugar indus-

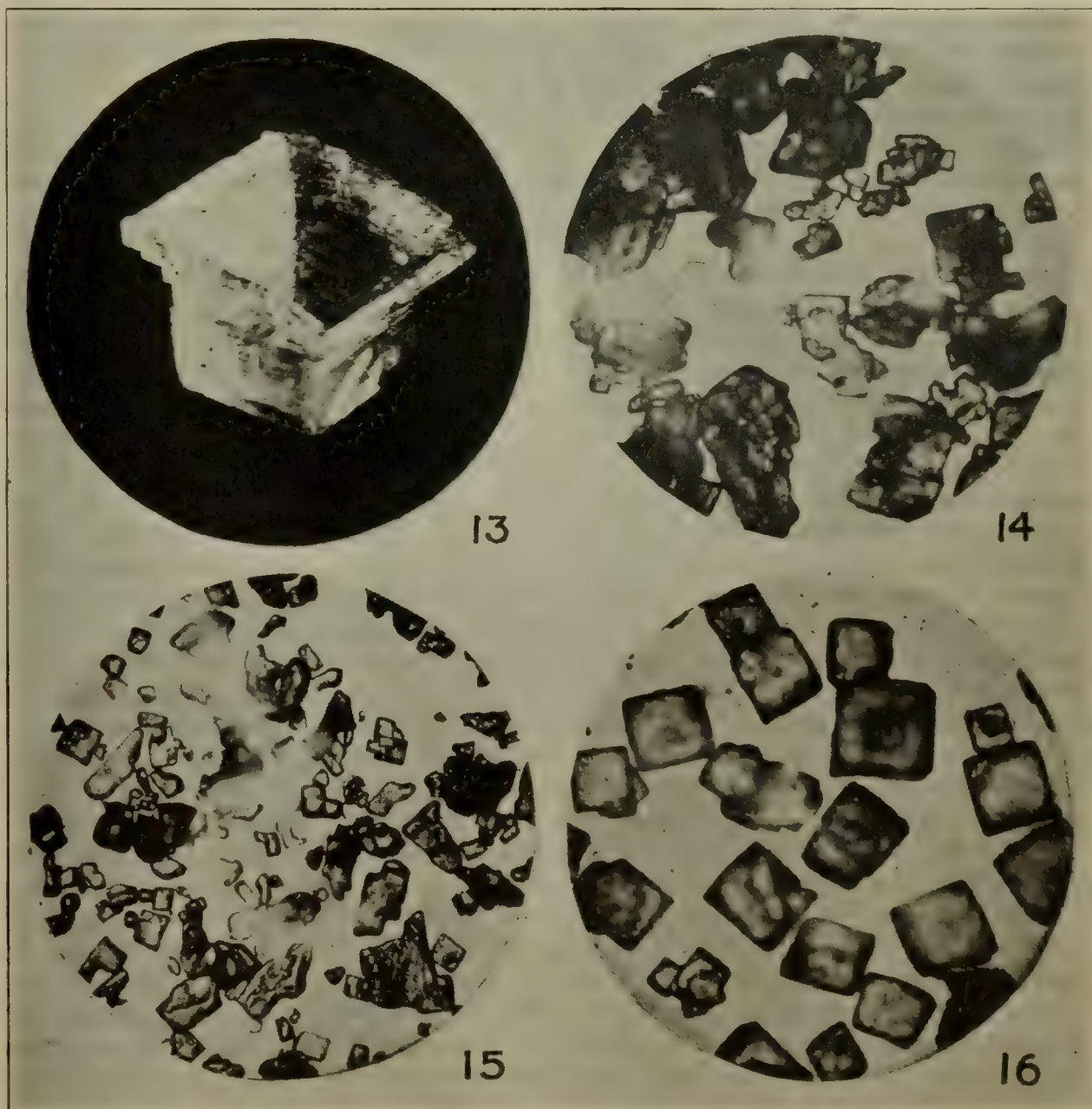


FIG. 13. HOPPER CRYSTAL
FIG. 15. FINE GRAINER SALT

FIG. 14. COARSE GRAINER SALT
FIG. 16. VACUUM PAN SALT

⁵Loc. cit.

try, where the first vacuum pan was built in 1812 and the first multiple effect pan in 1845, it will be seen how little engineering attention has been given to salt manufacture. The obvious reason is that salt in Michigan has always been a byproduct of industries having large amounts of waste heat, so that questions of fuel economy never arose. About 20 per cent of the country's total salt production is now made in vacuum pans. In the Michigan districts the capacity for vacuum pan salt production is nearly equal to the grainer capacity.

In salt manufacture, double effects are common and triples are often met with. Quadruple effects are rather rare, due to excessive losses from the difference between the boiling point of salt solution and that of pure water under the same pressure. Without going into the theory of multiple effect evaporators, it may be said that this elevation of the boiling point of a solution is a total loss of available temperature drop in a multiple effect evaporator. This loss is repeated in every effect. As the working range of such evaporators is usually limited by conditions outside the designer's control, too many effects leave too little working temperature drop. Since capacity depends directly on the working temperature drop, attempts to increase economy, by increasing the number of effects, rapidly result in decreased capacity.

The standard form of evaporator is the usual vertical tube evaporator, with a central downtake. The tubes are usually from 4 ft. 6 in. to 5 ft. 6 in. long, and from $2\frac{1}{2}$ to 3 in. in diameter. A small salt pan will be 6 ft. in diameter and a large one 20 ft. Steam pressure, of course, varies, but multiple effects are seldom run on steam much above atmospheric pressure. Most plants succeed in maintaining a vacuum on the last effect better than 27 in. on a 30-in. barometer.

The central downtake varies in size, but is usually from 75 to 150 per cent of the total tube area. In pans built by the Manistee Iron Works, one of the best known builders of salt pans, there is a propeller in this downtake to aid circulation. Below the calandria is a conical bottom, the sides inclined 30 deg. or less to the vertical, and this cone is prolonged into a "salt leg" in case an elevator is used to remove the salt. The upper part of the body is also conical, sometimes having a belt sloped outward, just above the tube sheet, to prevent material caked on its sides falling into the salt below. Fig. 17 shows the essential features of a typical salt pan with its elevator.

Due to the universal presence of calcium sulphate in brines of this district, heating surfaces gradually become coated with sulphate scale. There is also the phenomenon of "salting up" which must be met. Most of the salt formed, as evaporation proceeds, forms as free crystals suspended in the solution. Gradually, however, a coating of salt crystals builds up on all hot surfaces just as scale forms. The cause of this difficulty is not definitely known, though each plant has a theory. In conjunction

with the presence of calcium sulphate scale, "salting" helps to make the deposit on the tubes grow more rapidly. Consequently most salt pans have to be boiled out with water or dilute brine at intervals; and at longer intervals the pan must be shut down and calcium sulphate scale drilled out.

One method is to have vapor lines so arranged as to permit cutting out one body for cleaning while the rest are operating. The three pans of the Worcester Salt Co. are so arranged that all three can be run as a triple effect, or any two as a double effect, or any one as a single effect. They are generally operated as a double, one after the other being cut out for cleaning. The pan used as a first effect will be boiled every ten to fourteen hours; the second effect every twenty to thirty hours. The three pans of the Canadian Salt Co. at Windsor, Ont., are arranged as two first effects and one second effect. One first effect is cleaned each day, and the second effect once a week. The three pans of the Inland-Delray Salt Co. in Detroit are arranged as a straight triple effect. They are boiled Wednesday each week by letting the brine down a couple of feet and filling with water to the former level. This dissolves out salt that has formed by "salting." On Saturday the whole evaporator is shut down and drilled. In most cases pans are drilled often enough to prevent much more than $\frac{1}{8}$ in. of calcium sulphate, though there may be a good deal of salt on top of this.

The capacity of a vacuum pan depends on many factors, and few operators have exact data on the capacity of their equipment. Steam pressure, amount of scale and salt on the tubes, brine level and many other factors enter into a statement of capacity.

REMOVING THE SALT

The commonest method for removing salt from pans is the "salt leg" (see Fig. 17). This consists of running a bucket elevator into a boot at the bottom of the cone of the evaporator body and lifting the salt into storage bins. Hence, the normal brine level must be 30 ft. or more above the elevator foot, so that a vacuum may be carried. Also, the elevator must be cased at least above the normal brine level so that the vacuum may be broken without emptying the pan. Hence in all but the largest pans there is a long vertical pipe extending down from the lower cone of the pan into the elevator boot. By feeding fresh brine in at the bottom of the "salt leg," instead of the point shown in Fig. 17, the rising current of brine in the salt leg forms an automatic sizing device and prevents crystals settling into the boot till they have attained a certain size. Even without this device, the natural circulation in the pan holds small crystals in suspension, so that a vacuum pan product is always quite uniform.

Buckets for a salt elevator are usually of screen to allow drainage. At that, the discharge from such an elevator will be nearly 50 per cent water. In one case a chain drag conveyor is used, but this results in excessive rusting of the worn iron surfaces at each shutdown. The best design has the elevator chain running in recesses in elevator casing so that dirt from the chains cannot fall into the salt.

A less common method for removing salt from a pan is the use of receivers and centrifugals. The Worcester Salt Co. is so equipped. Below the cone of each effect is a cylindrical receiver with gate valves top and bottom. The top valve is open and the bottom one closed during usual operation, and salt settles into the receiver as

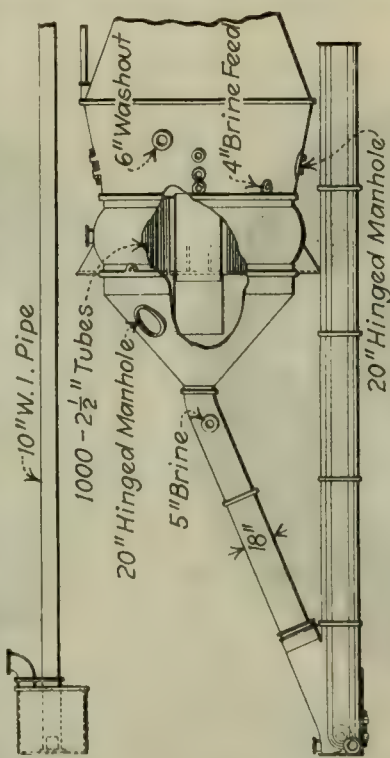


FIG. 17. SALT PAN WITH CONTINUOUS ELEVATOR

formed. A sight glass is provided to show when the receiver is filled. When a charge has accumulated, the top valve is closed, the bottom one opened, and the entire charge dropped into a centrifugal below.

Vacuum pan salt has a very characteristic grain. Since the crystals are suspended in a strongly agitated solution during formation, loose crystal aggregates cannot form, and the salt is in the form of hard, uniform cubical grains (Fig. 16). When rolled between the finger tips, they feel almost like spheres. This hard uniform structure makes a salt which dissolves more slowly than grainer salt. Due to its smaller relative surface and more compact structure, it is not so hygroscopic as the more open grains of grainer salt and hence pan salt makes a more free-running table salt. Also, due to its more regular surface, pan salt does not occlude mother liquor so readily, and hence is usually purer than grainer salt.

FINAL TREATMENT

If a salt leg was used, after draining several days in bins the salt is withdrawn and conveyed to storage piles, from which it is reclaimed to the driers. Where receivers and centrifugals are used, the centrifuged product goes directly to the driers. These are usually about 6 ft. in diameter by 30 ft. long, steam heated, and supplied with a hot air blast. There may be drums or coils to furnish direct heat, and air is usually blown over tempering coils before entering. The Inland-Delray Co. operates a direct coke-fired drier, and claims that it has no difficulty in making a high-grade product. The steam-heated drier is, however, much commoner. The drier shell either is made of maple staves or, if steel, is maple lined.

From the driers the salt is elevated to screens, from which the various sizes go to storage bins and packing machines. The finest size recognized is through about 80 or 90 mesh and is called "paste" or "flour." Above this the grades recognized vary with the plant. Little pan salt is put out finer than 18 or 20 mesh. Some recognize but one size between 20 and 80 mesh, others make several grades in this range. The product obtained between, say, 20 and 80 mesh, carefully dried, and treated with 0.1 to 0.3 per cent of some inert fluffy material such as magnesia, forms the "shaker" or best grade of table salt. Such a product must be packed in paraffined paper cartons to protect it from moisture and to insure "free-running" when it reaches the consumer.

Handling dry salt is very easy compared to handling wet salt. Screw conveyors running in maple troughs, and bucket elevators on rubber belts are successfully used without discoloring the product.

The highest grade salt, when put up for table use, is usually in the familiar 2-lb. pasteboard box. Some of this very fine or "paste" salt is sold for use as loading material in certain products where it is in effect an adulterant. The ordinary grades are shipped in 2-, 5-, 10-, 25-, or 50-lb. cloth sacks, and in the standard 280-lb. barrel. Much is also sold in bulk.

The writer wishes to express his appreciation of the many courtesies offered him by salt manufacturers in the Detroit and Saginaw district. Especial acknowledgement should be made to the Inland-Delray Salt Co. of Detroit, the Worcester Salt Co. of Ecorse, Mich., the Canadian Salt Co. of Windsor, Ont., and the Willcox Engineering Co. of Saginaw, Mich.

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Satisfactory Etching Reagents

Below is a list of most of the common reagents in use at the Bureau of Standards for etching various metals and alloys before microscopic examination, with brief remarks as to the suitability of each and the various features which are revealed:

Material	Method of Etching	Remarks
Copper and copper-rich alloys (brass, bronze, aluminum bronze).	An ammoniacal or an acid oxidizing solution.	Suitable oxidizers for use: hydrogen peroxide, ammonium persulphate, potassium permanganate, potassium dichromate, chromic acid, ferric chloride.
	Ammoniacal solution of copper ammonium chloride.	Electrolytic in its nature.
	Oxidizing acids.	Nitric acid and chromic acid.
	Aqueous solution of silver nitrate.	The film of precipitated silver must be removed.
	Concentrated ammonium hydroxide.	Accompanying oxidation is necessary to produce satisfactory results.
	Heat tinting.	Valuable for certain bronzes.
Aluminum and aluminum-rich alloys.	Hydrofluoric acid	An approximately 10 per cent aqueous solution is used, a supplementary immersion in concentrated nitric acid or in chromic acid may be necessary to clean the surface.
	Aqueous solution of sodium or potassium hydroxide.	0.1 per cent aqueous solution is suitable for revealing the constituents, more concentrated solutions for grain boundaries.
Lead.	Nitric acid.	
Lead and tin alloys, including "white metals."	Dilute nitric acid.	Alone or with an addition of chromic acid.
	Dilute hydrochloric acid.	
	Aqueous solution of silver nitrate.	
Nickel.	Concentrated nitric acid.	Used alone or in a solution of glacial acetic acid, approximately nitric acid 50, acetic acid 40, water 10 per cent.
	Electrolytic etching.	
Nickel-rich alloys. (Monel metal, Benedict nickel, nickel brass, invar, etc.)	Same as for nickel.	Same as for nickel.
	Ferric chloride.	
	Ammonium persulphate.	
Zinc and zinc-rich alloys.	Sodium hydroxide; mixture of chromic and nitric acid.	Alcohol solutions, approximately 1 per cent.
	Iodine.	
	Electrolytic etching.	
Gold, platinum and "noble" metals and alloys.	Aqua regia.	
Silver and its alloys with copper.	Nitric acid.	
	Ammonium persulphate solutions.	
Wrought iron, "pure" iron.	Nitric acid.	2 per cent alcoholic solution, commonly used.
	Picric acid.	
	Cupric reagent (Stead's reagent)	To reveal phosphorus banding, and similar structural features.
Carbon steels.	Nitric acid, picric acid and cupric reagent, as above.	Used to color cementite.
	Hot alkaline sodium picrate.	
	Hydrochloric acid.	
Alloy steels.	Same reagents as for carbon steels above.	For revealing grain boundaries.
	8 per cent alcoholic picric acid, very prolonged etching.	
	Sodium picrate.	
Cast iron.	Picric acid, or nitric acid as above.	For steels showing free carbide.
	Heat tinting.	
	Sodium picrate.	
		To identify iron phosphide and manganese sulphide.

Recovery of Diamond Powder From Waste Paste

BY RICHARD G. BERGER

DIAMOND powder, commonly called "diamond dust," suspended in olive or lubricating oil is much used as an abrasive for cutting facets on diamonds, shaping sapphire and diamond points, and polishing where a very hard abrasive is required and where nothing else will serve satisfactorily. After a period of use on the iron polishing wheel or bronze cutting wheel the diamond powder becomes clogged with metal, dirt and carbonaceous matter which covers the sharp crystal diamond powder so that it no longer acts as an abrasive.

In the past it has been customary to throw away waste diamond powder paste, but by use of the following procedure the diamond powder present in the accumulated waste can be recovered and used repeatedly. Whether the recovery of the diamond powder is a paying proposition or not depends upon the amount present in the waste. The waste paste taken from the bronze cutting wheels, called "sawing machinery" in diamond cutting establishments, is much richer in diamond powder than that from the iron polishing wheels which have been used for cutting facets on diamond gems.

IS THE CRYSTALLINE DIAMOND POWDER CONVERTED INTO GRAPHITE DURING POLISHING?

The small yield of diamond powder and the large yield of amorphous carbon (graphite) obtained in the recovery from waste paste taken from polishing wheels has led to the question in the writer's mind if there may not be a possibility of the crystalline diamond powder being converted into graphite during the operation of polishing facets. Under somewhat different conditions R. Vogel and G. Tammann (*Inst. Phys. Chem. Göttingen, Z. physik. Chem.*, vol. 69, pp. 598-602), found that when diamond chips were heated in a quartz tube at 1,000 deg. C. and at higher temperatures at times a partial and even complete conversion into graphite took place. It does not seem improbable to the writer that on the polishing wheels with the combined elevated local temperature and great pressure at the point of contact between facet of gem and diamond powder conversion of the crystalline diamond powder into graphite may take place.

Under no conditions should the dry diamond powder or paste be heated over a free flame, for although a diamond of gem size will not burn in an ordinary flame, the experience of the writer has been that diamond powder of fine mesh such as is used for abrasive purposes behaves differently and readily burns to ash in a free flame.

SOLVENT TO BE USED

The solvent to be used for extraction depends upon the kind of oil which has been used as a carrier for the diamond dust. Dry acetic ether (ethyl acetate) is the best solvent available with petroleum pastes. For the removal of sand and glass particles fusion with sodium hydroxide has been found to be much more rapid and satisfactory than treatment with hydrofluoric acid, as where there was considerable sand, such as in floor sweepings, sand particles were found to be present even after four treatments with hydrofluoric acid.

The procedure as given can be used also for recovery from waste rags with which machinery has been wiped

off and for sweepings from work benches. The waste rags should be washed in acetic ether or benzene, and the solution containing the powder evaporated down to dryness, and the solid residue put through the regular procedure.

METHOD OF REFINING WASTE

Extract the oil present in the waste by shaking thoroughly the waste paste with acetic ether or benzene, and allow to settle, decanting the clear supernatant solution after the paste has settled, which will take anywhere from ten minutes to three hours. Repeat several times until the deposit is free of oil, which state can be seen when the solid particles settle readily. The oil must be completely removed, as even small amounts will cause considerable annoyance because of the disagreeable odors generated during the acid treatments and difficulties in filtering the residue. If desired, the solvent used for extraction of the oil can be recovered by distillation.

Dry the paste which has been freed from oil on a steam table or in a hot air bath at a temperature not exceeding 130 deg. C. until it is free from solvent, and treat in an evaporating dish under a chemical hood with strong nitric acid. Heat over a free flame, adding nitric acid until there is no further action, but do not allow to go to dryness. Dilute with water, allow residue to settle, and decant the supernatant liquid. Repeat the washings and decantations until the deposit is clean. Dry the residue on a steam table or in a hot air bath at a temperature below 130 deg. C.

Heat the dried powder in an evaporating dish with strong hydrochloric acid under a hood until no further action, but do not carry down to dryness. Dilute with water, allow residue to settle and decant the supernatant liquid. Repeat the dilution and decantation until the solid deposit is clean. Put in an evaporating dish and place on a steam table or in a hot air bath below 130 deg. C. until dry.

Melt solid sodium hydroxide in a wrought iron crucible. Remove the flame and allow to cool from red heat to dark and while the mass is still molten add the dried residue, stirring with a platinum wire or iron rod. Place a cover on the crucible and heat gradually to dull red heat. Cool until the sodium hydroxide is solid and then leach out the crucible by placing it in water and heating until all the sodium hydroxide is dissolved. Wash the solid particles in an evaporating dish or in a beaker by repeated decantation with water until clean. Dry the deposit, which should be clean, bright and crystalline diamond powder.

If there should be considerable black particles of amorphous carbon (graphite) present, these can be removed by adding the dried powder to a solution of specific gravity approximately 3.2, allowing the crystalline diamond particles to settle and pouring off the suspension of carbon particles.

Bridgeport, Conn.

Canada's Wood Pulp Supply Reaches Enormous Total

An official estimate of Canada's pulpwood resources places the supply of all woods suitable for pulping in the Province of Quebec at 360,000,000 cords; 150,000,000 cords are of spruce and balsam. In Ontario there are 250,000,000 cords and in New Brunswick 36,000,000 cords of spruce and balsam. The present annual rate of cutting of these two species is 5,750,000 cords.

Finish of Metallic Materials

Heat-Treatment Yields Quality, Finish Gives Durability and Appearance—Finish of Metallic Materials Discussed as an Essential Detail in Modern Manufacturing, With Brief Notes on Cleaning, Polishing, Lacquering, Coatings, Slushes and Wrapping

By SIDNEY CORNELL

MODERN methods of manufacture demand specialization, but in the routine many important details practiced in an industry have been somewhat neglected. Thus, although we may have a factory specializing on cutlery, on sheet metal goods, on cans, on this, that and the other thing, fundamental processes occur in all of them, which if studied in detail would yield greater returns than at present. There are few if any specialized concerns practicing heat-treatment only, or polishing and finishing only, yet these two items largely determine the worth of vended articles. Methods used are often employed in a manner not up to the standard represented by the position the concern holds in its line and loss of economic value results.

Articles are commonly finished to give a pleasing and salable appearance; and more important considerations of protection against rust, corrosion or wear are of a secondary nature from this viewpoint. Many concerns in the past few years have attacked problems they did not thoroughly consider, due to lack of knowledge of these highly important details of their business. Or, on the other hand, changes in the finished product were brought about by war-time changes in their materials. For instance, lacquered products are not the same as they were. Polishing as practiced in this country is not quite up to foreign standards, especially French, and the American mechanic does not seem to be able to file metal with the skill of a Frenchman.

In the writer's opinion, finishing the metal should be regarded from a different angle, so that manufacturers should understand that a protection against corrosion in the form of a proper finish should primarily be aimed at, and this finish at the same time should furnish a pleasing and salable article.

It is with a hope of noting the various necessary factors that this article is written, and it is further hoped that others will contribute much of importance to this art. Its position in the scheme of modern production is as important as is heat-treatment.

FIVE DIVISIONS OF THE SUBJECT

The subject naturally divides up into five steps, some or all of which are practiced on all articles sold. They are:

1. Cleaning after fabrication.
2. Polishing, buffing, burnishing, sand blasting or rougher finish depending on the nature of the article.
3. Coloring of polished articles, by numerous methods producing an oxidized film, a subject whose discussion is deferred. Painting rougher articles. Japanning of pressed metal goods or articles of a similar nature. Lacquering.
4. Coating finished articles with a protective metal or other semi-metallic coating. Calorizing, galvanizing and electroplating of metals.
5. Slushing oils, and other temporary coatings.

It is commonly believed that cleaning is a simple operation, whereas such is far from being the case. Many troubles arise over lack of understanding what cleaning really is. Cleaning primarily has to deal with the removal of "dirt." Chemically it would be hard to define "dirt," which may mean a very complex foreign substance, varying from pure silica (sand) up through innumerable chemical compounds into very complex animal, vegetable and mineral matters. Detergents, soaps and cleaning compounds are more or less simple substances which will act on "dirt" of varied chemical composition and physical nature in different ways. Thus all cleaning compounds may be said to have a "factor of adaptability," many of the common detergents being of very limited use in cutting factory dirt.

ACTION OF CLEANERS

A glass surface is not exactly smooth, but consists of a series of very flat undulations. When such a surface has a coating of grease or oil these small hillocks act as banks for the formation of small drifts of dirt. In rougher metal parts, no matter how highly polished, these inequalities in smoothness cause greater drifts, and in fabrics these accumulations may become relatively enormous. Dirt and its cementing oil will vary widely in composition dependent on local conditions, and there can be a wide variation in the nature and composition of the oil or grease coating the solid particles. Their release is not so simple as it might seem, for although certain cleaning agents will dissolve some oily binders they may not clean a certain article at all, since there is no universal solvent for all oils.

While the theory of soaps is still debatable, they may act by forming water-soluble compounds, emulsifying the materials to be removed, or by forming absorption bodies with other substances. In the latter case removal is largely a mechanical operation. In some one or more of these methods the dirt is loosened and then whisked away by means of a stream of flowing water, brushing by a broom, wiping by cloths, fibers, etc. Various cleaning materials commonly used may be listed, many of which are not necessarily desirable, or used to good advantage in particular places.

1. Gasoline, kerosene, benzine, benzene, solvent naphtha, carbon bisulphide, carbon tetrachloride. All of these liquids are volatile, expensive, some dangerous, and none a perfect dirt remover.

2. More common chemicals form a second group, embracing soda ash, sal soda, sodium hydrate lye, potash lye or lime water. Common yellow laundry soaps, sulphuric acid, usually diluted to 10 per cent, hydrochloric acid, nitric acid and hydrofluoric acid. Two rather dangerous cleaners are left to the last of this group—potassium cyanide and oxalic acid. Ammonium carbonate might be included. Substances in group 2 are seldom intelligently used; for instance sal soda, con-

taining a large amount of water of crystallization, is often used, when soda ash would give like results at a lower cost. Other examples are the careless use of cyanide and oxalic acid.

3. Various patented and often secret combinations of the above materials with other cleaning chemicals. A majority of these compounds are frauds, but there are several reliable concerns turning out cleaning mixtures which are excellent and do the work. As a practical consideration, economic and otherwise, it is advisable to deal with a reputable vender of this material, since it is quite impracticable for a small concern to make a cleaning compound good for all its work, and in view of the normal variation in raw materials, impossible to obtain a uniform mixture without accurate chemical control.

4. Some material of group 3, when used in conjunction with electrolytic cleaning, probably represents the most advanced step in the art of cleaning. In an electrolytic bath composed of a solution of some good cleaning compound, the detergent acts on some of the dirt in various ways as pointed out above. Electrolysis reduces some oxides to metal. A third mechanical action takes place by evolution of gas on the surface of the article being cleaned, which action lifts off slivers of dirt. Temperatures used in such solutions are various, some being used at 150 deg. F., others up to the boiling point. The tank is provided with a close steam coil for this purpose. The electric current used may run to 110 volts or a low tension, 10-volt current may be used. In degreasing wools it is common to reduce the amperage after the process has progressed—e.g., 65 amp. at the start and 20 amp. at the finish. Many cleaning compounds offered for such use contain potassium-sodium cyanide, and caution is suggested, as poisonous cyanogen gas may be liberated under electrolysis.

POLISHING

In a discussion of this sort it would be quite impossible to cover the subject of polishing completely. To be finished, many articles must be cleaned, polished, cleaned again to remove polishing materials, and lastly coated in some manner.

After polishing, all materials must be further cleaned to rid them of tallow and grease, and in many classes of work real difficulty is experienced in the removal of crocus, tripoli and rouge, even with the use of satisfactory cleaners. Work must be clean before it can be finished.

Polishing, like other trades, had its tricks, but most of the polishing supplies are now supplied by reliable concerns, superior to the hand-made canvas or emery wheels, buffs and burnishers formerly made by the artisan, who seems now to have almost disappeared. The simplest finishing wheel is the scratch brush, used in carding, an operation discussed¹ under "Bluing and Browning." Whip brushes of wire are used to produce the so-called "satin finish," while a brush with wires set closer together produces a matte effect. Swing brushes are used to produce a frosted effect on soft metals, and contain only four (seldom six) spokes topped with small wire whisks. In order to obtain a finish with wire wheels such as given by sand blasting it is often necessary to sharpen the wires by holding a block of emery against the brush turning in the wrong direction. Wire brushes are made from various kinds of metal wire. When carding brass, a wheel of brass wire must be used, as steel wire discolors the work. Similar precautions are

necessary for brushing copper and other metals. Stiff wire wheel brushes are often used to clean castings prior to plating.

Excessive pressure is not necessary for this operation and it only wears out the wires. It is the cutting action of the wire ends that cleans, not the rubbing with the sides of the bristles. Wet grinders are operated at approximately two-thirds the speed of dry grinders, polishing wheels one and one-half times as fast and buffing wheels at twice the speed of dry grinders.

Canvas wheels are made from layers of heavy canvas cemented together, yielding a resilient surface, largely used for rough polishing, or "roughing out." Leather wheels are used for oiling and finishing. Semi-flexible but hard leather wheels coated with emery are used for general work. Soft wheels should be used on silver, nickel or brass; medium hard wheels on saddlery, piano- and automobile-hardware, and for stove and agricultural implement parts; while a hard wheel should be used for heavy brass, gold, and for oiling almost any work. (A wheel with polished face should generally be used for oiling finished work.) For especially fine polishing, sheepskin wheels may be used, and for some classes of work felt wheels find favor.

Aside from wheels, the following polishing materials will be mentioned, glue and emery being neglected, although their importance is evident. Turkish emery is the standard, with Greek and American following in favor. Tripoli, a light-colored infusorial earth, is compounded with various greases and waxes so that it will adhere to a polishing wheel. Care should be taken in this selection, as the mixture may yield a cutting compound in place of the polishing compound required. Other grinding aids which may be mentioned are silex, pumice stone, crocus (iron oxide), hydrated lime, precipitated chalk, rotten stone, etc.

TUMBLING BARRELS

The next simplest polishing mechanism is the tumbling barrel. The simplicity of the tumbling operation is such and the work done so good that it is a wonder that more use is not made of this mechanism. Small duplicate work is usually treated in this device, but articles with finished, square, sharp corners cannot be tumbled. Barrels are operated both wet and dry. The packing materials are leather meal, sawdust, sized flint, etc., for dry tumbling, and solutions of cleaning compounds in wet tumbling. In wet tumbling, steel balls are often used, but the size of the ball must be chosen with great care. If there is the least doubt as to whether a cleaning compound in use in a tumbling barrel is inadequate or that a cleaner used on some other job might be substituted, it would be well to try a solution of borax soap, Ivory soap, or some non-alkaline compound.

Barrels are made in a variety of shapes, but in all types the speed of rotating must be slow enough (ordinarily 40 r.p.m.) to permit the work to roll on the ascending side of the barrel and not be held stationary against the lining by centrifugal force.

Burnishing with small steel balls contained in a tumbling barrel will produce work comparable to buffing. Figured work is well done, but the ball used must be of such size as to slide readily in and out of the crevices, angles, curves and depressions. Such burnishing gives certain alloy parts a luster that cannot be duplicated by any other means, and in a general way it may be said that the smaller the ball the better the result.

¹To be published in a subsequent issue.

Enough balls must be provided, usually running twice as many balls by volume as the work, with a hot 2 per cent solution of borax soap equal in volume to the volume of the work. This burnishing may also be done after plating and is probably as economical in direct labor as any existing process for finish.

SANDBLASTING

Many articles, especially tools, are given dull matte finish by sandblasting. Parts of rifles and other small arms are sandblasted as a cleaning operation, and British bayonet blades were sandblasted for finish. The small articles can be sandblasted semi-automatically in barrels or on revolving tables. Work on revolving tables must be turned over after each passage under the nozzle in order to be finished on all sides.

PICKLING

Less finely made metallic articles of commerce may be covered with the well-known blue-black scale if it was heated during the process of formation. Before such an article can be successfully coated with a material other than paint, this scale must be removed and this is usually done by a process called pickling. "Pickling" ordinarily means immersion in sulphuric acid. Sulphuric acid of fairly high concentration will not entirely dissolve such scale, and the reactions taking place in the usual pickling tank are exclusively a direct solution of iron oxides. Scale is actually removed partly by dissolving the iron underneath the scale, and partly by forcing it off the metal by hydrogen gas generated between the scale and the surface of clean metal beneath.

Acid pickling is fundamentally an incorrect operation, as a loss of good metal takes place. Tests determining the iron lost in pickling sheets before galvanizing showed an average of 2.32 per cent less by weight. It might be stated here that titanium-treated iron is reported as losing only half this amount in pickling, but why titanium in the amounts present should make steel acid-resistant is not apparent, as the mechanical process of scale removal seems to depend upon the loss of some good metal to generate hydrogen to lift off the scale.

Pickling acids are sulphuric, hydrochloric and hydrofluoric. Sulphuric acid, as mentioned, is the common pickling agent. Mixtures of sulphuric and hydrochloric acids do not quicken the process, but quite the reverse, retarding the action materially. Impurities such as arsenic or lead retard the action of sulphuric acid materially, often cutting down its effectiveness one-half. Sulphuric acid pickle ranges in strength from 3 to 8 per cent, and is kept as near boiling as possible. Lead-lined tanks and lead pipe are necessary; discharging live steam directly into the solution is often practiced for heating. Agitation of the articles being pickled increases the output of correctly cleaned articles and cuts down the time of immersion. On some small articles from six to ten minutes is required, using 6 to 8 per cent pickle. With a weak solution of say 3 per cent at lower temperature (approximating 175 deg. F.), the time of immersion required to remove the scale will be thirty minutes or more.

The amount of acid required will vary with the nature of the articles being pickled. On fair-sized work about 200 lb. of 66 deg. sulphuric acid will be required per ton of material pickled, while on heavy material such as sheets the work can be done for as low as 125 lb. per ton of sheet.

Thorough washing in clean water is necessary after

pickling, and often "liming" is done to neutralize any remaining acid. Small springs pickled to remove defective browning developed "acid" brittleness to a marked degree; this was corrected by heating the pieces for approximately one hour at 400 deg. F., just under the usual drawing temperature.

ELECTROLYTIC PICKLING

The loss of metal in acid pickling is an important matter, and as indicated approximates 2 per cent. Removal of defective blue or brown coloring on gun parts may be readily accomplished in an ordinary electrolytic cleaner, the oxide being reduced to metal. Parts so treated did not change in dimension, some of which were to limits of 0.0001 in. It would therefore seem that the electrochemical process of pickling might be given serious consideration and investigation as to whether it could not replace much of the more wasteful acid pickling. Incidentally, gun springs so treated did not lose their physical properties, and passed inspection perfectly when refinished by bluing or browning.

LACQUERING

An article left in the polished state, except gold or other noble metal, must be protected if it is to stay bright. The simplest protection is lacquer.

There are many lacquers on the market, but none of them is an absolutely perfect coating. A few months at the most will witness the darkening or peeling of such coatings. The best of lacquer can be ruined if applied carelessly, a fact well recognized on all sides. Grades and types of lacquers are almost as numerous as paints, so mention of the process only is made.

Dust and moisture must positively be excluded from a lacquer room. Ventilation is also of high importance. As the solvents are highly volatile and flammable, open flame for lighting or heating must be avoided. Drying cabinets should be maintained at 100 deg. F. properly steam-heated to give such a temperature, controlled by adequate and correct thermometers. Note was recently taken of a temperature reading as 100 deg., whereas the actual temperature was 140 deg., and the manufacturer wanted to know what was wrong with his lacquer! The same conditions have been noted on japanning ovens, operated at a higher temperature.

Spraying probably gives the more even protective coating, and avoids brush marks. Automatic dipping machines have advantages from an economical and production standpoint over the spraying method. Such machines take the work in racks at one end and deliver the lacquered and dried articles at the other end of the apparatus.

Progress remains to be made in getting some method of stripping defective lacquer from work, as lye solutions are not satisfactory; amylacetate is expensive, and recovery systems are not common.

Dip lacquers require the work to be absolutely clean and dry. If moisture or grease happens to be present, the lacquered articles will appear white and cloudy either in spots or all over. Lacquer and work should be at the same temperature. As might be imagined, lacquers are obtainable in all colors, from purely transparent through the varied shades and degrees of transparency, to jet blacks resembling japan finish.

JAPANNING

Briefly, japanning is coating with a black varnish, which is hardened by baking in an oven. It is an inter-

mediate step between painting and porcelain enameling. The solvent in the japan allows it to cover the article completely. By baking, the viscous residue from the evaporation of the solvent is oxidized into an elastic coating, a reaction accelerated by elevated temperatures. Modern japans are baked in from thirty minutes to one hour, and it might be stated that experimentation has developed japans that bake in as short a time as ten minutes. Temperature control is highly important and is often not given proper attention. In other cases the most extreme care and highest type of automatic electric ovens have been installed. Ventilation naturally is important in a japanning department, as it is necessary for safety against fire as well as for proper operation of the process. About 1,200 cu.ft. of free air should be figured upon for ventilation of each gallon of japan baked in an oven. Temperatures as high as 450 deg. F. may be used for baking, and automatic conveyor-type ovens may be used to increase production.

Colored japans require an absolutely even temperature, and an oven which does not lose temperature rapidly or excessively when charged or drawn must be selected. Japans give the high gloss finish to adding machines and automobile parts, the dull black of the telephone, through all ranges of color effects to imitation mahogany, oak or walnut found on steel furniture.

PAINT AND "DOPE"

In a summary such as this a detailed discussion of "paint" would obviously be impossible, but opportunity will be taken to mention new paint which is the result of war work on airplanes. Waterproofing coatings for the fabrics on aircraft wings must dry in a few minutes after application. It was found that when cellulose acetate or nitrate is dissolved in a mixed solvent, such as methylacetate, benzene, acetone and alcohol, and to which is added about 5 per cent of castor oil, there results a quick-drying paint, consisting of an elastic film, with a hard surface. As substitutes for shellac and paint the use of such "dope" is obvious, as it yields a moisture-proof, flexible film. Such coatings will not last as long as paint, but for many purposes they will find extensive application and usefulness.

OILING, SLUSHING AND WRAPPING

There is today a marked tendency toward carelessness in packing salable articles. Bottles seem to be the exception, probably due to their friable nature and the introduction of corrugated paper as a protection medium, and the use of folding boxes as containers. Finished metallic articles should be wrapped in tissue paper, or if of a nature requiring it in oiled paper or in heavy manila.

Polished and highly finished tools, metal parts, etc., should be given a proper coating of oil. Any oil will not do, and there is a large loss annually in defective goods due to the use of a common machine or engine oil as a slushing agent. The old practice of coating bearings and shafting of machines with white lead is a messy procedure at the best, especially for the person who has to remove it. Still there are a number of excellent semi-fluid slushing oils on the market, varying in consistency and in color from colorless to green. They successfully keep out moisture and air, yet are readily removed when desired.

These substances should be applied hot, either by dipping the article into a body of melted oil or by painting with hot oil. On cooling these oils set to a stiff,

jelly-like mass, are free from acid and corrosive materials and do not decompose.

Other coatings containing wool grease, which on oxidizing glues itself to the surface of the article, are not as desirable as more modern types, although they are a very good substitute for white lead.

A satisfactory slushing oil to resist corrosion can be made by mixing 55 per cent kerosene by weight with 45 per cent English wool grease. Another less satisfactory protective coating may be made from 50 gal. of heavy-bodied machine oil, to which there is added 900 lb. of red petrolatum. This will yield about 1,250 lb. of coating grease, which should be either applied by hot dipping or cold painting. There is a tendency to use too much slushing compound in many cases, and hot dipping with a proper draining is recommended for economy.

CONCLUSION

Many of the subjects mentioned above are worthy of more detailed attention, and it is certain that many persons have acquired valuable experience when using some of them. It is suggested that such men contribute such information to the technical press, as there seems to be a dearth of such matter in print. The writer further believes that many manufacturers will gain much by paying more attention to apparently insignificant details of operations in their polishing room, electroplating room, lacquer room, or wherever their finishing may be done, as there is possibility for big savings and improvements therein.

Yields of Alcohol From Wood Waste*

Softwood lumber mill waste can be made to yield 20 gal. or more of 95 per cent alcohol per ton and hardwood waste about half as much. Some actual yields obtained from the waste of various woods are given in the following table:

Kind of Wood	Softwood Waste		Gal. of 95% Alcohol From 1 Ton of Wood
	Percentage of Wood Convertible Into Sugars	Percentage of Sugars Fermentable	
White spruce.....	23	71	25.8
Longleaf pine.....	23	72	25.1
Red spruce.....	22	72	24.0
Norway pine.....	25	66	23.4
Idaho white pine....	21	74	23.4
Western hemlock....	21	77	23.0
Montana white pine..	20	75	22.0
Lodgepole pine.....	21	67	21.8
Sugar pine.....	20	66	21.5
Douglas fir.....	21	67	20.7
Kind of Wood	Hardwood Waste		Gal. of 95% Alcohol From 1 Ton of Wood
	Percentage of Wood Convertible Into Sugars	Percentage of Sugars Fermentable	
Silver maple.....	20	47	14.1
Birch.....	20	46	12.9
White oak.....	17	50	12.4
Red gum.....	20	38	11.0
Sycamore.....	18	38	9.7
Hard maple.....	18	34	9.1
Red oak.....	19	30	8.1
Cottonwood.....	18	30	7.2
Slippery elm.....	16	26	6.0

The manufacture of industrial alcohol is at present about the only feasible method of utilizing lumber mill refuse on a large scale. An alcohol plant with a daily supply of 180 tons of wood can produce 3,600 gal. of alcohol at a cost, under present conditions, of approximately 25c. a gal. The success of plants now in operation justifies a serious consideration of this process by mills having a large quantity of waste.

*From *Technical Notes*, Forest Products Laboratory.

Easy Money From Peat

Wonderful Invention for Extracting Methyl Alcohol and Gasoline Out of Peat and Money Out of the Pockets of Investors — Description of the Apparatus and of the Supertechnical Process Used, Which the Inventor Says Will Put Standard Oil Out of Business

WE COUNT among our pleasant acquaintances a gentleman who retains the Yankee tradition of wanting to know; holding in maturity that engaging quality of curiosity which most of us enjoy as children but which, to our great hurt, we are likely to slough off in some inexplicable manner before our student days are over. Our only regret in regard to what follows is that owing to a quality of intense shyness he withholds permission to mention names and places. We may say this much but no more, so we hasten to acquaint our readers with a record of his experience in "looking up an investment." Our comments may be a trifle fanciful, but there is no imagination in his statements of what he saw and what he heard. They were carefully recorded while his memory was fresh.

WONDERFUL OPPORTUNITY FOR INVESTMENT

He learned of a wonderful opportunity for investment; an opportunity to make the original purchasers of telephone stock turn in their graves with envy; a chance to participate in a corporation for the development of a chemical process that will (or perhaps in the interest of sound conservatism we had better modify the tense and say that *should*) make the Standard Oil Co. look like thirty cents. The great invention, he was told, consists in making 20 to 25 gal. of pure methyl alcohol and 120 to 125 gal. of high-grade gasoline out of a ton of peat—out of a ton of any old kind of peat. He availed himself of the opportunity to meet the inventor and his assistants Charlie and George, together with upward of a dozen other gentlemen who were, partly already—partly pledged and partly prospective—investors. Most of them were actually men of means. He witnessed an official test of the process, and he saw the apparatus in operation.

On arriving at the place indicated, which is the site of the initial plant, he found the inventor installed in his office in a house, with a desk covered with papers, with bottles containing different colored liquids, and with numbers and cryptic labels that are not designed to be understood by the common, everyday chemist. The inventor was a very affable gentleman, well along in years, but showing no trace whatever of the infirmities of age. Our friend learned that the official test was to take place at 10:30 a.m., which was shortly after his arrival, and that the option to buy the stock held by a major portion of those present was to expire at noon.

CAPITALISTS CRY FOR IT

"I might as well tell you, gentlemen," said the inventor, "that last night a group of New York capitalists came out with their chemist, and after an unofficial test which was carefully passed upon they were so taken with this process that they offered me \$4,000,000 for 40 per cent of the stock! I couldn't accept because I am

resolved to retain 60 per cent myself, and I felt in honor bound to have a talk with you beforehand."

At this point one of the investors interrupted him with, "You shouldn't sell a share, Professor! We are able to provide all the funds you need."

STANDARD OIL NEED NOT APPLY

"Well," the Professor, as they called him, went on, "early this morning there was a group of California oil men out here; they drove out in automobiles; and they were so gratified by what they saw that they offered to pay me \$500,000 in cash for the rights in California, and somewhat less for similar rights in each of the two other Coast states, Oregon and Washington. It looked tempting, because we could pay 40 to 50 per cent dividends on our stock from this offer without making a gallon of gasoline. One thing that held me back was that I can't make out whether they were Standard Oil men or not. I don't propose to let John D. Rockefeller or any of his associates buy one share of this stock. Why, two weeks after we begin to produce we shall have the whole Standard Oil crowd on their knees before us! I told those fellows I'd think it over till 6 o'clock this evening. I figure, though, that the rights are worth a good deal more than they offer. We can put up plants in nearly every major town in every state. They'd be getting their rights very cheap at those figures.

"Another thing I have to say is that our plant is progressing better and faster than I expected. The men have been very faithful. I am 50 per cent ahead on costs and 50 per cent ahead on construction. We can begin to turn out gasoline on Jan. 15.

EIGHT-CENT PRICE IS PROFITEERING

"Now we can start out selling the gasoline for 20c. a gal. Of course we could sell for a good deal less. My agreement with you gentlemen who have subscribed is not to sell it below 10c. a gallon, although we could sell it for 8c. and still be profiteering. But there's no use in selling too much below the Standard folks. That would only mean a fight, and I don't see the use of it. Their gasoline has been costing them 14.8c. a gal. That is inside information, and I *know*. We shall be able to sell all we make all right."

"Professor," said Charlie, one of the assistants, "Did you tell the gentlemen about our success yesterday?"

"Why, no," said the Professor. "I forgot all about it. There's an automobile dealer near by who wants to contract for half the entire output of our plant, and to pay for it in advance at 20c. a gal. There are a number of others also who are after it. We shall have no trouble in making sales.

"I'm almost getting ready to begin building a second plant. It's just a little matter of a real estate deal that's holding me back."

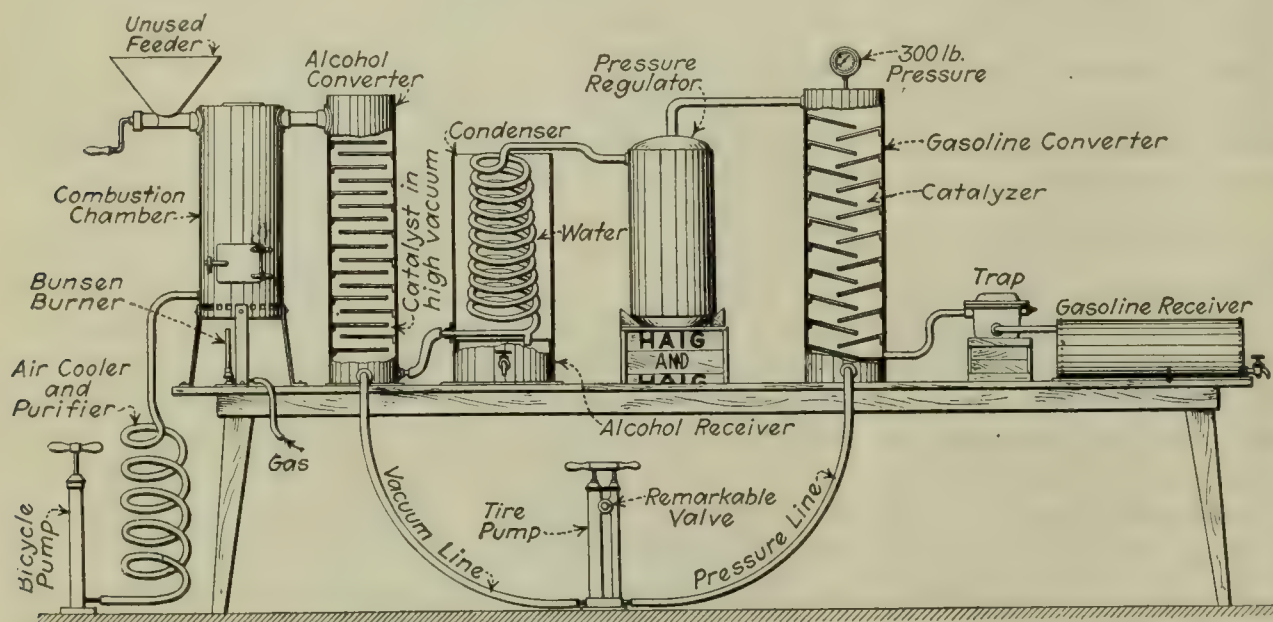
"But, Professor," said one of the investors, "wouldn't it be better to start the one, and then build up extensions from the profits on the first?"

"No, sir!" he replied. "I'm getting old, and I want to put this thing through. I've got no time to dally. We must have four plants in operation by July 1!"

George (the other assistant) asked if he hadn't better go and get "that pressure tubing." It seems the evening before they had burst a piece, and George was urged to get into a motor and hurry back with the new one. Then Charlie said he thought all the gentlemen who were coming were there, and he suggested that they might as well start the official test. The Professor agreed to begin as soon as George returned; which he did shortly, with about 3 ft. of rubber hose.

COMPONENTS OF THE MYSTIC APPARATUS

He then led the way into a large cellar under his house, where, on an improvised table about 16 ft. long and 2 ft. wide, the mystic apparatus was set up. Unfor-



tunately we lack working drawings, but our friend made a sketch from memory, and we are able to give a description that is approximately correct. The series consisted of:

1. A bicycle air pump.
2. The air cooler or purifier.
3. The combustion chamber.
4. The alcohol converter and catalysis chamber.
5. Condenser and alcohol receiver.
6. The pressure regulator.
7. The gasoline converter, catalysis chamber and liquefier.
8. Gasoline trap.
9. Gasoline receiver.
10. An automobile tire pump containing a remarkable valve invented by the Professor, connected with the alcohol converter and the gasoline converter.

The Professor told the boys to fill up the condenser with water and then George took his place at the bicycle pump while Charlie manned the automobile tire pump that contained the remarkable valve.

He then explained how George pumped ordinary air into the system, and that the cooler, or purifier (which consisted of a coil of pipe, air cooled), cooled and purified the air before it entered the combustion chamber. This (the combustion chamber) was a cylindrical apparatus provided with a grate underneath, and with an unused feeder above. The Professor took a few handfuls of moss, which was the peat, opened a door of the combustion chamber, put in his peat and then sealed the door shut. He lighted a bunsen burner, put it under the grate below the peat in the combustion chamber, and said,

"Now begin, boys!" Tense excitement reigned while the Professor began gesticulating, like the walking-beam of a steamboat; one hand up and the other down, then 'tother hand up and the first one down, first very slowly, and then speeding up slightly until they had good, synchronized action.

NOT ONE BIT OF HEAT WASTED

One of the guests placed his hand in the combustion chamber and remarked that it was cold, although the operation was already in process. The Professor cautioned all present to keep their hands off the apparatus, as it was very delicate, and then he explained to the inquirer that this was a peculiar feature of his invention. "The combustion," said he, "is going on all the time, but not one bit of heat is wasted. We use it all."

"Now that peat," he continued, "is all being burned to CO₂ except the ash," which seemed to our friend to be doing pretty well for the cold combustion of peat. "The CO₂," he explained, "is carried over into the alcohol converter, where a high vacuum is maintained, and there in the presence of a catalyst" (which he had discovered) "part of the CO₂ is converted into methyl alcohol."

In other words, we have at this point, which the Professor did not take the time to explain, the highly original reaction:



We don't want to steal any of the Professor's secrets, but we merely suggest that, in addition to his catalyst

in the converter he may have an argon burner in the combustion chamber! The Professor didn't say so, but why shouldn't he have one? After this methyl alcohol reaction we are ready to believe almost anything. It might worry Irving Langmuir, but if he could invent an argon-filled lamp why shouldn't the Professor invent an argon burner? However, things proceeded to happen so fast that we have no time to pause for a reply.

From the converter the unconverted CO₂ passes into a pressure regulator, of which only the outside was visible, and, according to the inventor, thence into the gasoline converter, which is a second catalysis chamber with a complex arrangement of baffles (which were not exhibited), and containing another catalyst which was discovered only after experimentation with "400 metals." This converter is operated under 300 lb. pressure, the Professor announced, and, to prove it, there was a pressure gage that registered 300 lb.

This variety of pressure, the "high vacuum" followed by 300 lb. to the sq.in. in the series of apparatus, was accomplished by means of Charlie working at the automobile tire pump which contains the Professor's remarkable valve. By this Charlie produced the high vacuum in the alcohol converter by the up-stroke, and the 300 lb. pressure in the gasoline converter by the down-stroke.

That valve alone was worth going a long distance to see. Unfortunately it was so inclosed that our friend could not see it.

From the converter, which is also a liquefier, the gasoline passes out into a trap and thence into a gasoline receiver. That is the operation. In no more time than it has taken to tell it the Professor exclaimed, "The operation takes eight minutes, gentlemen, and" (looking at his watch) "seven minutes are gone—seven minutes anna half. Slow down, boys!" And the walking-beam motion began again with the Professor's elbows, while he looked diligently at his watch. "Slow-er. Seven an' three quarters. E-i-g-h-t minutes. Stop! Gentlemen, the operation is completed."

He opened the smaller alcohol receiver, and there it was, over half full of pure water-white methyl alcohol, "absolutely pure excepting only for a little water in it," he said. The gasoline receiver was better still and showed a larger quantity. It also seemed to have more speed than the alcohol receiver because it leaked gasoline even before the pumps were started. "That," said the Professor, "is pure hexane, C_6H_{14} , 71 deg. pure. The gasoline you buy is only 57, but this is 71 deg."

GASOLINE "71 DEGREES PURE"

Somebody wanted to know what he meant by degrees pure. The Professor asked him if he was a chemist, and on getting a negative answer, he said, "It is rather hard to explain if you don't understand chemistry, but there are degrees of purity, and this is 71 against ordinary gasoline, which is only 57." Some people are never satisfied. It made the Professor a little testy, for he said:

"My gasoline is 71 deg. pure, and if you can get any in New York that is as pure as I am making here I'll give you my 60 per cent of stock in the company. At Eimer & Amend's you can get small bottles of very pure gasoline, but it isn't as pure as this."

We merely want to call attention to more wonders of catalysis in this invention, and to ask Prof. Bancroft, for instance, who has spent years in research on the subject, what he has to say, or to call on Sir Ernest Rutherford to explain how he feels after his few atoms of hydrogen derived from an atmosphere of nitrogen, when either of them ponders over the Professor's final reaction which, as nearly as we can give it, is



PRODUCT TOO STRONG FOR A FORD CAR

The question was raised whether Henry Ford knew about this process, and it appears that he is not only thoroughly informed but that he is having a special truck designed for economical hauling with it. Then somebody wanted to know whether the gasoline had been thoroughly tested out with automobiles. "I should say it had," responded the Professor. "Charlie," he commanded, "come over here and tell this gentleman about that test we made the other day." "Well, sir," said Charlie, "we mixed some of it up with ordinary Standard Oil gasoline, fifty-fifty, and they drove a big car seventy-five miles on 3 gal. of it!" Then Charlie added a statement which may well induce automobile engineers to pause and consider. He said:

"Our gasoline is *too strong* for the ordinary Ford car."

Everyone present was deeply impressed. One of the investors said: "Professor, this is wonderful. It certainly beats the world. But you've got plenty of peat here. Would you mind making another run for us?"

"No," said the old gentleman. "I'm tired. Once is

enough. What's the matter anyway? Any of you getting skeptical?"

"Oh, no, no. Not in the least. I only thought——."

SKEPTICS TOLD WHERE TO GO

Like many men of genius, the Professor is rather quick on the trigger, for he interrupted the speaker with:

"Look here; if you're getting skeptical you can go plum' straight to hell! I'll not be insulted with doubts. I don't need your money." Then, going over to Charlie, he caught him by the arm and said: "Charlie, if any of these people are getting skeptical they can go straight to hell!" And with that he led the way upstairs to his office.

It lacked only twelve minutes of noon, and at noon the options expired. Try as we will we cannot pry out any information as to what happened before the sun reached meridian. How much was subscribed, or who subscribed, or who let his option lapse, is hidden from us. We have been told that before the "official test" which we have described about \$200,000 had been underwritten and about \$60,000 paid in. We have no knowledge of the commitments which followed the official test, or what became of the California oil men or the group of New York capitalists with their chemist.

One other pearl of information that we have from the Professor is that there is only 2 per cent of ash from peat as consumed by his process and that this is so high in potash and phosphorus that the fertilizer people are literally crying for it. And, aside from the ash, there is no waste, solid, liquid or gaseous, from the operation. "I convert everything," said the Professor. We should say he did!

A New Process of Drying Turf for Fuel in Finland

Consul Leslie A. Davis, of Helsingfors, reports that a Finnish company, called Oy. Hydroturve A. B., has been formed, with a capital of 1,000,000 marks, for the purpose of promoting the hydroturf process of drying turf to relieve the serious fuel shortage in Finland. Similar companies have been organized in Sweden and Denmark.

The new method was invented by engineers working under orders from the Russian Soviet Government to find a more labor-saving method of preparing turf as fuel for the great central power station near Moscow, the process being made known in Finland through an escaping engineer.

The fundamental principle of the process is quite simple. The raw turf in the swamp, by a powerful jet of water under a pressure of 20 atmospheres, is freed from all old roots and changed to thin mud. This is pumped out on a drying field and spread in layers from 20 to 30 cm. in depth. When sufficiently dry it is cut into bricks of uniform size by means of a tractor. The roots are lifted out of the mud by a special crane without interfering with the removal of turf. The turf pump is constructed like an ordinary water turbine, is reversible with aid of electric motor, is equipped with a cutting apparatus which completes the work of the water jet, and can be raised or lowered as the surface of the mud requires. Both the crane and the pump are mounted on a plate-covered car which can be pushed backward or forward on rails along the line of work.

Experiments in Russia demonstrated that the hydroturf dries better in ordinary weather than turf prepared in any other way.

Potash in 1919*

BY W. B. HICKS AND M. R. NOURSE

THE quantity of potash produced in 1919 fell short of the production in 1918, as is shown by Table I. The tonnage from the alkali lakes of western Nebraska continued to exceed that from any other

TABLE I. DOMESTIC POTASH PRODUCED AND SOLD IN THE UNITED STATES IN 1915-19

Year	No. of Plants	Production		Sales		Value
		Crude Potash (Short Tons)	Available Content of Potash (K ₂ O), (Short Tons)	Crude Potash (Short Tons)	Available Content of Potash (K ₂ O), (Short Tons)	
1915.....	5	4,374	1,090	4,374	1,090	\$342,000
1916.....	70	35,739	9,720	35,739	9,720	4,242,730
1917.....	95	126,961	32,573	126,961	32,573	13,980,577
1918.....	128	207,686	54,803	140,343	38,580	15,839,618
1919 (a).....	77	110,243	30,845	173,786	46,732	11,370,445

(a) Production for 1919 includes a quantity of material either utilized by producer or reported as not marketed; sales for 1919 include material produced in 1918 but sold in 1919.

region or source. At the beginning of 1919 about twenty plants in this region were ready to operate, but only eight of these reported production.

Other producers from salines are American Trona Corporation and the Solvay Process Co., both at Searles Lake, Cal.; the Utah-Salduro Co., Salduro, Utah; Salt Lake Chemical Co., Burmester, Utah, and the Salt Lake Potash Co., Kosmo, Utah.

In the Marysvale region, Utah, the Mineral Products Corporation continued production from alunite in 1919. Some potash alum was produced by one company from alunite, and several companies are known to have shipped raw and calcined alunite either for experiments or for incorporation in fertilizers. The mill of the Florence Mining & Milling Co. was used by several companies for experimental purposes.

Silicate rocks as a possible source of potash continued

to receive attention. The plant of the Liberty Potash Co., at Green River, Wyo., which utilized the potash-bearing rocks of the Leucite Hills, was completed during the year and operated for a short time in November and December, but was closed on account of technical difficulties. A plant for the extraction of potash from green sand was constructed by the Eastern Potash Corporation on Raritan River near New Brunswick, N. J., but no production was reported.

In the early part of 1919 eighteen cement mills had potash-recovery plants installed or under construction. Of this number fourteen were in operation, several for only a part of the year. Several discontinued the production of potash at the end of the year.

Only one kelp plant other than the experimental plant of the Bureau of Soils, United States Department of Agriculture, at Summerland, Cal., reported production of potash in 1919.

TABLE II. POTASH PRODUCED IN THE UNITED STATES IN 1919, CLASSIFIED ACCORDING TO SOURCES.

	No. of Plants	Crude Salts (Short Tons)	Available Potash (K ₂ O), (Short Tons)	Percent-age of Total	Total Value
Natural brines:					
Nebraska lakes.....	8	35,733	9,022	29.2	\$1,890,302
Other brines.....	6	32,385	11,293	36.3	2,875,908
Alunite.....	14	68,118	20,315	65.8	4,766,210
Dust from cement mills.	6	6,594	2,293	7.4	683,055
Molasses distillery waste	14	11,567	1,159	3.8	233,977
Steffens waste water (a)	6	8,541	2,802	9.1	801,533
Wood ashes.....	9	12,460	3,618	11.7	1,078,291
Dust from blast furnaces, kelp, and silicate rocks (a).....	21	593	358	1.2	202,714
	77	2,370	300	1.0	71,093
	77	110,243	30,845	100.0	7,836,873

(a) Includes a quantity of material either utilized privately by the producer or reported as marketed, the value of which is estimated

Crude mixed salts made up 50.8 per cent of the potash (K₂O) which was produced in 1919 and sold; muriate, 34.1 per cent; sulphate, 7.8 per cent; dust from cement mills and blast furnaces, 2.2 per cent; and other materials, 5.1 per cent.

TABLE III. POTASH MATERIALS IMPORTED AND ENTERED FOR CONSUMPTION IN THE UNITED STATES, 1913, 1916, 1919 (a)

Material	Approximate Potash (K ₂ O) Content (per Cent)	1913				1916				1919			
		Quantity (Short Tons)	Available Content of Potash (K ₂ O), (Short Tons)	Per-cent-age of Total	Value	Quantity (Short Tons)	Qty. (Short Tons)	Per-cent-age of Total	Value	Quantity (Short Tons)	Qty. (Short Tons)	Per-cent-age of Total	Value
Kainit.....	12.4	521,176	64,626	23.9	\$2,201,730	40	5	0.1	\$1,173	57,427	7,121	18	\$921,481
Manure salts.....	20.0	250,529	50,106	18.5	2,245,509	1,241	248	3.1	21,273	45,372	9,074	22.9	1,269,750
Muriate.....	50.0	237,630	118,815	43.8	7,075,745	1,299	650	8.3	348,961	23,202	11,601	29.2	1,783,916
Sulphate.....	48.6	44,349	21,554	8.0	1,677,429	1,693	823	10.4	81,684	1,415	688	1.8	188,592
Total (b).....		1,053,684	255,101	94.2	13,200,413	4,273	1,726	21.9	453,091	127,416	28,484	71.9	4,163,739
Bicarbonate.....	46.0	223	103	.....	20,968	2	1	.....	1,133	24	11	.....	8,921
Bitartrate (argol).....	20.0	14,499	2,900	1.1	2,779,180	14,943	2,989	37.9	5,021,291	12,904	2,581	6.5	4,311,610
Bitartrate (cream of tartar).....	25.0	75	19	.....	28,314	48	12	0.2	29,213	12	3	.....	10,879
Carbonate, crude.....	61.0	4,858	2,963	1.1	272,973	341	208	2.6	113,413	258	157	0.4	104,744
Carbonate, crude black salts.....	50.0	344	172	0.1	17,852	1,081	541	6.9	109,121	102	51	0.2	10,075
Carbonate, refined.....	67.0	6,145	4,117	1.5	393,284	76	51	0.7	40,496	23	15	.....	9,665
Caustic.....	80.0	4,324	3,459	1.3	342,056	24	19	0.2	16,694	242	194	0.5	134,166
Chlorate.....	38.0	596	226	0.1	64,468	5	2	.....	7,167	100	38	0.1	34,996
Chromate and bichromate.....	40.0	9	4	.....	1,819	(c) 459	(c) 184	.....	75	8	3	.....	4,271
Cyanide.....	70.0	735	514	0.2	216,844	1	1	.....	803	588	412	1.1	68,848
Ferricyanide (red prussiate).....	42.0	34	14	.....	12,035	2	1	.....	6,952	17	7	.....	18,096
Ferrocyanide (yellow prussiate).....	44.0	1,706	751	0.3	388,379	25	11	0.1	45,497	258	108	0.3	122,372
Iodide.....	28.0	.....	.....	.....	.....	5	1	.....	26,578	9	3	.....	54,250
Nitrate (saltpeter), crude.....	40.0	4,826	193	0.1	261,078	5,769	2,308	29.3	1,519,375	18,826	7,530	19.0	1,107,313
Nitrate (saltpeter), refined.....	46.0	203	93	.....	22,602	2	1	.....	771	37	17	.....	8,171
Permanganate.....	29.0	273	79	.....	38,188	45	13	0.2	33,728	2	1	.....	10,163
Rochelle salt.....	22.0	54	12	.....	13,412	.....	.....	.....	.....	20	4	.....	9,537
Total (d).....		38,904	15,619	5.8	4,873,452	22,369	6,159	78.1	6,972,307	33,430	11,135	28.1	6,028,077
Grand total.....		1,092,588	270,720	100.0	18,073,865	26,642	7,885	100.0	7,425,398	160,846	39,619	100.0	10,191,816

(a) The figures in this table were compiled from the records of the Bureau of Foreign and Domestic Commerce, United States Department of Commerce, by recalculation to short tons and to actual potash (K₂O), and by giving the totals for calendar years instead of fiscal years. The tons are calculated to the nearest even unit and the values are those given in the original records, so that the value given for a high-priced commodity received in small quantity may not be strictly applicable to the quantity given. For instance, 2,705 lb. of cyanide received in 1916 is reported as 1 ton, but the value given is that of the actual quantity received. Furthermore the values are those placed on the commodities by the shippers, and represent the values at point of shipment, and do not agree with market quotations in this country.

() Used principally in fertilizers. (c) Pounds. (d) Used principally in chemical industries.

Mechanism of Solidification of a Copper:Aluminum Alloy

A Study of Piping, Segregation and the Mechanism of Solidification of Cu:Al Alloys (Especially No. 12 Containing 8 per Cent Aluminum) by Means of Precision Measurements on Density at Various High Temperatures

By JUNIUS DAVID EDWARDS
Physical Chemist, Aluminum Company of America

IN AN earlier paper¹ the experimental methods were described and measurements of the density of aluminum over a wide range of temperatures were given. The same methods have been applied to an investigation of the copper:aluminum alloys, rich in aluminum. Although these measurements were made for a specific purpose, they yielded as a byproduct many interesting and suggestive theories regarding the casting of alloys in general. These will be developed somewhat in detail as illustrating the practical bearing of such measurements on the casting of aluminum and its alloys.

The density of the solid metal was determined by weighing in water and air; the density of the liquid metal was obtained by the densimeter method described in the preceding paper. Most of these measurements were carried out by T. A. Moormann.

RESULTS OF DENSITY DETERMINATIONS

In Table I are given the results of density determinations of alloys containing approximately 8, 30 and 60 per cent copper. The aluminum used as the basis of these alloys averaged 99.4 to 99.5 per cent aluminum. The copper was electrolytic copper of high purity. The solid specimens for the density determinations were chill cast in a small graphite mold. This method of casting gives a uniformly dense material in the sense of being as free as possible from voids and pores. The alloys tested cover the range for which the density was desired and permit reasonably accurate interpolation of intermediate values.

The observed values were plotted on an ample scale and the values for convenient temperatures as given in Table II were interpolated from these graphs. The greatest deviation of the observed values from a straight line fitted to them is only about 0.1 per cent.

In order to show the relation between density and composition, a series of isotherms for 20, 700, 800, 900

1,000 deg. C. have been given in Fig. 1. From these curves the density of compositions other than those given in the table can readily be obtained. A portion of

TABLE II. DENSITY OF COPPER:ALUMINUM ALLOYS

Temperature	Condition of Metal	Centigrade Temperature Scale			
		Density			
		Copper 0.0 Per Cent	Copper 7.84 Per Cent	Copper 30.0 Per Cent	Copper 59.9 Per Cent
20	Solid	2.706	2.857	3.433	4.680
700	Liquid	2.373	2.524	3.068	4.345
800	Liquid	2.345	2.494	3.032	4.300
900	Liquid	2.318	2.464	2.997	4.254
1,000	Liquid	2.291	2.434	2.962	4.208
		Fahrenheit Temperature Scale			
		Copper 0.0 Per Cent	Copper 7.84 Per Cent	Copper 30.0 Per Cent	Copper 59.9 Per Cent
68	Solid	2.706	2.857	3.433	4.680
1,300	Liquid	2.371	2.523	3.066	4.344
1,400	Liquid	2.356	2.506	3.047	4.318
1,500	Liquid	2.341	2.490	3.027	4.293
1,600	Liquid	2.326	2.473	3.007	4.267
1,700	Liquid	2.311	2.456	2.988	4.242
1,800	Liquid	2.296	2.440	2.968	4.217
1,900	Liquid	2.280	2.424	2.949	4.192
2,000	Liquid	2.265	2.408	2.930	4.167

the thermal equilibrium diagram for this series is also given to show the approximate freezing points of the various alloys.

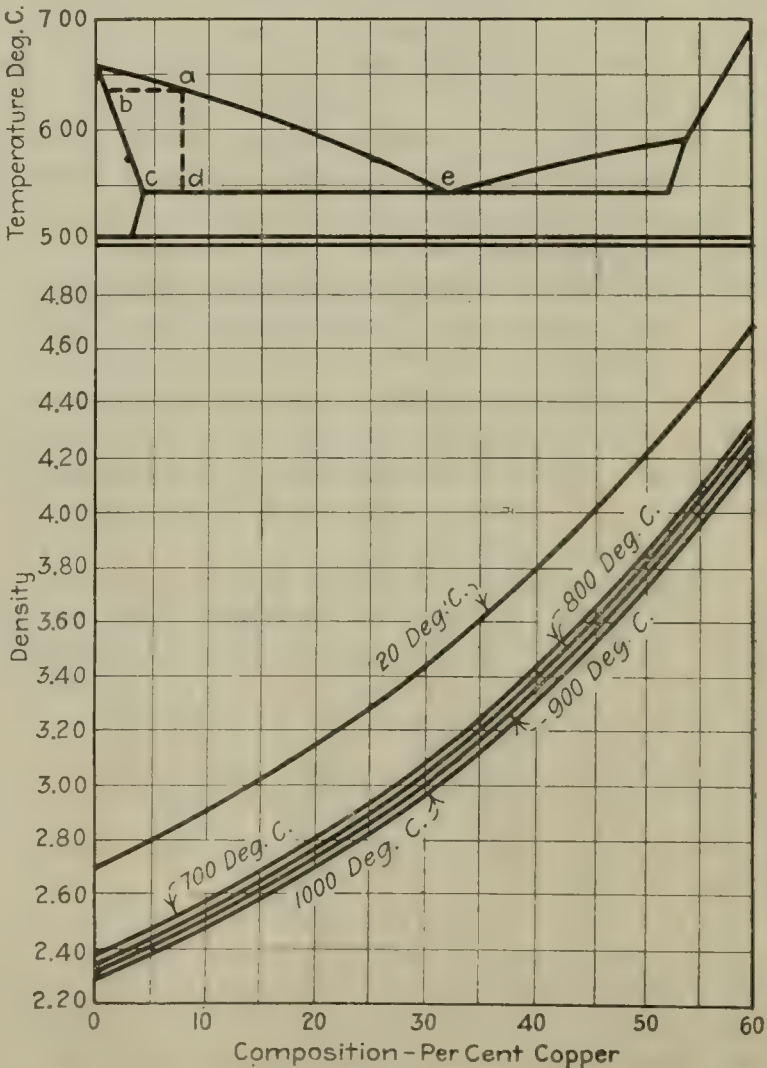


Fig. 1. Density of copper:aluminum alloys at 20, 700, 800, 900 and 1,000 deg. C. for the range from 0 to 60 per cent copper; equilibrium diagram for these alloys (upper figure).

TABLE I. DENSITY OF COPPER: ALUMINUM ALLOYS							
Sample No.	Composition					Temp., Deg. C.	Density g./ml.
	Si Per Cent	Fe Per Cent	Cu Per Cent	Mn Per Cent	Al Per Cent		
75	0.22	0.19	7.84	0.00	91.75	20	2.857
75	0.22	0.19	7.84	0.00	91.75	675	2.531
75	0.22	0.19	7.84	0.00	91.75	791	2.499
75	0.22	0.19	7.84	0.00	91.75	927	2.456
38	0.17	0.20	29.96	0.00	69.67	20	3.433
38	0.17	0.20	29.96	0.00	69.67	703	3.067
38	0.17	0.20	29.96	0.00	69.67	877	3.006
38	0.17	0.20	29.96	0.00	69.67	927	2.998
31	0.09	0.19	59.86	0.00	39.86	20	4.680
39	0.10	0.13	59.89	0.00	39.88	720	4.335
39	0.10	0.13	59.89	0.00	39.88	837	4.284
39	0.10	0.13	59.89	0.00	39.88	1,006	4.205

¹"Density of Aluminum From 20 to 1,000 deg. C.," CHEM. & MET. ENG., vol. 24, No. 2, p. 61, Jan. 12, 1921.

THE SPECIFIC VOLUME OF SOLID COPPER:ALUMINUM ALLOYS

Although there is no direct relation between density and composition, the specific volume (reciprocal of the density) of the copper:aluminum alloys is very nearly a linear function of the composition over quite a range. This relation is illustrated in Fig. 2, where the density and specific volume are each plotted as functions of the composition. The specific volume data are very well represented by a straight line—at least in the region 0 to 60 per cent aluminum where we worked. Some of the published data in the region 90 to 100 per cent copper deviate from the linear relation.

In a heterogeneous mixture of two substances one would expect the specific volume of the mixture to be a linear function of the composition. In the system copper:aluminum, there are at least two compounds formed (CuAl_2 and Cu_3Al) and a number of fields of solid solution. The effect of these additional phases, however, in causing the specific volume to deviate from a straight line is apparently quite small, except in the copper-rich alloys as previously noted.

This relation offers a useful method of calculating the approximate specific volume (or density) of the solid alloys at temperatures up to their melting points. The expansivities of aluminum and of copper are quite well known, and their specific volumes at any temperature can therefore be calculated with reasonable accuracy. Then if the linear relation still holds for their alloys at this temperature, the specific volume of the latter can readily be calculated.

For example, the specific volumes of copper and aluminum at 20 deg. C. are $1 \div 8.90$ and $1 \div 2.703$ respectively. The specific volumes at 540 deg. C. are calculated from the expansion formulas to be 0.1157 and 0.3860. The specific volume of the alloy containing 32 per cent copper (the eutectic) is then $0.32 \times 0.1157 + 0.68 \times 0.3860 = 0.2995$, and its density is $1 \div 0.2995$, or 3.33, at 540 deg. C. This value may be checked in another way. An approximate determination of the total linear shrinkage from 540 to 20 deg. C. of an alloy of this composition gives a value of 0.15 in. per foot. The cubical expansion (20 to 540 deg. is then $1 + (0.15 \div 12.00) \times 3 = 1.0375$. The density of the eutectic mixture at 20 deg. is 3.46 and its density at 540 deg. equals $3.46 \div 1.0375 = 3.33$, which is the same value as calculated by the method of specific volumes. It seems probable that the values for solid alloys calculated from the specific volumes of the component metals and their expansion are accurate to at least 1 per cent for the alloys under consideration.

The phenomenon of growth or the production of permanent volume changes in aluminum alloys by heating to 300 deg. C. and over seems well established (see article by Zay Jeffries, *J. Soc. Aut. Eng.*, vol. 7, p. 295, 1920). The measurement and interpretation of such changes would logically be a part of a complete investigation of the density of the solid at temperatures up to the melting point, but they have not been undertaken as yet.

No. 12 ALLOY

The alloy containing 8 per cent copper and known as No. 12 alloy is so generally used for casting purposes that it is of interest to give it a more detailed discussion.

Density at 20 Deg. C. The density of the cast 8 per cent copper alloy is about 2.86. Although the specimen which had this density was apparently sound and free

from holes, it is probable that working would increase the density somewhat due to the elimination of microscopic voids. It is, however, representative of a sound ingot of this composition. For reasons which will be discussed later, No. 12 alloy cast under certain conditions may be somewhat porous and such metal will have a correspondingly lower density. Samples have been examined running as low in density as 2.80 or 2.75, but examination under the microscope revealed the presence of voids between the grains. As used, No. 12 alloy may vary from 7.0 to 8.5 per cent of copper; its

TABLE III. COMPOSITION AND PROPORTIONS OF SOLID AND LIQUID IN EQUILIBRIUM IN NO. 12 ALLOY

Temperature Deg. C.	Equilibrium Composition—		Proportions in Equilibrium—	
	Solid Per Cent Copper	Liquid Per Cent Copper	Solid Per Cent	Liquid Per Cent
636	0.9	8.0	0	100
616	1.6	14.4	50	50
600	2.2	19.0	66	34
560	3.6	28.0	82	18
540	4.3	32.0	86-100	14-0

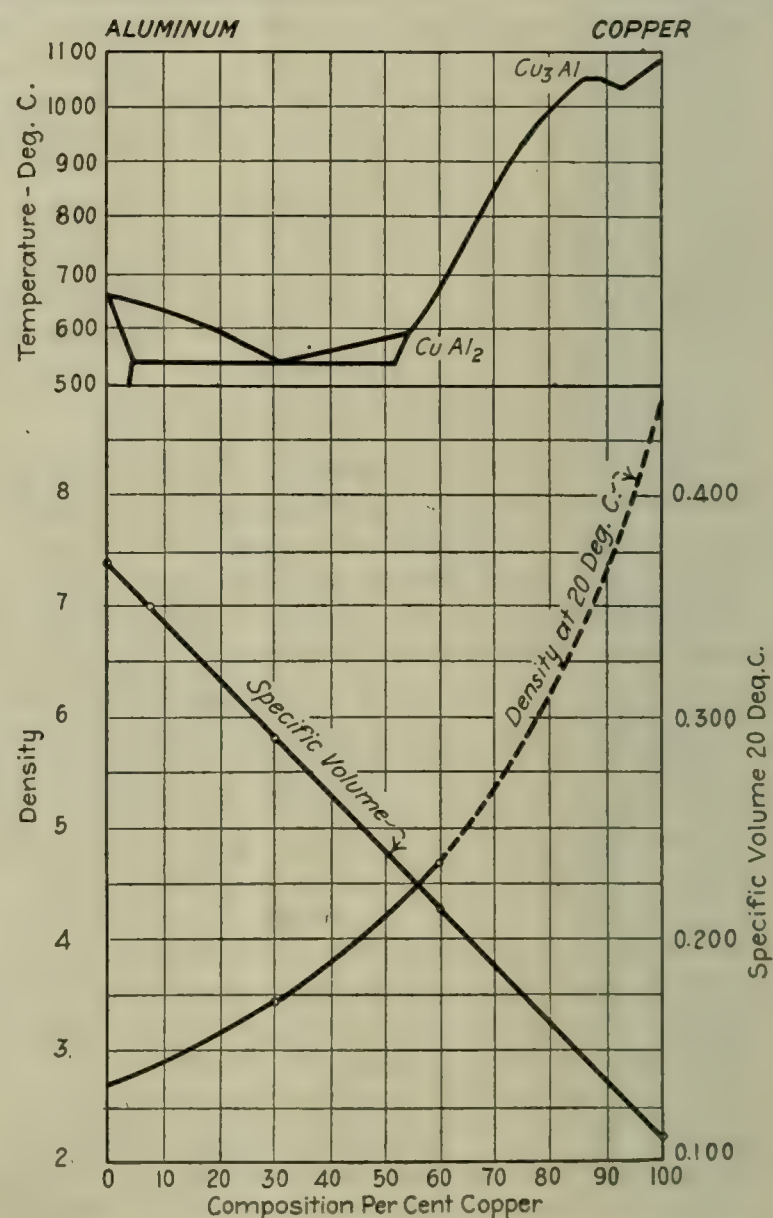


Fig. 2. Specific volumes of copper:aluminum alloys; equilibrium diagram (upper figure).

density, according to Fig. 1, will vary from 2.84 to 2.87. The commercial alloy usually has a higher iron and silicon content, which will tend to raise the density slightly. Taking into consideration all of these factors, the density range of No. 12 alloy may be placed at 2.82 to 2.88 at 20 deg. C.

Course of Freezing With Copper:Aluminum Alloys. To understand the process of freezing of No. 12 alloy, it is instructive to consider the equilibrium diagram as shown in Fig. 1. The main features of this diagram are taken from the work of Carpenter and Edwards² with

²Proc., Inst. Mech. Eng., p. 57 (1907).

some slight modifications. The alloys containing less than 32 per cent copper are the only ones of interest in the present connection, and it is this portion only of the diagram which need be considered. The alloy containing 8 per cent of copper begins to freeze at 636 deg. and the freezing is completed at 540 deg. These temperatures are given by the points of intersection of the vertical line *ad* at 8 per cent copper with the liquidus and solidus curves respectively. The first crystals to separate at 636 deg. have the composition given by the intersection of the horizontal line *ab* through this point with the solidus curve at *b*. The limit of solubility of copper in aluminum as CuAl_2 is reached at 4.3 per cent copper (Merica)³ and crystals of this composition are in equilibrium with liquid of the eutectic composition (32 per cent copper) at 540 deg. The relative proportions

of liquid and solid are then $\frac{cd}{ce}$ and $\frac{de}{ce}$. The composition

of liquid and solid in equilibrium at any other temperature in the freezing range is given by the intersection of the horizontal temperature line with the liquidus and solidus curves, and the relative proportions by the inverse ratio in which the vertical line at 8 per cent copper divides the horizontal distance between the solidus and liquidus. In Table III certain of these values as calculated from the diagram are tabulated. It is recognized that the solidus curve in particular has not been determined with any great accuracy and that these values calculated from the diagram are subject to revision as more accurate data on the equilibrium relations are obtained.

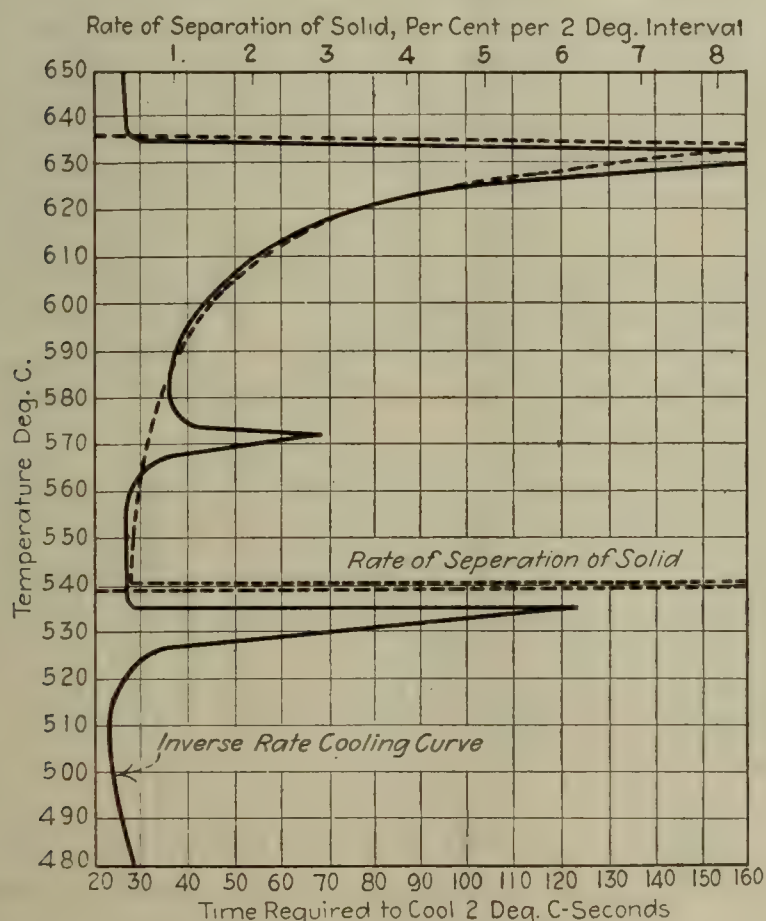


Fig. 3. Comparison of the rate of separation of solid from the 8 per cent copper:aluminum alloy with an inverse rate cooling curve of the same alloy.

In the course of cooling, when the temperature of 540 deg. is reached, about 86 per cent of the metal has crystallized and the remaining 14 per cent of liquid has the eutectic composition. This eutectic liquid then freezes at constant temperature, as in the case of a pure metal. The above data are for the condition of equilibrium

which can only be approximated by extremely slow cooling. The effect of more rapid cooling is to prevent equilibrium being reached at any temperature, between the crystals already formed and the liquid. One result of this failure to reach equilibrium will be to increase the proportion of eutectic present at 540 deg. C.

It is obvious from the data of Table III that the solid separates most rapidly during the first part of the freezing and the rate gradually decreases as the eutectic temperature is approached. This is shown graphically by the dotted line curve in Fig. 3, in which the rate of crystallization, expressed in grams of solid separating per 100 g. of metal, for each 2 deg. fall of temperature is plotted as a function of the temperature. There is also given for comparison an inverse rate cooling curve (solid line curve) of No. 12 alloy as determined in this laboratory. Since the time required for the melt to cool any interval, such as 2 deg., is a measure of the

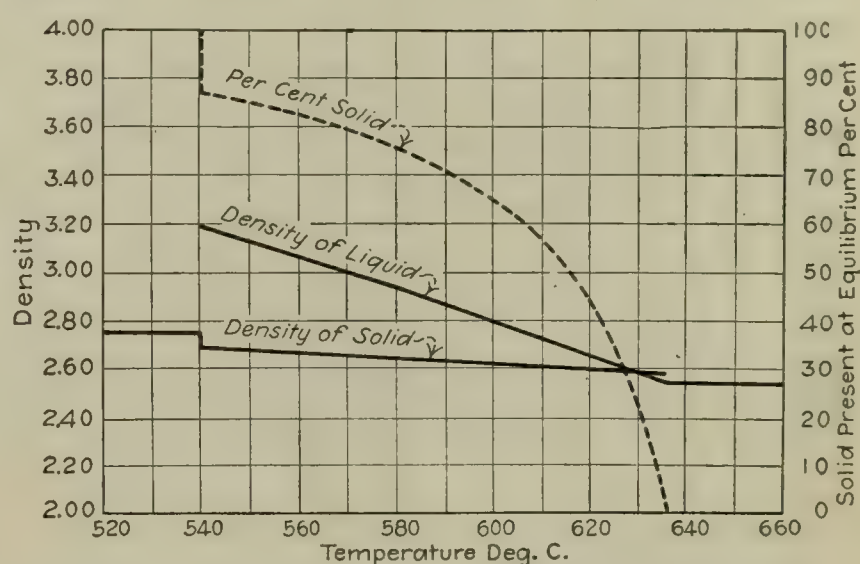


Fig. 4. Density of solid and liquid in equilibrium at different temperatures; also per cent of solid present at equilibrium.

amount of solid separating, the two curves are substantially equivalent and the agreement between the theoretical and observed rates is quite satisfactory.

There are two points in connection with the inverse rate curve which require further mention. At about 577 deg. there is a point of inflection corresponding with the separation of the silicon as a eutectic mixture with aluminum; the constituents classed as impurities were not considered in connection with the equilibrium diagram, so there is no corresponding point on the dotted curve. The observed eutectic temperature is depressed several degrees; this phenomenon is frequently observed where the eutectic is present in relatively small proportions.

From the observed data and by the methods already discussed the density of the solid and liquid in equilibrium with each other at any temperature can be ascertained and they have been plotted in Fig. 4. There is also plotted the relation between the amount of solid and liquid present in equilibrium at different temperatures. These curves indicate several very significant facts. It will be noted that the first crystals formed, at 636 deg. C., are heavier than the liquid from which they separate and consequently they tend to sink. The crystals which separate have, however, less copper than the liquid and copper concentrates in the liquid; as a result, the liquid increases in density faster than the solid. They become equal in density at about 630 deg. when approximately 25 per cent of the liquid has crystallized. At all temperatures lower than 630 deg. the graph shows the crystals to be lighter than the liquid

³Bureau of Standards, Scientific Paper No. 337 (1919).

and they consequently tend to float. The consequences of this relation will be considered in the succeeding paragraph.

Segregation in No. 12 Alloy. In the course of an examination of various small experimental ingots of No. 12 alloy it was noticed that there was considerable variation in the copper content and density of different parts of the same sample. The copper content increased from top to bottom of the ingot and the density increased in the same manner. Such segregation was marked in large ingots which had cooled very slowly. Because of the difference in density between crystals and liquid, as shown in Fig. 4, it is not surprising that segregation should occur with this alloy and that the region of highest copper should be at the bottom of the ingot. The rate of cooling and shape and size of the mold will largely determine the amount of segregation which will occur.

The difference of density between crystals and liquid may be indirectly a cause of porosity in castings. For example, if a large mass of crystals is floating in the liquid, they may form a network which gains considerable rigidity as freezing nears completion. Consequently, when the eutectic solidifies, there is a tendency for it to withdraw downward from the interstices of this network and leave voids between the crystals unless additional fluid eutectic metal is supplied. Such behavior tends to reduce the apparent size of the pipe by converting the upper part of the ingot into a porous mass. Microscopic examination has demonstrated the existence of these voids caused by the withdrawal of eutectic, and

as with pure aluminum, which gave the value 6.6 per cent. The relative piping effect with the pure metal and the alloy is, however, quite different. The reasons for such a difference will be developed later.

SUMMARY

The density of a series of copper:aluminum alloys has been determined for the solid metal at 20 deg. C. and for the liquid metal at temperatures ranging from the freezing point to 1,000 deg. C. By the employment of the expansion data for the solid metal and by several methods of interpolation the density of any alloy containing between 0 and 60 per cent copper can be estimated with a fair degree of accuracy for temperatures from 20 to 1,000 deg. C.

These data taken together with the thermal equilibrium diagram for the system copper:aluminum have furnished some very interesting information regarding the volume changes occurring in the copper:aluminum alloys during freezing. They have been discussed with particular reference to the 8 per cent copper alloy and furnish a very reasonable explanation of piping, segregation, etc., as observed with No. 12 alloy.

Research Bureau,
Aluminum Company of America,
New Kensington, Pa.

Perfumery Industry in France

Grasse, a small city in the mountains about twenty-five miles from Nice, is the center of the French perfumery industry. The commodities manufactured at Grasse are the primary products of perfumery, such as floral concretes, essential oils and enfleurage grease. In 1919 the demand for these articles was so large that their prices increased, and even at the higher prices the manufacturers were not able to fill their orders. It is said that the percentage of profit on the turnover was comparatively smaller than before the war, however.

The manufacturers point out that the price of flowers has taken an incredible flight since the war. Violets advanced from 5 fr. (1 fr. = 19.3c. normally) per kilo (1 kilo = 2.2 lb.) in 1914 to 10 and even 12 fr. per kilo in 1919; roses, from $\frac{1}{2}$ fr. to $3\frac{1}{2}$ fr.; jasmine, from 1 fr. to $7\frac{1}{2}$ fr.

Wages for women increased from 4 to 9 fr.; for men, from 5 to 12 fr. In the Grasse manufacturing plants about 80 per cent of the work is done by women. Wages for skilled labor also increased. Coal and alcohol, the latter being extensively used in the manufacture of perfume, are difficult to obtain even at high prices, so that although the selling price of the primary articles of perfumery has increased, it has not advanced in the same proportion as the costs of production.

Alcobronze, a New Copper: Aluminum Alloy

A new alloy of copper and aluminum has been invented and tested by the Aktiebolaget Skandinaviska Armaturfabriken. The name given to the new combination is "Alcobronze." It has the color and luster of gold, and it is said to be stronger, tougher and harder than any other bronze. It is further stated that it can be wrought, forged or rolled in any way without suffering deterioration, and that it resists the action of the air, acids and salt water, being therefore particularly suitable for ships' forgings, propellers, condensers, machine parts, bearings, surgical instruments, skates, ornaments, etc.—*The Engineer*, Dec. 17, 1920.

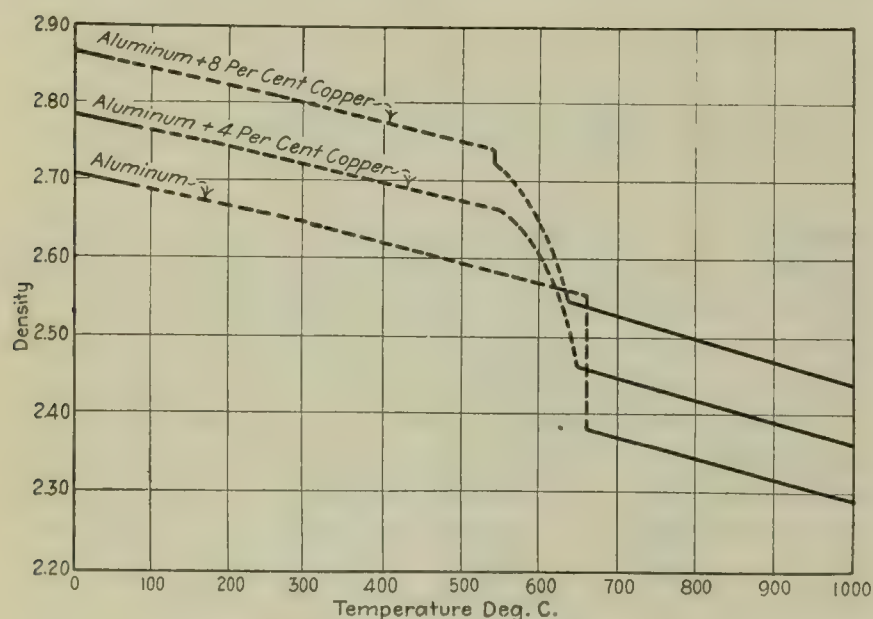


Fig. 5. Density of aluminum and of the 4 and 8 per cent copper:aluminum alloys from 20 to 1,000 deg. C. Dotted portions of the graph are calculated. (See text.)

density determinations combined with chemical analyses have given further proof of their extent. The presence of such voids is prevented in commercial foundry practice by the use of suitably designed gates and risers which supply the necessary liquid metal.

Shrinkage of the 8 Per Cent Copper Alloy. From the data of Table II and by the methods outlined for the calculation of the specific volumes of the alloys at temperatures up to the melting point, the complete density curves of Fig. 5 were constructed. The average density of the mixture of solid and liquid present during the melting range was calculated from their calculated proportions and density (cf. Table III). The contraction in volume of No. 12 alloy from the beginning to the end of freezing (636 to 540 deg. C.) is about 7 per cent. The solidification shrinkage is therefore about the same

The Chemistry and Manufacture of Satin White*

BY A. COBENZL

SATIN white is a calcium aluminate mixed with hydrate calcium sulphate. It is a very important white pigment and is of particular value in the manufacture of coated paper, as well as in the preparation of alumina lakes.

The chemical reactions which take place in the preparation of satin white, as well as those responsible for the formation of alumina lakes, have been expressed usually by empirical chemical formulas; but the physical conditions and factors attending these reactions have been neglected entirely, almost intentionally, it would appear. The importance of conducting the operations under the most advantageous physical conditions was not appreciated or understood. It was all a matter of following blindly old-established directions, which were guarded most zealously and carried out to the letter.

Very often the product, although correct according to the chemical equation, was nevertheless valueless, because the physicochemical conditions under which it was made were not right. Satin whites which were found to be identical by quantitative chemical analyses have shown very different physical properties and we must look to colloidal chemistry for the true explanation of these phenomena.

THE "RULE-OF-THUMB" PROCESS

The author was called upon to supervise the operation of a factory making satin white. He was given the operating information and was told to follow this to the letter. He was warned to continue using the same raw materials, to obtain them from the same source of supply and not to make any change whatever in the long-established practice of the plant. The directions received for making satin white were:

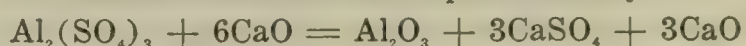
Eighty-five kg. of caustic lime is dissolved in about 200 liters of boiling water. The volume is brought to 450 to 500 liters by the addition of more water and the solution is passed through a fine-meshed sieve. The cold solution is then pumped into a powerful churn of about 1,500 to 1,600 liters capacity. A cold solution of 125 kg. of aluminum sulphate (containing 18 per cent Al_2O_3) in 500 liters of water is added quickly, with vigorous agitation. The mixture is heated strongly until the mass became very viscous. The excessive rise in temperature due to the exothermic reaction and the difficulty in stirring due to the thickening of the mass are obviated by adding water up to about 1,100 to 1,200 liters. The mass, which was pasty at the beginning, is changed gradually into a uniformly viscous sirup, which can be drawn out into lustrous threads. The sirup is pumped into a 7,000-liter capacity vat, provided with stirring apparatus and well mixed with water, until the volume reaches 5,500 to 6,000 liters.

The end of the operation is reached when a sample of 100 c.c. of the filtered solution requires no more than 24 to 26 c.c. of a N/10 oxalic acid solution for neutralization with phenolphthalein as an indicator. If this test shows a higher degree of alkalinity, add 4 kg. of H_2SO_4 (40 deg. Bé.) and bring the solution to the proper degree of alkalinity by the further addition of aluminum sulphate.

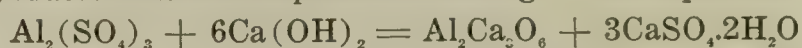
To avoid the yellow coloration of the product, the various materials used in the manufacture must be as free as possible from iron. The last traces of any yellow color visible to the naked eye are neutralized by the addition of indanthrene blue, 2GSZ of the Badische Anilin- und Soda-Fabrik, in the form of a solution of 250 g. of the commercial pasty dyestuff in 5,000 c.c. of water. From 100 to 150 c.c. of this solution is usually required for each charge. The satin white is then separated from the solution by filtration.

THE CHEMISTRY OF THE PROCESS

The chemical reaction was represented by



but a closer examination of the progress of the operation and the several observations on the chemical conditions surrounding the same have shown that this equation is fundamentally false and that the actual equation of the reaction gives a calcium aluminate with hydrated calcium sulphate according to the equation



Properly made satin white is a pure white lustrous mass which when added to water becomes gradually a finely pulverized mass and which when suspended in the liquid settles with difficulty.

To test the product for its free alkali content, 50 g. of the mass is agitated with 300 c.c. of water and 100 c.c. of the filtrate is titrated with N/10 oxalic acid solution. A good product should require for neutralization about 1.5 c.c. of this acid solution—that is, about 7 c.c. per 100 g. of the original mass.

The moisture content has to be determined by drying on a water-bath that is at a temperature not exceeding 100 deg. C., because at a higher temperature the hydrated calcium sulphate ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) loses its water.

The proportion of calcium corresponding to the aluminate is found in the most accurate manner when a weighed quantity of the mass is mixed with water and titrated with N/2 HCl solution, using phenolphthalein as indicator, until the solution is decolorized permanently.

The total lime, alumina and H_2SO_4 can be found accurately by the regular gravimetric methods. Analyses for moisture, calcium (corresponding to the aluminate) and free alkali are all that is necessary for routine control of the process. The average analysis of satin white is:

	Al_2O_3	CaSO_4	CaO
Found	5.06	18.47	8.06
Calculated from $\text{Al}_2\text{Ca}_3\text{O}_6$	5.00	20.00	8.23

The great discrepancy between the CaSO_4 percentages found and calculated is due to the fact that usually the $\text{Al}_2(\text{SO}_4)_3$ employed does not have the required alkalinity.

IMPORTANCE OF THE ALALINITY OF THE $\text{Al}_2(\text{SO}_4)_3$ EMPLOYED

The lime used in the manufacture of satin white must be very pure, white, free from iron, sand and carbon, must slake quickly and give a pure, white and porous hydrated lime. The sulphate of alumina to be used should contain about 18 per cent Al_2O_3 and only 80 to 85 per cent of the theoretical quantity of H_2SO_4 corresponding to the Al_2O_3 present. The insoluble matter (silica) is not to be over 0.4 per cent and the iron content, at the most, 0.005 per cent. The use of aluminum sulphate containing more than the above corresponding amount of H_2SO_4 is harmful.

In one case, when production was being forced, an

*Abstracted and translated from *Chemiker Zeitung*, Sept. 7, 1920, pp. 661-662.

aluminum sulphate of undetermined alkalinity was used. A preliminary examination indicated that there was no reason why a good product should not be obtained, as the sulphate seemed to be of the best quality and equal to the standard brand, in outward appearance at least. But the results were very bad. The mass became very viscous in the stirring apparatus and eventually it was necessary to stop the operation and break up the hardened mass with hammer and chisel. A laboratory experiment was made to determine why this happened. It was found that the new sulphate was just as good as the standard material in every respect but one—viz., that the former contained almost the total calculated quantity of H_2SO_4 corresponding to the alumina content of the sulphate, hence more than the appropriate 80 to 85 per cent of the theoretical amount of H_2SO_4 .

CONTROL OF THE H_2SO_4 CONTENT OF THE ALUMINUM SULPHATE

The H_2SO_4 content of the sulphate solution can be controlled easily by the addition of milk of lime. The $CaSO_4$ found settles and has to be separated. If it is allowed to remain suspended in the solution, then, strange as it may seem, no satin white is formed, but the reaction proceeds according to the equation



until a solid mass is formed. The explanation of the phenomenon seems to lie within the realms of colloidal chemistry. It is known that the presence of a pure crystalline (in this case $CaSO_4$) will prevent the formation of the colloid—viz., will hinder coagulation. The entire question was investigated in the laboratory and the results obtained therein have been applied to actual practice with good results.

About 2,750 kg. of the sulphate which gave the above negative results is placed into a perforated basket and suspended in a vat provided with a stirring device and containing about 6,600 liters of water. The salt is dissolved in a few hours without any further treatment. Milk of lime, made by slaking 80 liters of caustic lime with 250 liters of boiling water, is then added with constant stirring. After about one hour the stirring apparatus is stopped and the clear liquor decanted. This liquor shows a gravity of 25 deg. Bé. and can be used successfully in the usual way for making satin white. This process of de-acidifying is unprofitable, especially in plants that manufacture their own aluminum sulphate. Therefore a process for obtaining a sulphate of the proper H_2SO_4 content directly from $Al(OH)_3$ has been developed. This consists in treating in lead-lined pots the aluminum hydroxide obtained from bauxite with a quantity of 50 to 52 deg. Bé. H_2SO_4 (the Al_2O_3 content of the press-cake is first determined very accurately) sufficient to neutralize about 80 to 85 per cent of the Al_2O_3 . The mass becomes heated up to 106 to 107 deg. C. by the heat generated during the reaction and kept at 108 deg. C. until the mass becomes viscous. This substance when dissolved in water up to a 25 deg. Bé. solution can be used successfully in the regular process of satin white manufacture.

EXPERIMENTS INSTITUTED TO PROVE THAT CALCIUM ALUMINATE IS ACTUALLY FORMED

Pure $Al(OH)_3$ in the moist condition just after being made is intimately mixed in a mortar with slightly more than the theoretically calculated quantity of a milk of lime. At first the mixture becomes almost solid, but by continuing the mixing it becomes soft, then a

fluid of such consistency as to be capable of being drawn into threads, exactly as happens in the process of making satin white. When this mass is stirred up with water, it settles easily. In order to eliminate the excess of lime, the mass is washed with water several times until 100 c.c. of the final wash water can be neutralized by not more than 3 c.c. of N/10 oxalic acid, when it may be considered that all the excess lime has been washed out. The analytical results indicated that Ca content in relation to the Al content is somewhat less than the calculated value from the aluminate. When the aluminate is treated with an excess of water it is partly decomposed and some $Ca(OH)_2$ is found in the solution. When freshly precipitated $Al(OH)_3$ is treated with lime water at normal temperature no change takes place even after long standing, but at boiling temperature the reaction takes place rapidly and the product obtained is calcium aluminate.

COLLOIDAL CHEMISTRY AND THE SATIN WHITE LAKES

The chemical investigation of the satin white manufacturing process, from the standpoint of colloidal chemistry, was not only instrumental in explaining the technology of this process, but also had an important bearing on the formation of alumina or alumina-lime lakes. The statement is found in printed literature that the alumina-lime process for forming lakes is uncertain and will not always give good results; but the author has found that there is scarcely a more dependable process to be found. All that is necessary to obtain good quality lakes is to work out the process in accordance with the equation



as given above for the preparation of satin white.

When satin white, still in the liquid condition in the agitator, is transformed into the unfilterable state, the colloidal particles are from 0.0001 to 0.000001 mm. in size. To be filtrable, the satin white must be coarser than 0.0001 mm. It is well known that as the dispersion of the colloidal substance increases the surface area increases.

A cube, having sides 1 cm. in length and a surface area of 6 sq.cm., cut up into cubes, having sides 0.0001 cm. in length, will give 10^{15} cubes with a surface area of 60 sq.m., and by further subdivision into cubes having sides 0.000001 mm. in length will give 10^{21} cubes with a surface area of 6,000 sq.m. This means that 1 g. of a pigment in a colloidal dispersion could cover a surface of about 600 sq.m. Nature itself shows us best how the most brilliant colorations are obtained with almost infinitesimal quantities of coloring matter. It is well known in dyestuff technology that coarsely grained dyes are without gloss and are lifeless. Hence it follows, as has been proved by actual experience, that satin white in the proper state of colloidal dispersion gives lakes of surpassing brilliancy in color.

THE AUTHOR'S PROCESS OF MAKING SATIN WHITE

Laboratory research has enabled the author to devise a process of making satin white. The principle of the process briefly stated is:

About 90 g. of lime is slaked in 220 c.c. of boiling water. To this solution add quickly 130 g. of finely pulverized (260-mesh sieve) $Al_2(SO_4)_3$ of the proper degree of acidity, as explained above. The mass is heated until it becomes almost solid, when 250 c.c. of water is added and the mixture agitated thoroughly. The resulting product is a very good quality satin white.

Legal Notes

BY WELLINGTON GUSTIN

Sympathetic Strike to Compel Employment of Union Men Only Held Unlawful

A contract of employers with labor unions to employ only union men was held to be against public policy by the New Jersey Court of Chancery in an injunction sought by the Lehigh Structural Steel Co. and others against the Atlantic Smelting & Refining Works and others.

The Lehigh company contracted to fabricate and deliver to the Atlantic Smelting & Refining Works the steel for a building at Brills, Newark, N. J., and also to erect it. The erection was sublet to the Donnell-Zane Co. The work had been nearly completed when the erectors struck. The Donnell-Zane Co. decided to employ non-union labor, and was notified by a representative of the Atlantic company that it would not be permitted to finish the job with other than union workmen, the reason being given that there would be a general strike of the allied trades on the works if it were done otherwise.

The court said that the strike was called, and that the fact was not disputed that a general strike, in sympathy, would have been brought into play to force the Atlantic company to breach its contract with the Lehigh company if Donnell-Zane persisted in defying organized labor.

CLOSED SHOP THE ISSUE

The complainants set up that the strike was ordered to force them, against their will, to conduct their business on the closed-shop plan. The business representatives of the unions admitted this to be the avowed purpose and pleaded in justification that the Building Trades Employers' Association of New York City (comprising nearly all the building contractors of New York), of which the Iron League is a member, entered into a contract with the New York Building Trades Council of Greater New York and Long Island (an association of all the trades unions of those localities) whereby the employers' association bound its members to employ only union men in their various building enterprises in Greater New York and certain named additional territory.

The complainants admitted the making of the contract and their refusal to abide by its terms, claiming it was beyond the power of the employers' association to bind the Iron League and its members, restricting them in selection of their workmen to members of organized labor, because it was in contravention of public policy, and therefore unlawful.

In awarding the injunction against the Atlantic company, the labor unions and others, the court pointed out that the men were not under contract, and individually had the right to quit work as it pleased them, and as members of the federation it was their privilege to use the strike in sympathy and to advance the common cause of organized labor, provided the motive or the object sought to be attained was not an unlawful one. But it was said the privilege to strike was not license to strike. Those availing themselves of the privilege must

respond in damages for the injury inflicted, unless they can show just cause or excuse, and this burden is on them to do so.

A sympathetic strike, merely to force the employer in other territory to comply with the invalid provision of a contract to employ only union men in such territory, is without just cause or excuse, and is unlawful. Also, the court held, the provision of a contract between an association representing nearly all the building contractors of New York City and an association representing the labor unions thereof, binding the contractors to employ only union men in their enterprises therein and having for its object the closed shop, the monopolization of the labor market by the unions, violates public policy as to monopolies.

In the instant case, the Atlantic company urged it was acting in self-defense and feared the wrath of organized labor. In other words, it breached its contract to avert a general strike. But the court said that was not a legal excuse for breaching the contract. The company's protection lies in the law, not in the graces of those who transgress it. The company may have been wholly indifferent as to the success of the strike, but the enforcement of the closed shop at Brills made it a co-conspirator with the union.

Guano Company Held Liable for Unlawful Obstruction to Navigation

A loading crane, erected without permission of the Secretary of War, traveling on a track along the edge of a wharf, and which, although movable, was left at a time when not in use extending 38 ft. over the water of the slip was held to be an unlawful obstruction to navigation by the United States Circuit Court of Appeals, and the owner was held liable for injury to a boat which, without negligence on its part, struck the crane in passing out, in the case of *F. S. Royster Guano Co. vs. Outten*, with the *Pocomoke Guano Co.* as intervener.

The action was brought to recover damages for the negligent maintenance of a loading crane or derrick, erected without making application to the Secretary of War for his approval and which it was claimed constituted an unlawful obstruction to navigation. The crane was left suspended over a barge which it had been unloading. It extended 8 ft. beyond the barge over the water and about 45 ft. high when the *Mannie May*, loaded with fertilizer, collided with it, at the harbor of Norfolk, Va. The master of the vessel recovered \$1,315 damages and the *Pocomoke Guano Co.* was allowed damages of \$699.75, the full amount of its claim, for fertilizer lost when the vessel sank.

The court said any obstruction of a navigable stream must be subordinate to the right of navigation. The derrick or crane, reaching into the air a considerable distance from the water, rendered it all the more difficult for one navigating a vessel to determine accurately as to the proximity of such an obstruction to the top of a vessel. If this crane, after being used, had been immediately turned to one side, so as not to project over the navigable waters, and at all times kept in that position while not being used, it could not have been said to be an unauthorized obstruction. Even if this obstruction had been authorized by the proper authorities, it would have been just as much an obstruction to navigation as would have been a drawbridge left in an improper position when not being manipulated so as to permit vessels to have an easy passage.

Synopsis of Recent Chemical & Metallurgical Literature

Crystal Growth and Recrystallization in Metals—

Prof. H. C. H. CARPENTER and Miss C. F. ELAM presented a noteworthy paper on this subject before the fall meeting of the British Institute of Metals, in which they presented experimental results which cannot apparently be fitted into existing theories. They used an alloy containing 98.5 per cent tin and 1.5 per cent antimony; it is without phase changes, and after annealing is composed of allotriomorphic crystals of homogeneous solid solution. It is exceedingly active in its crystal growth—any polishing or cutting brings about spontaneous recrystallization¹ of a surface layer of exceedingly fine crystals, which may be removed only by alternate polishing and etching in ammonium sulphide. Enough stress remains to induce additional grain growth¹ after annealing at 200 deg. C. for thirty minutes, and the new boundaries are marked by a line which is really a difference in level, and by a distinct tarnish color. These successive contours occur at each arrest in the progress of growth, up to its limit, as is illustrated in Fig. 1. Repolishing gives new boun-

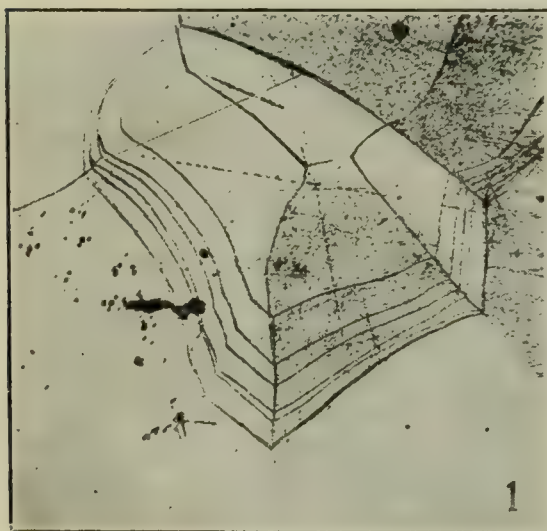


Fig. 1. Five-sided crystal absorbed by its neighbors in six successive heatings. $\times 85$.

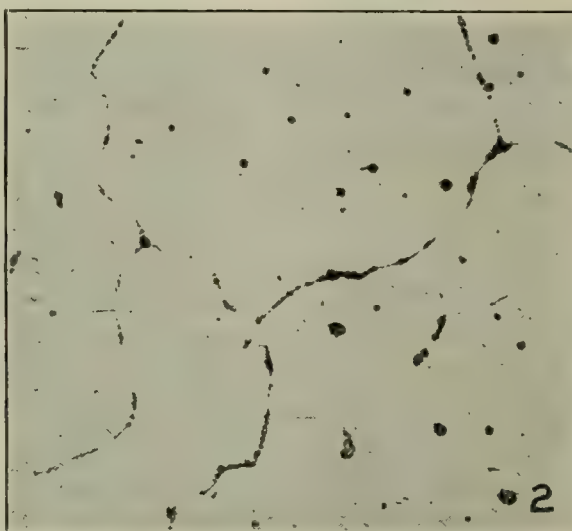


Fig. 2. Cast aluminum annealed ten weeks at 550 deg. C. $\times 85$.

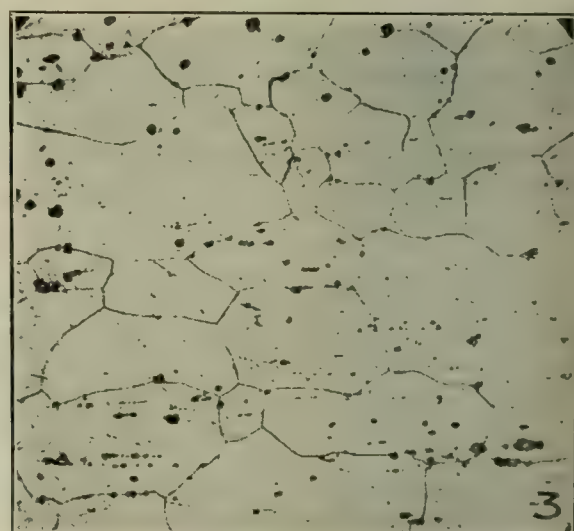


Fig. 3. Same as Fig. 2 after rolling and annealing ten weeks at 550 deg. C. $\times 85$.

daries identical with the most advanced lines; others vanish.

This is evidently an instance of grain growth. Similar experiments show that some rapidly growing crystals often grow in one direction very slowly; a crystal may disappear entirely in one anneal; growth may be halted for one anneal and later resume; growth near the end of absorption is relatively rapid; but in all cases growth is by gradual boundary extension and never by welding another crystal *en bloc*.² Chappell's idea² that similar orientation is necessary for grain growth is disproved by observations that one crystal may be absorbed simultaneously by several neighbors, each of a different orientation as revealed by the etching tone. The often-expressed hypothesis that difference in crystal size is necessary for grain growth, and Jeffries' theory³ that the smaller crystal is absorbed is controverted by the

now observed fact that the growth is not confined to large crystals—of two small ones in the same field one may grow while the other disappears. Indeed, a crystal has been observed to grow at one boundary and be invaded on another at the same time.

Strains induced by successive delicate polishing and etching are certainly small, and it would be important to find out whether, lacking even this amount, crystals would grow upon annealing. Castings often show non-homogeneous dendrites, a structure which obscures the crystalline boundaries, even though they are marked by segregates. Fig. 2 shows the structure of a cast aluminum ingot after having been annealed ten weeks at 550 deg. C. The boundaries are still outlined by FeAl, and other impurities; since the latter have not melted during the heat-treatment and are insoluble at that temperature, they cannot have moved, therefore the presumption is that neither have the original boundaries changed. Fig. 3, on the other hand, shows a portion of the same ingot, rolled and annealed. The boundaries are now independent of the impurities (an observation typical of pure sheet metal) due to the combined action of recrystallization and grain growth. This experiment is thought to prove definitely the wide assumption that recrystallization and grain growth in a non-allotropic metal is dependent upon previous strain.⁴

Given the fact that some strain was necessary for growth, the effect of various deformations was studied

by squeezing or scratching the Sn:Sb alloy, by pulling aluminum sheet various amounts, and by pulling a tapered test-piece of α brass, all indicating that:

1. On moderate strain, slip-bands or twins or both may be produced, giving a certain permanent deformation. On annealing slip-bands and most of the twins are reabsorbed without change in crystal size or shape.

2. A further amount of deformation causes growth of some of the existing crystals upon annealing, a direct growth of pre-existent grains involving no recrystallization. A few twins may persist. However, growing crystals do not invade unstressed regions.

3. All deformation beyond a certain fixed amount causes recrystallization. This is always followed by crystal growth from these new centers if sufficient time at high temperature be given. This growth does not involve a disintegration of the previous crystals, but their gradual reabsorption into the new ones (growing usually from the old boundaries). There is no evidence

¹The authors distinguish carefully between recrystallization and grain growth. Recrystallization involves a complete reorientation of a crystal or group of crystals. It starts from new and independent centers, and in its early stages at least involves refinement in size. Crystal growth, on the other hand, involves the absorption of a crystal by its neighbors, involves increase in grain size, and does not require previous "recrystallization" as defined here.

²J. Iron and Steel Institute, 1914, vol. 1.

³J. Institute of Metals, vol. 20, 1918, II.

⁴Guillet (*Revue de Metallurgie Memoirs*, 1913, vol. 10, p. 1130) describes a nickel brass (Cu 49.52; Ni 2.28; Fe 0.10) which exhibits a single constituent, and develops a coarsely polyhedral grain on reheating, following no working of any kind.

that stress beyond the critical amount necessary for recrystallization causes any reorientation of the former crystals.

Temperature and time are both factors in determining the boundaries of 1, 2 and 3, above. Carpenter and Elam's results check those of other investigators, as follows: The largest crystals are always formed after the minimum stress which induces growth at a given temperature. The lower the annealing temperature, however, the greater the requisite stress.

Strain being necessary for grain growth, and cold work being presumed to increase the amount of amorphous material in the metal, it is only natural to associate amorphous metal and recrystallization. However, the authors found that a cold-worked piece of aluminum, annealed sixty-five hours at 350 deg. C., lost all its acquired hardness (amorphous metal), yet showed no change in grain size. Reannealing at higher temperatures, however, gave exactly the same growth as another piece strained similarly but not softened.

It has been often suggested that structural equilibrium will ensue only when a piece of pure metal consists of one large crystal, but this limit has never been observed. In fact these experiments, involving annealings for a year's time, show a definite end to the growth short of this ideal. In view of the relations 1, 2 and 3 listed above the authors suggest that a certain critical strain is needed before any crystal will grow (a strain which varies inversely as the annealing temperature). Crystals strained below this point will be absorbed; unstrained crystals will show no change whatever. It follows that the less the total strain on a piece the fewer crystals will be strained the critical amount, the fewer the number of growing crystals and the larger their ultimate size. Now in order to have the mass converted into one crystal all the original ones must have been somewhat strained, but only one above the critical amount, not an unimaginable condition, but well-nigh impossible.

Whatever forms of energy operate during the growth or recrystallization of a crystal on heating, the authors' conclusion is that the energy is imparted during deformation. It apparently cannot be stored in amorphous films, nor can it be stored in amorphous crystalline cement, since castings are permanent.

Thermal Analysis by Differential Method.—It may be remembered that Roberts-Austin devised a useful method of determining the presence of small evolutions or absorptions of heat by comparing the rate of temperature change in the body under study and another body having no thermal discontinuities in that region. ARTHUR W. GRAY* described an interesting modification for moderate temperature ranges where the bulb of a precise mercurial thermometer serves as the neutral body. Bound close to this by several layers of silk is one junction of a copper-constant and thermo-element; the opposing junction is inserted into the fine-drawn tip of a glass tube, sheathing both thermometer and couple. This glass tip is inserted through a hole in the specimen under study, the whole arrangement wrapped in asbestos and heated and cooled in an electric tube furnace. With thermocouple attached to a Leeds & Northrup Type P galvanometer, readings of 0.01 deg. C. were easily obtained. Plotting temperature differences between specimen and neutral against temperatures of the neutral (readings of the thermometer) gives very clear indications of transformations in the bodies under study.

*"Transition Phenomena in Amalgams," Columbus meeting, A.I.M.E. (Institute of Metals Division), October, 1920.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office Southampton Buildings, Chancery Lane, London, England.

Color Photography.—Methods are described for producing multicolor grain screens in which the colors are produced partly by spraying a base with colored dyestuffs and partly by immersing the film in other dyestuff baths. The immersion treatment may affect the parts already colored by spraying or the sprayed colors may be utilized as a resist and subsequent to immersion in another colored bath be washed away and all the colors produced by such successive treatments. (Br. Pat. 152,002; not yet accepted; P. FAULSTITCH, Leipzig; Dec. 15, 1920.)

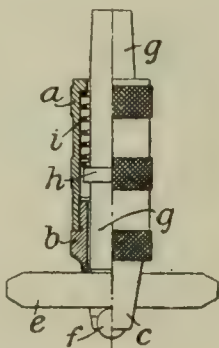
Nitric Acid.—Nitric acid up to 55 per cent strength is obtained by absorption of dilute nitrogen oxides in water absorbed in fibrous substances such as glass-wool or asbestos, or, if the strength does not exceed 50 per cent, cotton may be used. The acid may be expressed from the absorbent fibrous material, or the process may be made continuous by supplying a small stream of water to the fibrous material contained in a tower or chamber while the current of gas is passing, and drawing off the acid at the bottom. (Br. Pat. 152,031; not yet accepted; SOC. L'AZOTE FRANÇAIS, Paris; Dec. 15, 1920.)

Thorium Salts.—An insoluble compound of thorium is obtained by heating a material such as monazite sand in which thorium and phosphoric acid are associated with fuming sulphuric acid. The heating is effected first at 200 to 230 deg. C. and finally at 300 to 330 deg. C. The product is treated with water with slight agitation when the solution of the rare earths with the thorium compound in suspension is decanted from heavy residues and the thorium compound is filtered off. (Br. Pat. 151,854, LINDSAY LIGHT CO., Chicago; Dec. 15, 1920.)

Potassium Salts.—Leucite is ground to an impalpable powder preferably after first calcining alone or in presence of superheated steam, lime or magnesia, and the potash is then soluble in dilute acids such as acetic, formic, citric, oxalic and carbonic acids so that it may be used as a fertilizer. The potash may be extracted wholly or in part by treating in an autoclave with carbonic acid or with one of the organic acids mentioned at raised temperature and pressure. The product is leached to extract the potassium salt, and the residue, if it still contains potassium, may be used as a manure. (Br. Pat. 152,026; not yet accepted; G. A. BLANC and F. JOURDAN, both in Rome; Dec. 15, 1920.)

Paints for Leather.—A paint for leather consists of linseed oil, amber, sugar of lead, benzine and prepared paint. The linseed oil, amber and sugar of lead are heated together to 600 deg. F. and then allowed to cool. The thick paste thus formed is dissolved in benzine and mixed with paint, preferably also thinned with benzine. (Br. Pat. 151,853, J. RICHARD and A. DUBOIS, Montreal; Dec. 15, 1920.)

Testing Hardness.—Relates to the ball test by the Brinell method, and consists in the combination of a hardened steel ball, a striker for facing the ball against the material under test, and a standard member movably positioned between the ball and the striker, the holder for the ball being of a resilient character to permit of the removal or insertion of a ball. Within a sleeve or holder *a*, *b*, formed of two parts screwed together, is the striker *g*, normally forced downward by a spring *i* acting on a flange *h* so as to bear upon a rectangular bar *e* of uniform strength and hardness, that rests upon the ball *f* held in extensions *c* of the sleeve. When the complete gage is held with the ball resting upon the material under test, and the striker is struck with a hammer, impressions are made both in the standard and the material, and the relative dimensions of these determine the hardness. The extensions *c* of the sleeve are sufficiently resilient to admit of being forced open when it is required to replace a ball. In modifications, the necessary movement of the standard to present a new surface for each test may be obtained alternatively by the use of a rotatable standard. (Br. Pat. 152,000; not yet accepted; POLDIHÜTTE TIEGELGUSZTAHLFABRIK, Kladno, Czechoslovakia; Dec. 15, 1920.)



Anthranol.—Anthranol or gamma-hydroxy-anthracene is obtained by reducing anthraquinone. Instead of the usual reducing agents—such as zinc and acetic acid—it is proposed to use caustic alkali in the presence of a carbohydrate such as glucose, cane sugar, molasses, maltose or lactose. (Br. Pat. 151,707, A. G. PERKIN, Leeds; Dec. 15, 1920.)

Nitration of Oils.—The nitration of fatty, vegetable, animal or fish oils, or the fatty acids derived from such oils, is effected in the presence of an inert solvent, and the product either used as such or after separation of the solvent. According to the provisional specifications, the oil or fatty acid may be nitrated in the absence of a solvent. The oils specially suitable are tung oil, castor oil, lumbang oil, groundnut oil, cottonseed oil, soya bean oil, whale oil, linseed oil or herring oil; while as solvents, white petroleum spirit and the naphthene residue from the nitration of Borneo spirit are mentioned. The nitration is usually effected under agitation and using pure nitric acid with the application of heat, but dilute nitric acid may be employed and the reaction may take place under increased or reduced pressure or in the presence of an inert gas. During nitration ammonium nitrate, picric acid or nitrated benzene may be added; after nitration the excess of acid is neutralized by the addition of a nitratable solvent or of a base such as lime. Resin may be added before or after nitration, while pigments or filling materials may be added to the products, which may be employed in the manufacture of paints, varnishes, lacquers, cements, insulating compositions and rubber substitutes. (Br. Pat. 152,095, G. H. HOWSE, Birmingham; Dec. 15, 1920.)

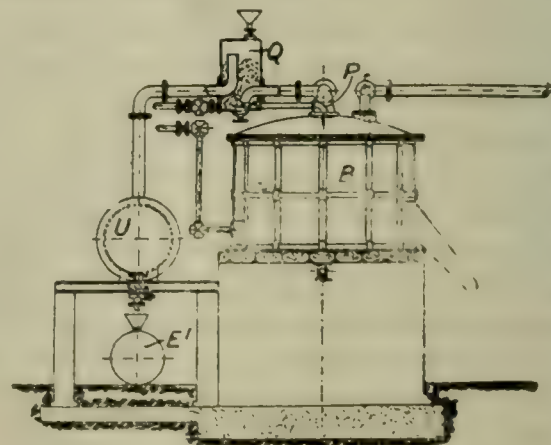
Pyrogenic Reactions.—In carrying out organic reactions at high temperatures, the deposition of solid carbon on metallic parts of the apparatus is prevented by coating the metal with tin or a tin alloy. The tin layer also acts as a catalyst. The production of benzene and toluene from cresol by treatment with hydrogen at 800 deg. C. in an apparatus consisting of

tinned iron tubes is given by way of example. (Br. Pat. 152,960; not yet accepted; F. FISCHER, Mulheim on Ruhr, Germany, Jan. 12, 1921.)

Hydrogen From Electric and Blast Smelting Furnaces.—Hydrogen or mixtures of nitrogen and hydrogen are obtained by treating with steam and preferably in the presence of a catalyst the gases from electric and blast smelting furnaces, and subsequently eliminating the steam, carbon monoxide and carbon dioxide; hydrogen is obtained if the gases treated are those from electric smelting furnaces or from blast furnaces fed with oxygen; in other cases, a mixture of nitrogen and hydrogen is obtained, the relative proportions of the two constituents depending on whether the furnace is blown with air or air enriched with oxygen. The hydrogen obtained from electric furnace, etc., gases may be mixed with the poorer mixtures from blast-furnace gases, or with nitrogen; also, this poorer mixture may be mixed with hydrogen. The gases after reaction with steam are passed through water scrubbers to remove the excess of steam, and then treated with alkali or alkali earth substances or with water under pressure to remove carbon dioxide; traces of carbon monoxide and carbon dioxide are removed by caustic soda, copper salts, etc. When suitably purified, the gases may be used in the hydrogenation of fats, the synthesis of ammonia, as fuel for internal-combustion engines, and for welding. (Br. Pat. 152,975; not yet accepted; C. TONIOLO and OFFICINE ELETTRICHE DR. ROSSI, Legnano, Italy; Jan. 12, 1921.)

Ferrochromium.—Carbon-free ferrochromium is obtained by the thermo-aluminic reaction of a mixture of chrome iron ore, aluminum or other reducing metal, and oxides of iron, preferably roll scale. Oxides of other metals, such as cobalt, nickel, tungsten, molybdenum and vanadium, may be added to produce the corresponding alloys. (Br. Pat. 152,990. T. GOLDSCHMIDT AKT. GES., Essen, Germany; Jan. 12, 1921.)

Benzene.—In the recovery of benzene and its homologues by means of steam distillation from the acid sludge produced in the purification of benzol, the vapors carried over by the steam are subjected to the action of a jet or spray of ammonia in order to arrest the acid impurities. Steam is passed through the acid sludge



contained in the retort *B* and escapes along with the benzol vapor through an outlet pipe in the head of the retort, where the vapors are met by a jet of ammonia or a spray of ammonium carbonate solution introduced through the pipe *P*. The purified vapors then pass through a scrubber *Q*, in which any excess of ammonia is removed by means of dilute acid, to a condenser *U*, the benzol being finally separated into the vessel *E*. (Br. Pat. 152,054, G. STEPHENSON CROOK, Durham; Dec. 15, 1920.)

Current Events

in the Chemical and Metallurgical Industries

Aid Asked of Congress for Federal Power Commission

Successful operation by the Federal Power Commission is seriously hampered by lack of congressional appropriation for personnel and other needs and continuation even of the present staff will be difficult next year unless Congress comes to the rescue with more money. The commission requested an appropriation of \$482,000 for the year beginning July, 1921. The Appropriations Committee cut this to \$100,000, which was approved by the House, and this is the sum named in the sundry civil appropriations bill now pending in the Senate. There is little likelihood that it will be increased by the Senators, as it is felt that without authorization for increase in personnel the commission could not spend a larger sum effectively.

Representative Esch has introduced a bill (H.R. 15,126), now before the House select committee on water power, which is intended to correct these conditions by amendment of the Federal Power Commission Act in the following particulars:

1. Authorizing employment of personnel in the District of Columbia and elsewhere.
2. Permitting transfer to the Power Commission of employees of other Government departments without regard to the rule requiring three years' service before transfer, which now prevails.
3. Authorizing use of a portion of the appropriations for printing and binding, and purchase of books and periodicals.
4. Providing for reimbursement of other departments of the Government from the appropriations of the Power Commission for work done by these departments on request of the commission.

The Power Commission gets its staff now from the War and Agricultural Departments. As these have had their appropriations cut it will be more difficult to continue the present staff next year than it has been in the past. Therefore the need for the employment of a staff directly by the Power Commission is more urgent.

There are 160 applications, representing about 13,000,000 hp., now pending before the commission. This is five times the horsepower of all the applications handled by all of the Government departments in the twenty years preceding the establishment of the Power Commission. Means for handling this tremendous amount of business are not available.

Representative John J. Esch, of Wisconsin, is chairman of the House select committee on water power, and Representative Philip P. Campbell, of Kansas, is chairman of the House Rules Committee. The assistance of the latter is necessary since a special rule advancing the Esch bill must be brought in or the bill will fail for want of time at the present session.

Edgar F. Smith to Address New York Chemists

Invitations have been issued for a joint gathering of the New York sections of the American Electrochemical Society and the American Chemical Society, and the American sections of the Society of Chemical Industry and the Société de Chimie Industrielle to hear an address by Dr. Edgar F. Smith on "Research." The meeting will be held in Rumford Hall in the Chemists' Club on the evening of Feb. 11. Dr. Smith's prominent position among electrochemists and chemists in the United States warrants a large attendance, and his familiarity with his subject insures a profitable evening to those who attend.

Patent Bill Conference Delayed

Illness on the part of Senator Norris of Nebraska has delayed the conference on the Patent Office bill. Senator Norris is chairman of the Senate Committee on Patents. The other conferees have not felt justified in considering the bill during his absence.

Nitrogen Corporation Bill Believed Dead

Some of the strongest advocates of the bill authorizing the incorporation of the U. S. Fixed Nitrogen Corporation believe the measure has no chance to become a law at this session of Congress. The disinclination of Representative Kahn, chairman of the Committee on Military Affairs, to give the bill precedence before his committee is held mainly responsible for the delay which has overtaken the measure. Mr. Kahn is unwilling to report out the bill until each side of the controversy can be presented at a public hearing before his committee. To insure House action would require the intervention in behalf of the bill by the steering committee. It is believed that this committee is opposed to any effort to rush the bill through at this session.

Mining and Metallurgical Engineers Meet in New York

The annual meeting of the American Institute of Mining and Metallurgical Engineers will be held in New York Feb. 14 to 17, at Institute headquarters, Engineering Societies Building, 29 West 39th St. Hotel reservations for members and guests will be handled by Wilber Judson, 14 Wall St. Members of the Institute of Metals division are requested to make their reservations at the Hotel Seville, Madison Ave. and 29th St. The dinner and dance will be held Wednesday evening, Feb. 16, at the Waldorf-Astoria Hotel. Applications accompanied by remittance of \$5 per cover should be sent to Donald M. Liddell, Room 332, 2 Rector St. A smoker will be held Monday evening, Feb. 14, at Institute headquarters.

The program includes technical sessions on mining and metallurgy, non-ferrous metallurgy, non-metallic minerals, iron and steel, coal, industrial relations, petroleum and gas. There will also be a discussion of a proposed research on the heat-treatment of drill steel. Industrial films will be shown on the mining of asbestos and sulphur and the welfare work of the United States Steel Corporation. Luncheon will be served daily at Institute headquarters. Appropriate entertainment has been arranged for visiting ladies.

Meeting of the Louisiana Section A.C.S.

At the Jan. 21, 1921, meeting of the Louisiana Section of the American Chemical Society Dr. Charles E. Coates spoke on the use of kieselguhr as a sugar filtration medium, declaring that the solution of the filtration problems in sugar refinery work will eliminate many of the other present-day problems of that industry.

The microscopic examination of infusorial earth for filtering purposes was thought to give more information as to its action in filtration than a chemical analysis. Hydrated silica present in this material was thought to be responsible for cloudy filtration in some cases and this can be overcome by heating the infusorial earth to a dull red heat before using. The cost of infusorial earth per ton of sugar filtered can be cut by incinerating the earth, after filtering, to a dull red heat. Thus it may be used a number of times with equally good results. The carbon remaining in the incinerated earth has a slight bleaching power.

Another paper, by Mr. Slater of Bogalusa, La., on "Fuel Economy From the Standpoint of the Chemical Engineer," pointed out that the heat value of "black ash" in the paper pulp industry is very important and plans that are being worked out utilize it and reduce fuel costs.

The following officers of the section were elected for the ensuing year: Prof. H. Mosley, president; C. L. Clay, vice-president; W. R. Stryker, secretary and treasurer; F. W. Liepsner, member executive committee; Dr. Charles E. Coates, councilor.

January Meeting of T.A.P.P.I., Connecticut Valley Branch

The twenty-fourth meeting of the Connecticut Valley Branch of the Technical Association of the Pulp and Paper Industry was held on Jan. 18 in the social rooms of the American Writing Paper Co., Holyoke, Mass. R. B. Adams of Stowe & Woodard, Newton Upper Falls, Mass., spoke on "Rubber Rolls."

Mr. Adams said that the manufacture of rubber-covered rolls was a special branch of the rubber industry. He first reviewed the properties of rubber and told how the latex is obtained from the trees and converted into the raw material that is used by the factories. Most of the rubber today comes from the plantations of the Straits Settlements. The rubber, when it arrives at the factory, is broken, washed and run out into sheets. An interesting point brought out by the speaker was that in his mill a paper mill beating engine is used for washing the rubber.

Forsythe was the first to succeed in making a rubber-covered iron roll. He found that a very hard vulcanizing rubber could be united to the iron core. A thread of fourteen to the inch is cut on the iron body and the covering is then put on. The thread is used because it gives more surface for adhesion. The rolls are then wrapped in cloth and put into a steam boiler to be vulcanized, the time taken being ten to sixteen hours and the temperature about 260 to 270 deg. F. After vulcanization the wrapper is removed and the roll is then turned. The rubber next the iron body is so hard that high-speed steel tools cannot be used for turning, and diamonds are used instead.

The diseases of rubber rolls of interest to paper makers are corrugating, which is due to the stretching of the rubber and is curable, and checking, which is the breaking of the surface and is incurable.

The iron body should be cast vertically, like cannon, should be well balanced, have vent holes at each end and should be tively free of blow holes. Rubber can be vulcanized on cast iron best of all, next steel, and not very well on brass. Light, heat and dryness are enemies of rubber, while the opposites of these are preservatives.

Development of the British-American Nickel Co.

It is well known that the most important deposits of nickel known at the present time in America are in the Sudbury region of Ontario, Canada. During the early development of this district two men, M. J. O'Brien and R. C. Booth, became joint owners of a valuable deposit of nickel ore in this region. However, they lacked the necessary means for development, and an American, J. I. Holmes by name, determined to promote the property. He sailed to England to obtain capital and succeeded in getting both English and Norwegian financial men interested. The organization of the British-American Nickel Corporation resulted. Considerable development work and diamond drilling proved a greater tonnage of ore than was expected and a reduction plant was started when the war stopped the work. Dr. F. S. Pearson, one of the main American financial backers, was lost while en route to England on the Lusitania, together with all his papers and records. This further complicated and delayed the development of the nickel company.

At that time the affiliated Norwegians were operating a plant at Christiansand, making nickel by the Hybinette electrolytic process, which was sold to Germany at a very high price. Hearing of this traffic in nickel, the British Government on investigation determined to stop it. To this end it was necessary to pay the Norwegians a sum of money equivalent to that which they would have received from Germany, and also to aid the development of their Sudbury property. The British Government therefore advanced \$3,000,000 in return for 75 per cent of the capital stock of the company. It also agreed to take the output of the proposed reduction works in refined nickel for a period of ten years, at the prevailing London price in sterling. A smelter was hurriedly erected at Nickelton, Ont., and a refinery of about 5,000 tons nickel annual capacity at Duchene, near Ottawa, but the war was ended before

the plant was completed. Nickel was not shipped until about August, 1920.

In the meantime the demand for nickel has so lessened that the supply is more than sufficient for present needs. The bigger-producers—the International Nickel Co. and the Mond Nickel Co.—can more than supply the demand and have reduced their operating capacity to about 20 per cent of what it was during the war. These conditions, together with the fall of exchange, have probably made the production of nickel by the British-American Nickel Corporation a losing proposition. This situation has brought severe criticism on the British Government for its part in the transaction, which was but recently regarded as necessary as a war measure. A lively discussion is now under way among interested parties as to the propriety of the British Government canceling the amount it put into the industry as a necessary war expenditure, and turning the property over to private interests to work out its own salvation and succeed or fail according to its own merits.

Pending Petroleum Legislation

Several bills affecting the petroleum industry have been introduced in the legislatures indicated:

California: Every corporation, etc., in California owning or operating petroleum plants, or producing, refining, buying and selling or transporting crude petroleum is declared to be a public utility and subject to regulation by the Railroad Commission under the public utilities act. (Assembly Bills 12 and 27.)

Indiana: The use of a gage indicating the gravity of gasoline shall be required at all gasoline sales stations. (Bill 69.)

All gas and oil leases shall be void after failure for five years to operate or pay rentals and the Recorder's office shall provide for cancellation records.

New York: It shall be a penal offense for promoters of oil and mining corporations knowingly to make misrepresentations in an application to any stock exchange listing shares of such corporation. To advertise present or prospective earnings, value of property, etc., the president and board of directors must file with the state Comptroller detailed sworn statements of the facts to be advertised. (Bill 38.)

U. S. Senate: Whenever the President so proclaims it shall be unlawful to export petroleum or products to any country named in the proclamation. (Bill 4866.)

Niagara Water-Power Applications

The Federal Power Commission conducted hearings in Washington Jan. 24, 25 and 26 on the Niagara River applications made under the water-power act. The proceedings were simplified greatly by a ruling by the commission that no consideration would be given or discussion entertained on proposed use of water which might be made available if the treaty with Great Britain were amended. There was no disposition on the part of the commission to interfere with the existing arrangement whereby the Niagara Falls Power Co. uses 19,500 second-feet. The only one contesting the claim of the Niagara Falls Power Co. to that diversion was the city of Buffalo. It was brought to the attention of the commission, however, that the City Commission of Buffalo is divided on the question. John W. Van Allen, representing the Buffalo Chamber of Commerce, made strenuous objection to any additional allocation of power to the electrochemical and electrometallurgical companies at Niagara Falls. His argument was that these companies use a great amount of power and have few employees. Were the same amount of power made available in Buffalo and its diversified industries employment could be given to a much larger number of persons. The members of the Federal Power Commission made it very clear that they take no stock in such reasoning.

A.C.S. Advisory Committee to Meet Soon

A meeting in Washington in the near future of the American Chemical Society's advisory committee on chemical warfare matters has been requested by General A. A. Fries, head of the Chemical Warfare Service.

Meeting of the Chicago Section of the A.C.S.

The Chicago Section of the American Chemical Society met at the City Club on the evening of Jan. 1 with an interesting program prepared by the lady members and conducted under the leadership of Dr. Ethel M. Terry. The principal speaker of the evening was Dr. Paul Nicholas Leech, chief chemist of the American Medical Association, who spoke on "Home Remedies." It has been a long time since so interesting a paper has been delivered before this section, not only from the technical point of view but in outlining the work the American Medical Association has carried on in combating the makers of patent medicines and so-called shot-gun mixtures.

It was surprising to learn that Lydia Pinkham died in 1883, that Jess Willard was enabled to defeat Jack Moran and Jack Johnson through the use of Nuxated Iron, while Jack Dempsey in turn defeated Willard because he also took the same preparation, although evidently in greater quantities. Congressman Mason from the Chicago district also found that Nuxated Iron relieved him from that horribly tired feeling which one was so apt to acquire in Washington. Dr. Leech also proved to the satisfaction of the audience that such artists as Schumann-Heink, Julia Marlowe and Harrison Fisher, while exceedingly lucky in their artistic endeavors, are not necessarily intelligent as regards the chemical content and therapeutic value of patent medicines.

Meeting of Rochester Section, A.C.S.

The Rochester Section of the American Chemical Society on Monday evening, Jan. 24, listened to a lecture by Dr. John E. Teeple, treasurer of the American Chemical Society and consulting chemist and chemical engineer of New York City.

Dr. Teeple spoke on the subject "Some Problems in Handling Brines." He stated that about 70 per cent of the potash produced in this country during the last few years was obtained from the brines found in Nebraska, Utah and California.

The oldest and largest plant in the United States is at Searles Lake, owned and operated by the American Trona Co. This very unusual lake is located in San Bernardino County not very distant from Death Valley and Funeral Ridge. Its area is equivalent to about twelve square miles and its depth is between 60 and 70 ft. The lake is fed from underneath and the composition of the brine can be said never to vary. It is estimated that there must be about 12 million tons of potassium chloride in the brine and about 40 million tons of this same material in the salts. The reason that this potash has not been recovered before is because of the difficulty of separating it from the other salts present such as sodium chloride, sodium sulphate and borax.

The brine taken from the potash plant is obtained at about 50 ft. below the surface and its temperature is practically constant winter and summer. Of the numerous salts present in this brine only the potassium chloride and borax are valuable enough to be shipped, the freight on the sodium chloride and sodium sulphate being more than they are worth. The brine contains nearly 4.5 per cent of potassium chloride and about 65 per cent water. Various schemes for evaporating or getting rid of this large amount of water have been tried. At present triple effect vacuum pans are being used because they were in the original installation.

The most difficult chemical problem in handling this brine was to get rid of the sodium sulphate so that the potassium chloride would be left free. This was finally done by forming a double salt consisting of sodium chloride and sodium sulphate. The brine now contained borax with the potassium chloride, but this difficulty was overcome by cooling the brine rapidly so that the potassium chloride would be immediately precipitated and then the mother liquor poured off would later precipitate the borax. This method gives extremely pure borax and potassium chloride, the former ranging 99 per cent and the latter 92-99 per cent.

Another difficulty experienced was foaming in the vacuum pans during evaporation. It was finally thought to be due to organic matter in spite of the apparent lack of vegetation and animal life in this vicinity. So a study of the watershed

was made. The trouble was finally traced to minute quantities of an organic substance coming from the creosote bush which grows in that region. Certain alcohols and sulphonic acids will prevent the foaming. The efficiency of the plant is not at its highest, but work is constantly going on to improve it. The greatest costs are freight and fuel. If co-operation can be obtained from the oil producers and railroads, a large portion of the country's needs of potash can be supplied without even the protection of a tariff. It seems that this industry should be protected, however, for a few years hence Germany in her urgent need for money and goods will be sorely tempted to convert some of her supplies of potash into cash. Should this protection last about three years, it would enable most of the investigations and development work under way to be finished and thus the country would be on a firm foundation to produce a considerable quantity of its own. Should production drop off there would be little incentive to keep spending money on the problems confronting this youthful industry. The average consumption based on last year's prices is about \$60,000,000 and based on pre-war prices it would be about \$20,000,000. It would seem either figure would justify the encouragement of the growth of the potash industry in this country.

American Engineering Council Opens Office in Washington

The transfer of the activities of Engineering Council and Engineering Societies Service (Employment) Bureau was made on Jan. 1 to American Engineering Council. An office has been opened by American Engineering Council in the McLachlan Building, 10th and G Sts., Washington, D. C., with A. C. Oliphant as acting assistant secretary in charge. This office is available for the member societies of Engineering Council.

Engineering Societies Service Bureau is being maintained in the Engineering Societies Building, 29 W. 39th St., New York City, with Walter V. Brown in charge. Pending the development of a more permanent organization which may direct this very important activity of American Engineering Council, the secretaries of the American Institute of Mining and Metallurgical Engineers, the American Society of Mechanical Engineers and the American Institute of Electrical Engineers have been requested to act as a committee on management to conduct the Service Bureau until a permanent organization under American Engineering Council can be effected.

American Engineering Council to Meet in Syracuse

American Engineering Council will hold a two-day meeting in Syracuse, N. Y., Feb. 14 and 15. It is expected that Mr. Hoover will outline the new Council's plans for dealing with industrial relations, and particularly with unemployment. L. W. Wallace, who is assuming the duties of the Council's new committee on elimination of waste in industry, will discuss the subject of how to get America's idle men back to work and keep them at work. The Syracuse meeting will mark the beginning of a movement to organize engineers on a territorial basis, through the formation of State Engineering Councils under American Engineering Council.

Lower Silver Content in English Token Coins

During the high level of silver prices the bullion content of silver coins was worth more than their face value. Great quantities were melted and refined for export to the Orient both in Great Britain and the United States. New coins 0.500 instead of 0.925 fine are being introduced in England and the old silver pieces will be gradually withdrawn from circulation.

Dye Bill Compromise Rumored

A compromise has been effected between the friends and opponents of the dyestuffs bill, according to a rumor in circulation in Washington last week. Senator Curtis, the majority whip, expressed the opinion that the compromise has come too late to make possible the passage of the bill at this session.

Senate Resolution Asks for Fertilizer Report

Senator Fletcher of Florida has introduced a resolution calling upon the Department of Agriculture to advise as to "the amount of commercial potash, nitrogen and phosphoric acid available for fertilizer purposes, and the price of each of these articles, as compared with the prices for 1913." The resolution also asks for suggestions for relieving the situation in case the amount of any of these materials is insufficient or the price prohibitive. Senator Fletcher is anxious to have the department make a report similar to the one issued by it in 1916.

Book Reviews

CHEMISTRY AND CIVILIZATION. By *Allerton S. Cushman*, director, Institute of Industrial Research, Inc., Washington, D. C. 148 pages and index; illustrated. Boston: Richard G. Badger, 1920. Price \$2.50.

For the "tired business man" whose idea of chemistry is the study of substances which smell like asafetida and which probably explode if you look at them, this very entertaining book will prove both interesting and a revelation. The historical prologue and the short biographical sketches interspersed throughout the text add a most interesting touch to Dr. Cushman's story of the development of the science of chemistry and the marvelous achievements which it has made possible.

Nitrogen fixation, the Brownian movement, colloids and dispersoids, are all explained so that he who runs may read, but the author with a nice sense of values has given the reader only so much of the purely scientific side as is necessary to explain the commercial possibilities and accomplishments of chemical engineering. Alloy steels, dyes, explosives, artificial leather and many other products of everyday interest are bereft of their mystery and explained in the simplest possible language.

It is certain that after reading the book a millionaire clothing manufacturer or embryo bank president will bemoan the shortsightedness of his parents and wish that he had had the opportunity to study for a Ch.E. degree. If someone could place 10,000 of these books in the hands of as many college men studying for an A.B. degree there is no doubt that a big switch in courses would immediately take place.

IRVING FELLNER.

Personal

ROSCOE BRUNNER, chairman of Brunner, Mond & Co., Ltd. (England), has been appointed a director of the Allied Chemical & Dye Corp., New York.

FRANK K. CAMERON, who has been in charge of the development of chemical enterprises at the Western plants of the American Smelting & Refining Co., has severed his relations with that organization and has resumed practice as a consulting chemist and chemical engineer. He will retain an office in Salt Lake City as well as in New York.

MILO R. DAUGHTERS, chief chemist in charge of the research laboratory of the Dominion Cannery, Ltd., Brighton, Ont., delivered an address at the National Cannery Convention in Atlantic City, Jan. 20.

SIR ROBERT HADFIELD, inventor of manganese steel and leader of the British steel industry, has been awarded the John Fritz gold medal for notable scientific and industrial achievement.

Prof. A. S. LOEVENHART of the University of Wisconsin, who is now serving also as one of the consulting chemists of Chemical Warfare Service, is spending some time in Washington assisting in the physiological chemical research work of this service.

Dr. FILBERT ROTH, professor of forestry of the University of Wisconsin, spoke before the Detroit Engineers' Society, Friday evening, Jan. 21, on the forestry situation in the United States.

W. G. SWART, vice-president and general manager of the Mesabi Iron Co., Babbitt, Minn., was in New York last week on a business trip.

ALBERT M. WOLF, who for the past ten years has been associated with Condron Co., engineer, of Chicago, engaged in the design and supervision of construction of bridges and industrial buildings of all kinds, and **LAWRENCE M. HARPER**, who has been engaged in mechanical and structural work with the same company, have associated under the firm name of Wolf & Harper, engineers, to conduct a general engineering business, with offices at Room 1508, 7 West Madison St., Chicago. The new firm will specialize in the complete design of commercial and industrial buildings and structures, power plants, the valuation and appraisal of properties and the preparation of engineering reports.

Obituary

HERMAN GARLICH, a notable metallurgical engineer, died on Jan. 8 at his home in Brooklyn, N. Y., at the age of sixty-one.

ERNEST P. MAYER of Beaver Falls, Pa., died recently. Mr. Mayer was at the head of the Mayer China Co. and a pioneer member of the American Ceramic Society, having served as president of the society at Cleveland in 1902.

WILLIAM T. SEDGWICK of the Massachusetts Institute of Technology, an authority on biology and sanitation and for a time president of the American Health Association, dropped dead on the evening of Jan. 25 as he entered his home at 282 Berkley St., Boston, Mass., on returning from a conference at the Women's City Club. He had been a member of the faculty since 1883 and was the fourth prominent technology official to die suddenly in office, the others being three presidents, MacLaurie, Walker and Rogers. Prof. Sedgwick was born at West Hartford, Conn., in 1855, was graduated from Sheffield Scientific School in 1877, and taught for five years at Johns Hopkins.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Jan. 31, 1921.

Local trading in chemicals did not involve very large dimensions during the past week. The movement was irregular and presented chiefly small transactions for actual wants. Consuming demand was reported quiet in most directions. The only outstanding feature of the market was the pronounced advance in foreign exchange. This had a tendency to stiffen prices on some of the imported chemicals.

Quiet absorption of resale *caustic soda* took place at prices ranging from \$3.90@4 per 100 lb. Large dealers were very firm in their views at the outside figure. It is believed that second-hand stocks are not very large and that a few large orders would clear the shelves of all available spot supplies. Leading manufacturers are booking business with the consuming trade on contract at \$3.60 per 100 lb. f.o.b. works, basis 60 per cent. Moderate inquiries for export also reached the market. Small lots of *bichromate of soda* brought 8½c. a lb. and the market was reported quite steady at this level. Inquiries, while only of a small nature, reached the market in a somewhat freer volume. February shipments were held firm at prices ranging from 10@12c. per lb. Miscellaneous inquiries reached the market for *soda ash* and the tendency of prices appeared quite steady. Resale offerings were very light and

those who did offer any material were firm at \$2.10@2.25 per 100 lb. Odd lots in barrels were quoted from \$2.25@2.30. Producers have placed business for domestic consumption at \$1.72½ per 100 lb., basis 48 per cent f.o.b. works for single bags in carload lots for prompt and future shipments. The market in general showed a strong tendency to remain firm at this level.

Trading in *yellow prussiate of soda* was reported at 16½@17c. per lb. Some sellers continued to refuse any offers under 17½c. The market remained quite steady at the outside figure and there seemed to be a fair amount of inquiries on the market for prompt shipment. Concentrated *sodium sulphide*, 60-62 per cent, is obtainable at 3@5½c. per lb. Large resale offerings continued to reach the market in heavy volume through second hands, and these were sufficient to keep dealers' quotations considerably under those named by manufacturers. Iron free *alumina sulphate* is selling in the open market at prices ranging from 3@3½c. per lb. The commercial variety is quiet at 2¼@2½c. per lb. The demand for this commodity has not shown any activity of late and this has resulted in a lowering of prices in some directions in order to stimulate new business.

Producers continued to name 10c. per lb. for *chlorate of soda* f.o.b. works and reported the demand quiet. Moderate quantities of resale stocks are on the market and it is believed that firm business could meet lower figures. The principal movement at present is confined mostly to contract deliveries. Sales of second-hand stocks of *bleaching powder* in large drums were reported at 2½c. per lb. f.o.b. works for prompt shipment. Dealers stated that it was doubtful if much prime material could be purchased under 3c. per lb. on spot. Small drums were quoted from 2¾@3c. f.a.s., according to seller. Producers are holding the market at 3½c. per lb. works. Spot prices on *nitrite of soda* ranged from 6@7c. per lb., but in most quarters 6½c. was given as the regular market figure. It is reported that transactions involving a better tonnage were becoming somewhat freer and buyers were taking more interest than noted earlier in the month.

COAL-TAR PRODUCTS

The coal-tar products market showed an increased underlying strength throughout the week. Stocks seem to be in stronger hands and not only producers but dealers are firmer in their views on prices. There was a better inquiry and some improvement in the volume of sales, although it could not be said that holders were pushing business. Leading factors are viewing the market largely from a conservative standpoint and are waiting for the demand that is due to appear shortly. Textile mills in various sections reported better business in staple goods and a resumption in operation of from four to six days per week has been noticed.

Prices of *benzoic acid* were quoted around 70@75c. per lb. Business has been of a very narrow scope, with few inquiries resulting in actual sales. Some variation exists between makers of *H acid* as to price. In one quarter as low as \$1.25 per lb. was heard, while others quoted \$1.50 as the minimum figure. The demand has been very limited of late and since business has not been actually consummated it is impossible to determine any standard market figure. Quotations on *aniline oil* remained at former levels with producers still at wide variance as to price. Offerings were heard from 22@28c. per lb., according to sellers. A somewhat better inquiry has been noted during the week, but this has resulted in little actual business. Some trading in *aniline salt* was done during the week at prices around 27@29c. per lb. Large orders could probably be filled somewhat below these figures.

Benzidine base was held on a fairly steady basis at \$1@1.10 per lb. The sulphate variety remained firm at 80@90c. per lb. It is probable that actual business would bring out concessions under these prices. One of the most distressing features of the market was the sharp break in technical *beta naphthol*. Dealers reported moderate quantities available at 30c. per lb., with no response from domestic channels. The figure represented a reduction of 10c. per lb. and also the lowest price in recent years. Prices on

dimethylaniline ranged from 55@65c. per lb. The inside figure is being done by second hands and it is believed that manufacturers would be willing to meet it on a sufficiently large business. Tightening of spot stocks of *phenol* has forced prices up to 10c. per lb. in the open market. Although business has been of a very limited nature the lack of any large stocks with which to meet the demand has emphasized the effect of the light buying movement recently noted in the market.

WAXES

With primary markets holding steady and exchange rates generally firm, prices for *beeswax* were well maintained. A fair inquiry was noted in some directions for African crude and at the close of the week sellers' views ranged from 18@19c. per lb. On the refined grade prices held at 27@28c. With no apparent changes in figures at primary centers the market on *Carnauba wax* was quite steady. No. 3 North Country was available at 19@20c. per lb. with the chalky grade at 20@21c. The inquiry was along routine lines only. Offerings of Japan wax on the spot market were limited and the prices were maintained at 19@20c. per lb. Shipment quotations were firm at 17½c. per lb. With the market for crude oil easier and the demand for *paraffine wax* showing little improvement prices remained barely steady. Offerings of *scale wax* were fairly liberal and selling pressure was noted in some quarters. For the 124-126 crude there were offerings at 4½c. per lb., with intimations that slightly lower bids would be accepted. *Refined wax*, 133-135, was quotably unchanged at 9¼c. per lb.

The Baltimore Market

BALTIMORE, Jan. 28, 1921.

While the local market on fertilizer raw materials has not regained its normal activity some signs of life in the trade are to be noted. This is taking the form of numerous inquiries from out-of-town manufacturers and mixers for various kinds of materials. It is doubtful if active trading will be resumed for several weeks, although this depends upon the rapidity of shipments of mixed goods to the farmers. Local manufacturers have reported a movement of some goods during the past week.

It is generally felt that prices on many raw materials have reached their lowest levels, and as a consequence some manufacturers are beginning to anticipate requirements by taking advantage of the most attractive offerings.

The local situation is far from being normal, but a generally optimistic view of the future prevails in this market.

Acid Phosphate—Sales have been reported this week at \$15.50 per ton, basis 16 per cent A.P.A., bulk, run of pile. This price may be given as the nominal quotation, although distressed lots might be secured at a shade less.

Nitrate of Soda—Importers of this commodity are not actively quoting at this time and their attitude toward the market is bullish. There are a number of resale lots still available at prices around \$2.75 per 100 lb. ex-vessel or ex-store Atlantic ports.

Sulphate of Ammonia—The market remains unchanged on this commodity. It has been reported that contracts are being booked at \$3.75 per 100 lb., which was the price quoted in the last letter.

Potash—There has been rather active trading in foreign potash during the past two weeks, the majority of the sales made being at the following prices: \$1.50@1.60 per unit for muriate of potash; kainit and manure salts at \$1.40 per unit, all ex-vessel or ex-store Atlantic ports, foreign analysis and domestic weights. The nominal quotations are about 10c. per unit higher than sale prices given above. Nebraska potash continues to be held at a slight premium over the foreign goods.

Fish Scrap—Machine dried unground menhaden fish scrap may be had on this market today at \$3.50 per unit of ammonia and 10c. per unit B.P.L., ex-schooner Baltimore, in buyers' bags. Very little scrap is being absorbed at this price, because other organic ammoniates may be had at a somewhat lower figure.

The Iron and Steel Market

PITTSBURGH, Pa., Jan. 28, 1921.

In the actual condition of the iron and steel market no important change has occurred in the past week, and in the circumstances no important change could well occur. The market is practically stagnant, and is awaiting a completion of the readjustment through which business and industry generally are passing. Undoubtedly progress is being made in the general readjustment, but a long course is involved and many men who must contribute their part are tending to hang back.

OPERATIONS

Several independents whose plants have been idle for short periods have accumulated a little business and are resuming operations. At the moment the rate of independent steel production is increasing, but only to perhaps 30 per cent of capacity, and a trend in the other direction will doubtless follow.

The United States Steel Corporation, which has been operating at higher than 90 per cent for a couple of months and at a better rate than at any time between March and October, is probably now on the verge of a distinct decrease in operation, not because it has not a large volume of business on books but because its customers find they do not need material at as heavy a rate as was expected when orders were placed. Indeed, most of the business had been booked "for shipment at mill convenience," while now the buyer's convenience must also be consulted. However, only last Tuesday the Carnegie Steel Co. blew in an additional blast furnace, one of the Carrie group that had just been relined, making forty-eight Carnegie stacks in operation. Restriction in Steel Corporation operations has already begun in the Chicago district, and there is a slight decrease in the corporation's sheet mill operations, though more than 90 per cent of its sheet mills are still going.

PRICES

It is in line with all precedents that when the steel market is quiet there should be reports of price cutting, and in the past the outcome has usually shown that the reports exaggerated the conditions. The spreading of the reports is largely a psychological phenomenon. In the main prices are being held, but that means hardly anything, for there is little incentive to cut prices, so little competitive business being offered. On the other hand price cutting, even if extensive, would mean hardly anything, certainly nothing as to the eventual course of the steel market or the final level of prices. The main result of price cutting at this time would be to cause the Steel Corporation to lower its prices, readjusting prices on the large amount of business it has on books. Buying would not be stimulated to any extent, for the next real buying movement is going to be predicated upon steel prices much lower than can be named now, because costs have not yet been shaken down to the minimum possible.

The finished steel market as a whole can be quoted steady if not firm at the Industrial Board prices, as follows: Bars, 2.35c.; shapes, 2.45c.; plates, 2.65c.; hoops, 3.05c.; pipe, 57½ per cent basing discount; wire, 3.25c.; nails, \$3.25; blue annealed sheets, 3.55c.; black sheets, 4.35c.; galvanized sheets, 5.70c.; tin plate, \$7.

PIG IRON

Some offerings of foundry pig iron show that this grade can be bought from furnace at \$30 valley, against \$31.50 previously regarded as the quotable market. Bessemer and basic remain quotable at \$32 and \$30 respectively, with no inquiry whatever. No doubt lower prices could be done on a firm bid for a round tonnage. Possibly never in the history of the market has it been so stagnant or devoid of definite indication where actual values stand. A suggestion as to the uncertainty in pig iron generally is furnished by the fact that while Southern pig iron had been quoted rather generally as being at \$32 Birmingham, the Standard Sanitary Manufacturing Co. on an inquiry for 2,000 tons for first quarter delivery to its Louisville plant was able to do \$27.50 Birmingham.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	—	\$0.55 - \$0.60
Acetone.....lb.	\$0.13 - \$0.13½	.13½ - .14
Acid, acetic, 28 per cent.....100 lbs.	3.00 - 3.25	3.50 - 3.75
Acetic, 56 per cent.....100 lbs.	6.00 - 6.25	6.50 - 6.75
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.50 - 11.00	11.25 - 11.50
Boric, crystals.....lb.	.14½ - .15	.15½ - .16
Boric, powder.....lb.	.15½ - .16½	.17 - .18
Citric.....lb.	—	.46 - .48
Hydrochloric.....100 lb.	1.60 - 1.75	1.85 - 2.25
Hydrofluoric, 52 per cent.....lb.	.15 - .16	.16½ - .18
Lactic, 44 per cent tech.....lb.	.10 - .11	.11½ - .12
Lactic, 22 per cent tech.....lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.	—	—
Nitric, 40 deg.....lb.	.07 - .07½	.08 - .08½
Nitric, 42 deg.....lb.	.08½ - .09	.09½ - .10
Oxalic, crystals.....lb.	.18½ - .18½	.19 - .20
Phosphoric, Ortho, 50 per cent solution.....lb.	.18 - .18½	.18½ - .19
Picric.....lb.	.30 - .32	.35 - .40
Pyrogallol, resublimed.....lb.	—	2.30 - 2.40
Sulphuric, 60 deg., tank cars.....ton	—	—
Sulphuric, 60 deg., drums.....ton	—	14.00 - 15.00
Sulphuric, 66 deg., tank cars.....ton	18.00 - 19.00	—
Sulphuric, 66 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 - 24.00	—
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 - 35.00	40.00 - —
Tannic, U. S. P.....lb.	—	1.15 - 1.25
Tannic (tech.).....lb.	.45 - .47	.48 - .50
Tartaric, crys tals.....lb.	—	.33 - .35
Tungstic, per lb. of WO.....lb.	—	1.20 - 1.40
Alcohol, Ethyl.....gal.	—	5.10 - 5.50
Alcohol, Methyl (see methanol).....gal.	—	—
Alcohol, denatur ed, 188 proof.....gal.	—	.66 - .70
Alcohol, denatur ed, 190 proof.....gal.	—	.71 - .75
Alum, ammonia lump.....lb.	.04½ - .04½	.05 - .05½
Alum, potash lump.....lb.	.05½ - .06	.06½ - .07
Alum, chrome lump.....lb.	.13 - .13½	.14 - .14½
Aluminum sulphate, commercial.....lb.	.02½ - .02½	.02½ - .03
Aluminum sulphate, iron free.....lb.	.03 - .03½	.03½ - .03½
Aqua amm onia, 26 deg., drums (750 lb.).....lb.	.06½ - .07	.07½ - .08½
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 - .32	.33 - .35
Ammonium carbonate, powder.....lb.	.11½ - .11½	.12 - .12½
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	.08½ - .09	.09½ - .09½
Ammonium chloride, granular (gray salamoniac).....lb.	.08½ - .08½	.09 - .09½
Ammonium nitrate.....lb.	.09 - .09½	.10 - .10½
Ammonium sulphate.....100 lb.	3.30 - 3.40	3.50 - 3.75
Amylacetate.....gal.	—	4.25 - 4.50
Amylacetate tech.....gal.	—	3.50 - 3.75
Arsenic oxide, (white arsenic).....lb.	.10 - .10½	.10½ - .11
Arsenic, sulphide, powdered (red arsenic).....lb.	.15 - .15½	.15½ - .16
Barium chloride.....ton	65.00 - 70.00	75.00 - 80.00
Barium dioxide (peroxide).....lb.	.24 - .25	.26 - .27
Barium nitrate.....lb.	.10 - .10½	.10½ - .11
Barium sulphate (precip.) (blanc fixe).....lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calc. hypochlorite).....lb.	—	—
Blue vitriol (see copper sulphate).....lb.	—	—
Borax (see sodium borate).....lb.	—	—
Brimstone (see sulphur, roll).....lb.	—	—
Bromine.....lb.	.50 - .52	.54 - .56
Calcium acetate.....100 lbs.	2.00 - 2.05	—
Calcium carbide.....lb.	.04 - .04½	.04 - .05
Calcium chloride, fused, lump.....ton	27.00 - 29.00	30.00 - 32.00
Calcium chloride, granulated.....lb.	.01½ - .02	.02½ - .02½
Calcium hypochlorite (bleach'g powder).....lb.	.02½ - .02½	.03 - .03½
Calcium peroxide.....lb.	—	1.25 - 1.30
Calcium phosphate, monobasic.....lb.	—	.16 - .18
Camphor.....lb.	—	.85 - .90
Carbon bisulphide.....lb.	.08 - .08½	.09 - .09½
Carbon tetrachloride, drums.....lb.	.11 - .11½	.11½ - .12
Carbonyl chloride (phosgene).....lb.	—	.60 - .75
Caustic potash (see potassium hydroxide).....lb.	—	—
Caustic soda (see sodium hydroxide).....lb.	—	—
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.09 - .09½	.10 - .10½
Chloroform.....lb.	—	.43 - .50
Cobalt oxide.....lb.	—	3.70 - 3.80
Copper as (see iron sulphate).....lb.	—	—
Copper carbonate, green precipitate.....lb.	.22 - .22½	.24 - .25
Copper cyanide.....lb.	—	.50 - .60
Copper sulphate, crystals.....lb.	.06 - .06½	.06½ - .07
Cream of tartar (see potassium bitartrate).....lb.	—	—
Epsom salt (see magnesium sulphate).....lb.	—	—
Ethyl Acetate Com. 85%.....gal.	—	1.05 - 1.10
Ethyl Acetate pure (acetic ether 98% to 100%).....gal.	—	—
Formaldehyde, 40 per cent.....lb.	.18 - .18½	.18½ - .19
Fusel oil, ref.....gal.	—	3.50 - 3.60
Fusel oil, crude.....gal.	—	2.75 - 3.00
Glauber's salt (see sodium sulphate).....lb.	—	—
Glycerine, C. P. drums extra.....lb.	—	.20 - .21
Iodine, resublimed.....lb.	—	3.85 - 4.00
Iron oxide, red.....lb.	—	.10 - .20
Iron sulphate (copperas).....100 lb.	1.50 - 1.75	2.00 - 2.50
Lead acetate, normal.....lb.	—	.14 - .16
Lead arsenate (paste).....lb.	.11 - .12	.12½ - .13
Lead nitrate.....lb.	—	.15 - .20
Litharge.....lb.	.09 - .09½	.09½ - .10
Lithium carbonate.....lb.	—	1.50 - —
Magnesium carbonate, technical.....lb.	.10 - .11	.11½ - .12
Magnesium sulphate, U. S. P.....100 lb.	2.50 - 3.00	—
Magnesium sulphate, commercial.....100 lb.	—	1.50 - 1.75
Methanol, 95%.....gal.	—	1.30 - 1.40
Methanol, pure.....gal.	—	1.50 - 1.70
Nickel salt, double.....lb.	—	.12 - .12½
Nickel salt, single.....lb.	—	.13 - .13½
Phosgene (see carbonyl chloride).....lb.	—	—
Phosphorus, red.....lb.	.45 - .46	.47 - .50
Phosphorus, yellow.....lb.	—	.35 - .37
Potassium bichromate.....lb.	.14½ - .14½	.15 - .15½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	\$	\$0.33 - \$0.35
Potassium bromide, granular	lb.		.25 - .40
Potassium carbonate, U. S. P.	lb.	.35 - .40	.45 - .50
Potassium carbonate, crude	lb.	.11 - .11½	.11½ - .12
Potassium chlorate, crystals	lb.	.08 - .10	.11 - .18
Potassium cyanide	lb.		.65 - .70
Potassium hydroxide (caustic potash)	lb.	.14 - .14½	.15 - .16
Potassium muriate	ton	75.00 - 80.00	
Potassium iodide	lb.		3.00 - 3.20
Potassium nitrate	lb.	.11½ - .12	.12½ - .13
Potassium permanganate	lb.	.48 - .50	.52 - .60
Potassium prussiate, red	lb.	.50 - .52	.53 - .55
Potassium prussiate, yellow	lb.	.31 - .31½	.32 - .33
Potassium sulphate (powdered)	ton	\$200.00 - 225.00	
Rochelle salts (see sodium potas tartrate)			
Sal ammoniac (see ammonium chloride)			
Salt soda (see sodium carbonate)			
Salt cake	ton		33.00 - 35.00
Silver cyanide	oz.		1.25 - . . .
Silver nitrate	oz.		.44 - .45
Soda ash, light	100 lb.	2.15 - 2.20	2.30 - 2.60
Soda ash, dense	100 lb.	2.60 - 2.75	3.00 - 3.25
Sodium acetate	lb.	.05½ - .05¾	.06 - .06½
Sodium bicarbonate	100 lb.	2.50 - 2.75	3.00 - 3.25
Sodium bichromate	lb.	.08½ - .09	.09½ - .09¾
Sodium bisulphate (nitre cake)	ton	7.00 - 7.50	8.00 - 11.00
Sodium bisulphite powdered, U.S.P.	lb.	.06½ - .07	.07½ - .08
Sodium borate (borax)	lb.	.07 - .07½	.07¾ - .08
Sodium carbonate (sal soda)	100 lb.	2.00 - 2.25	2.50 - 2.75
Sodium chl rate	lb.	.10 - .10½	.10¾ - .11
Sodium cyanide, 96-98 per cent	lb.	.21 - .23	.24 - .30
Sodium fluoride	lb.	.16 - .16½	.17 - .17½
Sodium hydroxide (caustic soda)	100 lb.	3.90 - 4.00	4.10 - 4.60
Sodium hyposulphite	lb.		.03½ - .04
Sodium nitrate	100 lb.	2.85 - . . .	3.00 - . . .
Sodium nitrite	lb.	.06 - .06¼	.06½ - .07
Sodium peroxide, powdered	lb.	.30 - .31	.32 - .34
Sodium phosphate, dibasic	lb.	.03½ - .04½	.04¾ - .05
Sodium potassium tartrate (Rochelle salts)	lb.		.31 - .32
Sodium prussiate, yellow	lb.	.16½ - .17	.17½ - .17¾
Sodium silicate, solution (40 deg.)	lb.	.01½ - .01¾	.02 - .02¼
Sodium silicate, solution (60 deg.)	lb.	.03 - .03¼	.03½ - .04
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.75 - 2.00		2.25 - 2.50
Sodium sulphide, crystal, 60-62 per cent (conc.) lb.	.05 - .05½		.05¾ - .06
Sodium sulphite, crystals	lb.	.04 - .04¼	.04½ - .05
Strontium nitrate, powdered	lb.	.20 - .20½	.21 - .22
Sulphur chl ride, red	lb.	.08 - .09	.10 - .10½
Sulphur, crude	ton	16.00 - 20.00	
Sulphur dioxide, liquid, cylinders	lb.	.09 - . . .	.10 - .12
Sulphur (sublimed), flour	100 lb.		3.70 - 4.35
Sulphur, roll (brimstone)	100 lb.		3.40 - 3.90
Tin bichloride, 50 per cent	lb.	.18 - .19	
Tin oxide	lb.		.48 - .50
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran	lb.	.11½ - .12	.12½ - .13
Zinc cyaride	lb.	.45 - .49	.50 - .60
Zinc dust	lb.	.12 - .13	.13½ - .14
Zinc oxide, XX	lb.	.08½ - .09	.09¾ - .11
Zinc sulphate	lb.	.03½ - .03¾	.04 - .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	\$1.10 - \$1.15
Alpha-naphthol, refined	lb.	1.45 - 1.50
Alpha-naphthylamine	lb.	.38 - .40
Aniline oil, drums extra	lb.	.22 - .28
Aniline salts	lb.	.27 - .30
Anthracene, 80% in drums (100 lb.)	lb.	.85 - 1.00
Benzaldehyde (f.f.c.)	lb.	2.00 - 2.10
Benzidine, base	lb.	1.00 - 1.10
Benzidine sulphate	lb.	.80 - .90
Benzoic acid, U.S.P.	lb.	.70 - .75
Benzoate of soda, U.S.P.	lb.	.75 - .85
Benzene, pure, water-white, in drums (100 gal.)	gal.	.30 - .35
Benzene, 90%, in drums (100 gal.)	gal.	.28 - .32
Benzyl chloride, 95-97%, refined	lb.	.30 - .35
Benzyl chloride, tech.	lb.	.25 - .30
Beta-naphthol benzoate	lb.	3.50 - 4.00
Beta-naphthol, sublimed	lb.	.75 - .80
Beta-naphthol, tech	lb.	.30 - .35
Beta-naphthylamine, sublimed	lb.	2.25 - 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 - .18
Ortho-cresol, in drums (100 lb.)	lb.	.23 - .25
Cresylic acid, 97-99%, straw color, in drums	gal.	.95 - 1.00
Cresylic acid, 95-97%, dark, in drums	gal.	.90 - .95
Cresylic acid, 50%, first quality, drums	gal.	.65 - .75
Dichlorbenzene	lb.	.06 - .09
Diethylaniline	lb.	1.25 - 1.30
Dimethylaniline	lb.	.55 - .65
Dinitrobenzene	lb.	.30 - .32
Dinitrochlorbenzene	lb.	.25 - .30
Dinitronaphthalene	lb.	.33 - .35
Dinitrophenol	lb.	.40 - .45
Dinitrotoluene	lb.	.25 - .30
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 - .40
Diphenylamine	lb.	.60 - .70
H-acid	lb.	1.30 - 1.50
Meta-phenylenediamine	lb.	1.25 - 1.30
Monochlorbenzene	lb.	.14 - .16
Monoethylaniline	lb.	1.75 - 2.25
Naphthalene crushed, in bbls. (250 lb.)	lb.	.08 - .08½
Naphthalene, flake	lb.	.08 - .08½
Naphthalene, balls	lb.	.09 - .09½
Naphthionic acid, crude	lb.	.70 - .75
Nitrobenzene	lb.	.12 - .15
Nitro-naphthalene	lb.	.35 - .40
Nitro-toluene	lb.	.18 - .25
Ortho-amidophenol	lb.	3.20 - 3.75
Ortho-dichlor-benzene	lb.	.15 - .20
Ortho-nitro-phenol	lb.	.75 - .80
Ortho-nitro-toluene	lb.	.20 - .28
Ortho-toluidine	lb.	.25 - .30
Para-amidophenol, base	lb.	1.90 - 2.00
Para-amidophenol, HCl	lb.	2.10 - 2.20

Para-dichlorbenzene	lb.	.15 - .25
Paranitroaniline	lb.	.90 - .95
Para-nitrotoluene	lb.	.95 - 1.10
Para-phenylenediamine	lb.	1.80 - 2.20
Para-toluidine	lb.	1.30 - 1.60
Phthalic anhydride	lb.	.55 - .60
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.10 - .12
Pyridine	gal.	2.00 - 3.50
Resorcinol, technical	lb.	2.00 - 2.25
Resorcinol, pure	lb.	3.60 - 3.80
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.25 - .28
Salicylic acid, U. S. P.	lb.	.29 - .35
Salol	lb.	.85 - .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.28 - .32
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.16 - .18
Sulphanilic acid, crude	lb.	.30 - .35
Tolidine	lb.	1.40 - 1.60
Toluidine, mixed	lb.	.40 - .45
Toluene, in tank cars	gal.	.30 - .32
Toluene, in drums	gal.	.33 - .35
Xylidines, drums, 100 gal.	lb.	.45 - .50
Xylene, pure, in drums	gal.	.42 - .45
Xylene, pure, in tank cars	gal.	.45 - . . .
Xylene, commercial, in drums, 100 gal.	gal.	.33 - .35
Xylene, commercial, in tank cars	gal.	.30 - . . .

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	\$0.24 - \$0.26
Beeswax, refined, light	lb.	.27 - .28
Beeswax, white pure	lb.	.40 - .45
Carnauba, No. 1	lb.	.75 - .80
Carnauba, No. 2, North Country	lb.	.35 - .40
Carnauba, No. 3, North Country	lb.	.19 - .20
Japan	lb.	.19 - .20
Montan, crude	lb.	.07 - .08
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.05 - .05½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.04½ - .05½
Paraffine waxes, refined, 118-120 m.p.	lb.	.06½ - .06¾
Paraffine waxes, refined, 125 m.p.	lb.	.07½ - .07¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.07¾ - .08
Paraffine waxes, refined, 133-135 m.p.	lb.	.09½ - .09¾
Paraffine waxes, refined, 135-137 m.p.	lb.	.10 - .11
Stearic acid, single pressed	lb.	.13½ - .13¾
Stearic acid, double pressed	lb.	.13¾ - .14
Stearic acid, triple pressed	lb.	.14¼ - .14½

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940	gal.	\$1.70
Pine oil, pure, dest. dist.	gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75
Pine tar, ref., thin, sp.gr. 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr. 0.900-0.970	gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990	gal.	.37
Pine wood creosote, ref.	gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl.	280 lb.	\$8.75 - . . .
Rosin E-I	280 lb.	8.75 - . . .
Rosin K-N	280 lb.	8.75 - . . .
Rosin W. G.-W. W.	280 lb.	9.00 - . . .
Wood rosin, bbl.	280 lb.	9.00 - . . .
Spirits of turpentine	gal.	.72 - . . .
Wood turpentine steam dist.	gal.	.68 - . . .
Wood turpentine, dest. dist.	gal.	.67 - . . .
Pine tar pitch, bbl.	200 lb.	. . . - 8.50
Tar, kiln burned, bbl. (500 lb.)	bbl.	. . . - 15.00
Retort tar, bbl.	500 lb.	15.00 - 15.50
Rosin oil, first run	gal.	.52 - . . .
Rosin oil, second run	gal.	.54 - . . .
Rosin oil, third run	gal.	.62 - . . .

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	\$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para-Upriver fine	lb.	\$0.18½ - \$0.19
Upriver coarse	lb.	.14 - .14½
Upriver caucho ball	lb.	.14½ - .14¾
Plantation—First latex crepe	lb.	.20 - . . .
Ribbed smoked sheets	lb.	.19½ - . . .
Brown crepe, thin, clean	lb.	.18 - . . .
Amber crepe No. 1	lb.	.20 - . . .

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	\$0.09½ - \$0.10
Castor oil, AA, in bbls.	lb.	.11 - .11½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.08½ - .08¾
Cocanut oil, Ceylon grade, in bbls.	lb.	.12½ - .13
Cocanut oil, Cochin grade, in bbls.	lb.	.12½ - .13
Cor oil, crude, in bbls.	lb.	.08½ - .09
Cottonseed oil, crude (f. o. b. mill)	lb.	.06 - .06½
Cottonseed oil, summer yellow	lb.	.08½ - .09
Cottonseed oil, winter yellow	lb.	.09 - .09½
Linseed oil, raw, car lots (domestic)	gal.	.73 - .74
Linseed oil, raw, tank cars (domestic)	gal.	.66 - .67
Linseed oil, boiled, car lots (domestic)	gal.	.75 - .76

Olive oil, commercial.....	gal	\$2 25	\$2 40
Palm, Lagos.....	lb.	07	07
Palm, Niger.....	lb.	07	07
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	06	07
Peanut oil, refined, in bbls.....	lb.	13	13
Rapeseed oil, refined in bbls.....	gal.	1 10	1 15
Rapeseed oil, blown, in bbls.....	gal.	1 20	1 25
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	08	09
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	05	05

FISH

Light pressed menhaden.....	gal.	\$0 50	\$0 52
Yellow bleached menhaden.....	gal.	52	54
White bleached menhaden.....	gal.	54	56
Blown menhaden.....	gal.	90	

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24 00	30 00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22 00	26 00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10 00	12 00
Barytes, floated, f.o.b. St. Louis.....	net ton	26 50	28 00
Barytes, crude, first grade, Missouri.....	net ton	10 00	
Blanc fixe, dry.....	lb.	05	05
Blanc fixe, pulp.....	net ton	60 00	65 00
Casein.....	lb.	14	18
Chalk, domestic, extra light.....	lb.	05	06
Chalk, domestic, light.....	lb.	04	05
Chalk, domestic, heavy.....	lb.	04	05
Chalk, English, extra light.....	lb.	05	07
Chalk, English, light.....	lb.	05	06
Chalk, English, dense.....	lb.	04	05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8 00	10 00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12 00	15 00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18 00	22 00
China clay (kaolin) crude, f.o.b. Virginia points.....	net ton	8 00	12 00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15 00	40 00
China clay (kaolin), imported, lump.....	net ton	25 00	35 00
China clay (kaolin), imported, powdered.....	net ton	30 00	35 00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8 00	14 00
Feldspar, crude, f.o.b. Maine.....	net ton	7 50	10 00
Feldspar, ground, f.o.b. Maine.....	net ton	21 00	23 00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17 00	21 00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17 00	21 00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27 00	30 00
Fullers earth, f.o.b. Mines.....	net ton	16 00	17 00
Fullers earth, granular, f.o.b. Fla.....	net ton	25 00	
Fullers earth, powdered, f.o.b. Fla.....	net ton	18 00	
Fullers earth, imported, powdered.....	net ton	35 00	40 00
Graphite, crucible, 90% carbon, Ashland, Ala.....	lb.		09
Graphite, crucible, 85% carbon, Ashland, Ala.....	lb.	07	09
Graphite, higher lubricating grades.....	lb.	11	40
Pumice stone, imported, lump.....	lb.	04	50
Pumice stone, domestic lump.....	lb.	05	
Pumice stone, ground.....	lb.	04	07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton		10 00
Quartz (acid tower) 1 1/2 @ 2 in., f.o.b. Baltimore.....	net ton		14 00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton		17 00
Quartz, lump, f.o.b. North Carolina.....	net ton	5 00	7 50
Shellac, orange fine.....	lb.	80	85
Shellac, orange superfine.....	lb.	95	1 00
Shellac, A. C. garnet.....	lb.	70	75
Shellac, T. N.....	lb.	60	65
Soapstone.....	ton	15 00	25 00
Sodium chloride.....	long ton		17 50
Talc, paper-making grades, f.o.b. Vermont.....	ton	12 00	22 00
Talc, roofing grades, f.o.b. Vermont.....	ton	9 50	15 00
Talc, rubber grades, f.o.b. Vermont.....	ton	12 00	18 00
Talc, powdered, Southern, f.o.b. cars.....	ton	12 00	15 00
Talc, imported.....	ton	40 00	50 00
Talc, California talcum powder grade.....	ton	20 00	45 00

Refractories

Bauxite brick, 55% Al, f.o.b. Pittsburgh.....	1,000	160
Chrome brick, f.o.b. Eastern shipping points.....	net ton	80-100
Chrome cement, 40-45% Cr ₂ O ₃	net ton	45-50
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50
Magnesite brick, 9-in. straight.....	net ton	100
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105
Magnesite brick, soaps and splits.....	net ton	120
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65-70
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56-61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	50-60

Ferro-Alloys

All f.o.b. Works

Ferrocobalt-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200 00	\$225 00
Ferrocobalt per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	16	17
Ferrocobalt per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	17	18
Ferromanganese, 76-80% Mn, domestic.....	gross ton	105 00	110 00
Ferromanganese, 76-80% Mn, English.....	gross ton	110 00	115 00
Spiegeleisen, 18-22% Mn.....	gross ton		45 00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2 00	2 50
Ferrosilicon, 10-15%.....	gross ton	55 00	60 00
Ferrosilicon, 50%.....	gross ton	78 00	80 00
Ferrosilicon, 75%.....	gross ton	140 00	145 00
Ferrotungsten, 70-80% per lb. of contained W.....	lb.	55	60
Ferroumium, 35-50% of U, per lb. of U content.....	lb.	7 00	
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5 75	6 75

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content, less than 2% Fe ₂ O ₃ , up to 20% silica, not more than H 4% moisture.....	gross ton	\$10 00	\$11 00
Chrome ore, Calif concentrates, 50% min. Cr ₂ O ₃	unit	60	65
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	55	60
Coke, foundry, f.o.b. ovens.....	net ton		7 00
Coke, furnace, f.o.b. ovens.....	net ton		6 00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	21 00	22 00
Fluorspar, lump, f.o.b. Tonuco, New Mexico.....	net ton	15 00	
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22 50	25 00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	01	01
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	38	40
Manganese ore, chemical (MnO ₂).....	gross ton	60 00	65 00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	55	65
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30 00	
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	12	
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	16	
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	12	14
Rutile, 95% TiO ₂ , per lb. ore.....	lb.	15	
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3 00	3 50
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3 00	3 50
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	2 75	3 00
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2 75	3 00
Vanadium pentoxide, 99%.....	lb.	12 00	14 00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1 50	
Zircon, washed, iron free.....	lb.	03	

Non-Ferrous Metals

New York Market.

Copper, electrolytic.....	Cents per lb.	15 00
Aluminum, 98 to 99 per cent.....		27 50
Antimony, wholesale lots, Chinese and Japanese.....		5 25 @ 5 50
Nickel, ordinary (ingot).....		43 00
Nickel, electrolytic.....		45 00
Monel metal, pipe and black.....		35
Monel metal, ingots.....		38
Monel metal, sheet bars.....		40
Tin, 5-ton lots.....		34 25
Lead, New York, spot.....		5 75
Lead, E. St. Louis, spot.....		5 25
Zinc, spot, New York.....		7 00
Zinc, spot, E. St. Louis.....		6 00

OTHER METALS

Silver (commercial).....	oz	\$0 66
Cadmium.....	lb.	1 40 @ 1 50
Bismuth (500 lb. lots).....	lb.	2 40
Cobalt.....	lb.	6 00
Magnesium (f.o.b. Philadelphia).....	lb.	1 35
Platinum.....	oz.	75 00
Iridium.....	oz.	350 00 @ 400 00
Palladium.....	oz.	75 00
Mercury.....	75 lb.	50 00

FINISHED METAL PRODUCTS

Warehouse Price Cents per lb.

Copper sheets, hot rolled.....	21 00
Copper bottoms.....	33 00
Copper rods.....	28 00
High brass wire and sheets.....	18 75
High brass rods.....	16 75
Low brass wire and sheets.....	27 50
Low brass rods.....	18 50
Brazed brass tubing.....	35 25
Brazed bronze tubing.....	40 50
Seamless copper tubing.....	25 00
Seamless high brass tubing.....	24 00

OLD METALS—The following are the dealers' purchasing prices in cents per pound.

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	11 50	18 50	10 00	10 50
Copper, heavy and wire.....	11 00	16 50	9 50	9 50
Copper, light and bottoms.....	9 00	14 50	9 00	8 50
Lead, heavy.....	4 00	7 25	4 00	4 00
Lead, tea.....	3 00	5 25	3 00	3 00
Brass, heavy.....	7 00	9 50	7 00	10 00
Brass, light.....	5 50	8 00	5 00	5 50
No. 1 yellow brass turnings.....	6 00	9 50	5 50	6 00
Zinc.....	4 00	5 00	3 00	4 00

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York		Cleveland		Chicago	
	*Current	One Month Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes.....	\$3 58	\$3 80	\$3 58	\$3 37	\$3 58	\$3 47
Soft steel bars.....	3 45	3 70	3 34	3 27	3 48	3 52
Soft steel bar shapes.....	3 45	3 70	3 48	3 27	3 48	3 52
Soft steel bands.....	4 18	4 65	6 25			
Plates, 1/2 to 1 in. thick.....	3 78	4 00	3 78	3 57	3 78	3 67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn.

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation California

LOS ANGELES—The Standard Film Laboratories, Seward St., has awarded the contract for the construction of a 2-story, 75x120-ft. film laboratory to Meyer & Holler, Collender Bldg., about \$125,000. Company plans to install \$50,000 worth of laboratory equipment.

TORRANCE—The Western Glass Co., 939 East 1st St., Los Angeles, plans to construct a plant here. Estimated cost, \$50,000.

Colorado

FORT COLLINS—The State Agricultural College is having plans prepared for the construction of a 2-story, 40x70-ft. women's club and chemistry building. Estimated cost, \$100,000. E. Groves, Foster Bldg., Denver, archt.

Florida

WEST PALM BEACH—K. Riddle, city mgr., is having plans prepared for laying main lines, laterals and installing septic disposal tank, etc. Estimated cost, \$100,000.

Illinois

ALTON—The Consolidated Chemical Products Co. plans to build a muriatic acid plant. J. W. Brandel, mgr.

Iowa

GILMAN—The Bd. Educ. is having plans prepared for the construction of a 3-story, 60x100-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$120,000. Keffer & Jones, 204 Masonic Temple, Des Moines, archts.

Kansas

PITTSBURG—The Atlas Powder Co. will build five 1-story, 25x55-ft. powder houses near here. Cost, about \$18,000.

Massachusetts

WORCESTER—R. F. Rob Power Co., Albany St., plans to rebuild its foundry building recently destroyed by fire. Estimated cost, \$50,000.

Michigan

DETROIT—Bd. Educ. has awarded the contract for the construction of a 3- and 7-story high school addition on Cass and Second Aves. A gas engine laboratory will be installed in same.

Minnesota

BEMIDJI—The Bd. Educ. is having plans prepared for the construction of a 2-story, 145x270-ft. high school on Main St. A chemical laboratory will be installed in same. Estimated cost, \$400,000. R. O. Bagley, Supt. E. F. Bromball, 707 Alworth Bldg., Duluth, archt. and engr.

LUVERNE—Bd. Educ. will receive bids until Feb. 17 for the construction of a 3-story, 68x120-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$300,000. F. A. Leicher, secy. Tyrie & Chapman, 1206 Second Ave., S., Minneapolis, archts.

MINNEAPOLIS—The Bd. Educ. will receive bids until Feb. 15 for the construction of a 4-story, 200x300-ft. high school on Monroe St. and 20th Ave., N. A chemical laboratory will be installed in same. Estimated cost, \$800,000. C. F. Womarth, City Hall, business supt.; E. H. Enger, 305 City Hall, archt. Noted Oct. 27.

New Jersey

DOVER—Jersey City plans to build main sewer and disposal plant for protection of Jersey City water pipe line here. About \$2,000,000.

TRENTON—The Puritan Rubber Co., Perrine Ave., plans to construct a 2-story,

60x80-ft. addition to take the place of one which was recently destroyed by fire.

WHARTON—Borough of Wharton will soon award the contract for construction of filtration plant and reservoir and laying 8 miles of pipe. Estimated cost, \$400,000. A. Potter, 50 Church St., New York City, engr.

North Dakota

KENMARE—City plans to construct septic tank, sludge bed and repair sewers. E. J. Thomas, Minot, engr.

Ohio

ALLIANCE—The city plans to vote on \$375,000 bond issue to construct a municipal artificial gas plant.

CLEVELAND—The Premier Refining Co., 1187 West 11th St., has awarded the contract for alterations to its factory on East 65th St. and Harvard Ave. Estimated cost, \$35,000. Noted Dec. 15.

PROSPECT—Bd. Educ. will receive bids until Feb. 8 for the construction of a 2-story high school. A chemical laboratory will be installed in same. About \$125,000. O. D. Howard, 8 East Broad St., archt.

Pennsylvania

DANVILLE—The Bd. of Educ. had plans prepared for the construction of a 3-story, 80x160-ft. high school. Estimated cost, \$200,000. A chemical laboratory will be installed in same. Richter & Lee, 32 South 17th St., Philadelphia, archts.

South Dakota

RAPID CITY—The State Senate, Pierre, has passed a bill appropriating \$2,000,000 for the purchase of a site and constructing a cement plant.

WAVERLY—The Bd. of Educ. will soon award the contract for the construction of 2-story, 80x109-ft. consolidated school. A chemical laboratory will be installed in same. Estimated cost, \$100,000. K. T. Snyder, 738 Plymouth Bldg., Minneapolis, Minn., archt. Noted Dec. 29.

Texas

LOCKHART—School Bd. is having plans prepared for the construction of a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, \$200,000.

WEATHERFORD—School Bd. is having plans prepared for the construction of a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, \$200,000.

Wisconsin

TAYCHEEDAH—The State Bd. of Control, Madison, rejected all bids for water softeners in connection with the power plant at the Wisconsin Industrial Home for Women. Bids will readvertised.

Ontario

CHATHAM—City plans to construct a filtered water basin and reservoir about 250,000 imperial gal. capacity. Estimated cost, \$50,000. C. H. R. Fuller, Chatham, engr.

OSHAWA—Town plans to build sanitary and storm sewers and Imhoff sewage disposal plant. About \$350,000. M. Shupe, town engr., Gore, Nasmith & Storrie, Toronto, consulting engr.

PETERBOROUGH—City receives bids after Feb. 1 for the construction of a rapid sand filtration plant, rein.-con. with a brick building over filters, coagulating basins, alum tanks, chlorinating apparatus, etc. Estimated cost, \$350,000. S. H. Parsons, City Hall, engr. Noted Jan. 19.

Quebec

MONTREAL—The E. F. Phillips Electrical Works, Ltd., De Gayre St., will receive bids about Feb. 7 for the construction of a copper rod rolling mill to have a capacity of 100 tons daily. Estimated cost, \$175,000.

British Columbia

PORT MELLON—The Western Canada Pulp & Paper Co. plans to construct a plant to have capacity of 40 tons of pulp daily. H. H. Helin, mgr.

Manufacturers' Catalogs

DWIGHT P. ROBINSON & Co., Inc., New York City, has issued two new booklets. "Work Done" gives in 192 pages illustrations and short descriptions of the work that has been done by this company. The other booklet, entitled "Clients," gives its list of clients according to industries.

PROCTOR & SCHWARTZ, Inc., Philadelphia, Pa., formerly known as the Philadelphia Textile Machinery Co., has issued an attractive catalog on "Proctor Dryers for Pigments, White Lead, Lithopone, Chemicals." Many interesting illustrations are given of the different types of drying machines, together with descriptions.

ELECTRIC FURNACE CONSTRUCTION Co., Philadelphia, Pa., has published a pamphlet on "Heat Treating and Annealing Furnaces," by Frank W. Brooke and George P. Mills, which discusses electric vs. combustion furnaces.

THE CLEVELAND AIR ENGINEERING Co., Cleveland, O., is issuing an 8-page booklet on "The Cleveland Automatic Reclaiming Separators," which are described and illustrated.

AUSTIN MACHINERY CORP., Chicago, Ill., is issuing a series of attractive art letterheads of an industrial character for following up inquiries on special types of mechanical equipment.

THE BARRETT Co., New York City, announces a new catalog entitled "Flotation Oils and Reagents."

THE NORTON Co., Worcester, Mass., calls attention to a new catalog on "Steadyrests, Form Grinding, Grinding of Plane Surfaces." Under "Steadyrests" is given the story of the development and a study of correct workshoes and the effect of steadyrests on production and suggestions for their use; under "Form Grinding" the evolution and the principles of the wide face wheel in grinding as related to form grinding, application of wide face wheel to grinding of irregular shapes, description of attachments and general suggestions; under "Grinding of Plane Surfaces" is given the types of machines, selection of wheels, accuracy possible, methods of handling work, and kinds of materials ground.

THE KEWAUNEE MFG. Co., Kewaunee, Wis., has just received from the press Catalog 14, on "Kewaunee Laboratory Furniture for Educational Institutions, Commercial Laboratories, Industrial Plants and Hospitals."

THE WRIGHT-AUSTIN Co., Detroit, Mich., announces three new publications on its products. These books deal with Austin separators, steamtraps, strainers and boiler trimmings and contain new data and useful information of interest to engineers and steam users.

ROSS HEATER & MFG. Co., Inc., Buffalo, N. Y., calls attention to Catalog "F," which illustrates and describes the various types of heaters, condensers, expansion joints, coolers and airjet pumps. Many illustrations are included.

THE SCOVILL MANUFACTURING Co., Waterbury, Conn., has issued a four-page folder on "Scovill Seamless Tubing." Another new publication is entitled "Getting Down to Brass Facts."

THE DEISTER CONCENTRATOR Co., Fort Wayne, Ind., has issued bulletin No. 6, which is a four-page folder on the No. 7 Deister-Overstrom Diagonal Deck Coal Washing Table.

THE MILWAUKEE ELECTRIC CRANE & MFG. Co., Milwaukee, Wis., has just issued a 48-page catalog illustrative and descriptive of its complete line of cranes. Information, which is the result of twenty-five years of active experience in the designing and building of hoisting machinery for shops, foundries, steel plants and other establishments, is incorporated in this book. A section of the book is devoted to the horizontal drilling and boring machine which is suited for operating, at one setting, on pieces too long or bulky for the usual type of machine. Copies may be had on request.

CROUSE-HINDS Co., Syracuse, N. Y., has published Bull. 304-A, on Crouse-Hinds Imperial Floodlight Projectors and Imperial Reflectors, which contain listings of projectors and reflectors developed since the publication of Bull. 304, which is still effective.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its annual meeting Feb. 21 to 24 at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN ENGINEERING COUNCIL will meet at Syracuse, N. Y., Feb. 14 and 15.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting Feb. 14 to 17 in New York City.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

COMMON BRICK MANUFACTURERS' ASSOCIATION OF AMERICA is holding its annual meeting at the Hotel Pennsylvania, New York City, Jan. 31 to Feb. 4.

NATIONAL PETROLEUM CONGRESS will meet at the Hotel Baltimore, Kansas City, Mo., March 22 to 25.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

THE SEVENTH EXPOSITION OF CHEMICAL INDUSTRIES will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

Industrial Notes

THE NATIONAL ANILINE Co. is sending sample sets of American-made dyes, comprising seventy-one dyes, to all the prominent colleges and universities in the United States.

THE ENGINEERING BUSINESS EXCHANGE, established some time ago by Charles Whiting Baker for the purchase and sale of engineering and technical business properties, announces the opening of a Pacific Coast branch with James T. Whittlesey as manager, with offices in the Claus Spreckels Bldg., San Francisco, Cal.

THE GOULDS MANUFACTURING Co. of Seneca Falls, N. Y., manufacturer of Goulds pumps, announces the appointment of Edward S. Jenison as acting general sales manager to succeed W. E. Dickey, who retired from business on Jan. 1. For the past five years Mr. Jenison had been manager of the Philadelphia office.

THE B. F. GOODRICH RUBBER Co., pioneer manufacturer of mechanical rubber goods and other rubber products, is now entering upon the second half of a century of progress. The first half of the century was completed Dec. 31, the company having been incorporated Dec. 31, 1870, by Dr. Benjamin Franklin Goodrich. Dr. Goodrich, who was a physician by profession, entered the rubber business as result of having acquired a rubber factory at Hastings-on-the-Hudson in a real estate deal. Seeking financial help he was attracted to Akron, where a group of progressive citizens promised to back him. He began manufacturing in a small two-story brick building with a force of twenty-five employees. This small factory has grown until today it comprises sixty-three giant buildings covering 110 acres of ground.

It is related that one time when Dr. Goodrich was trying to find a market for his goods he tried to sell rubber hose to the fire department of Cincinnati, which still used leather hose. The firemen scoffed at Dr. Goodrich's contention that rubber hose would be much superior to the leather, and refused to buy. It wasn't many years, however, before Dr. Goodrich had the laugh on them, for rubber fire hose soon came in universal use. After starting with the manufacture of hose Goodrich added article after article to its line of manufactured goods until today approximately 30,000 different rubber products are made, filling an almost infinite variety of needs. They can be classified into five general divisions, each ramify into numerous subdivisions: Mechanical goods, rubber footwear, druggists' sundries, hard rubber products, and tires—both pneumatic and solid. The manufacture of automobile tires followed naturally from Goodrich's early experiments in perfecting rubber shod wheels. Solid rubber tires for carriages were made first. Then came the pneumatic tires for bicycles, made in large numbers when the "bike craze" swept over the country. Auto tires came next, the same fundamental principles being used in their construction as for bicycle tires. With the universal use of the motor car today it is difficult to realize that so short a time ago as 1896 Goodrich produced the first American clincher type tires for automobiles. The Goodrich company commemorated the golden anniversary by publishing an attractive 48-page book called "The Golden Year of Goodrich," telling of the romance of the rubber industry, its history, and of what great importance it has been in the progress and development of the world. The book was written by Wilbur D. Nesbit and illustrated by W. T. Benda, the famous Polish-American painter.

THE WEIR FOUNDRY, at the northwest corner of Wallace St. and 24th Pl., Chicago, has been sold by Robert Weir to William McIlvaine, for a consideration of \$95,000.

D. J. LEWIS, JR., New York sales agent for the Cresson-Morris Co. and the Kestner Evaporator Co., Philadelphia, Pa., announces the removal of his offices from 277 Broadway to the Woolworth Bldg.

THE PORTLAND VEGETABLE OIL MILLING Co., Portland, Ore., has recently been incorporated to import and refine copra, and oils such as those of the peanut and soya bean. Large quantities of vegetable oil are being brought to Portland by steamers operating in the transpacific trade.

WHITING FOUNDRY EQUIPMENT Co., Harvey, Ill., announces that it has changed its name to Whiting Corporation, increasing its authorized capital stock from \$700,000 to \$3,000,000. The Whiting Corporation remains under the same management and will continue the manufacture of cranes, foundry equipment and railway specialties as heretofore.

CHICAGO PNEUMATIC TOOL Co. announces the appointment Jan. 1, 1921, of R. F. Eisler as assistant to the vice-president, with headquarters in the company's new office building at 6 East 44th St., New York. W. C. Straub, formerly district manager of the New Orleans branch, has been appointed district manager of the Pittsburgh branch to succeed Mr. Eisler, and Ross Wyeth, formerly attached to the Pittsburgh branch, has been appointed district manager of the New Orleans branch to succeed Mr. Straub.

THE CUTLER-HAMMER MFG. Co., Milwaukee, Wis., has secured new offices in the Railway Exchange Bldg., St. Louis, which is a branch of the Chicago district office. Harold Phillips, formerly of the engineering department of Chicago and later office manager of the Chicago office, will be in charge of the new St. Louis branch.

GARRED-CAVERS CORP., New York, announces that arrangements have been made with it by the Union Minière de Haut-Katanga for the use of its process, whereby pulverized coal is used to replace coke in blast furnaces. The Union Minière du Haut-Katanga has placed orders for a 42-in. Fuller mill and a Fuller-Kenyon pump for the coal-preparation plant which will be used in connection with the above process at its copper smelter in the Belgian Congo. Licenses were secured from the Garred-Cavers Corp. some time ago by the Cerro de Pasco Copper Corp., Peru, the International Nickel Co. and the Tennessee Copper Co., for the use of this process at their various smelters.

THE HALLIDIE MACHINERY Co., L. C. Smith Bldg., Seattle, Wash., has been appointed representative of the Conveyors Corporation of America, Chicago, formerly the American Steam Conveyor Corporation. It will handle the sale of the American Steam Conveyor and American Trolley Carrier in the states of Washington and Oregon.

PARRY, LEON & HAYHOE, LTD., Johannesburg, South Africa, announces the discovery of a high-grade chromium ore in southern Rhodesia. The property is being developed by the United Chrome Prospecting Syndicate, Ltd., and is now yielding from 800 to 1,000 tons per week. A sample of 500 tons shipped to Liverpool showed the following analysis:

	Dry Ore, Per Cent
Oxide of chromium.....	55.40
Protoxide of iron.....	16.39
Peroxide of iron.....	1.78
Alumina.....	9.40
Lime.....	1.50
Magnesia.....	12.72
Oxide of manganese.....	.10
Silica.....	1.54
Sulphuric acid.....	.17
Combined water, etc.....	.97
	99.97
Moisture in ore as received.....	0.88

Other samples taken from the same property contained 56.1 per cent oxide of chromium.

THE AUSTIN MACHINERY CORPORATION of Chicago, manufacturer of earth-working, concrete-mixing and material-handling machinery, has purchased the large plant of the Fairmont Machine Co., Fairmont, W. Va. This plant will continue to make a total line of machinery, besides contributing to the manufacture and distribution of the complete line of the Austin Corporation.

THE NORTHWESTERN CHARCOAL Co., of Olean, N. Y., has acquired ground for the erection of a plant near the Forest Products Chemical Co., at Memphis, Tenn. Charcoal from the Forest Products Chemical Co.'s ovens will be used at the new plant in the preparation of material for case-hardening and steel-treating compounds as well as for poultry and stock feed. Estimated investment will amount to around \$100,000. R. M. Hancock, of Cadillac, Mich., will be in charge of the new plant, which it is expected will be in operation about April 1.

THE GALION IRON WORKS & MANUFACTURING Co., of Galion, O., has established a distributing warehouse at 477 South Front St., Memphis, Tenn., in charge of R. M. Hammond. The new sales organization will handle a full line of road-building machinery, contractors' equipment and culvert pipe.

THE SOUTHERN CHEMICAL & MANUFACTURING Co., INC., has located at 17 South Cooper Ave., Memphis, Tenn., and will engage in the manufacture of liquid soaps, disinfectants, cleaners and polishes of various kinds. It is incorporated under the laws of Tennessee, with E. A. Hall, president and general manager; H. F. Reed, secretary-treasurer.

THE SEK MANUFACTURING Co., of Chicago, has established a branch agency at Memphis, Tenn., for the sale of preservative and waterproof compound for leather, cotton, shoes, automobile tops, etc. The branch office is in charge of Al Finberg.

THE METALS REFINING Co. has purchased twenty acres of land at Hammond, Ind., for the erection of a plant to produce lead for battery plates.

S. MORTIMER WARD, JR., GORHAM CROSBY and DYER SMITH announce that on Jan. 1, 1921, they became associated in the practice of patent and trade-mark law under the firm name of Ward, Crosby & Smith, with offices in the Woolworth Bldg., 233 Broadway, New York City.

THE YARNALL-WARING Co., Philadelphia, Pa., announces that H. J. Moyer, who has jointly represented that company and the Nelson Valve Co. in the Chicago territory, has severed his connection with the latter concern and will henceforth represent the Yarnall-Waring Co. exclusively in that field as district manager, with offices at 58 West Washington St.

THE SUREWAY CHEMICAL Co. has recently been organized in St. Louis, Mo., to deal in scale solvents. The company is incorporated for \$10,000. Further information may be had from Hans Fonseca, 1525 Bremen Ave., St. Louis, Mo.

WILSON-MAEULEN Co., New York City, manufacturer of pyrometers, announces that William Printz, sales engineer, has assumed charge of the New York territory. He has been actively associated with the sale and installation of pyrometers throughout the Middle West for the past five years. Mr. Printz will have his headquarters at the main office and works, 383 Concord Ave., New York City.

SHARPSVILLE BOILER WORKS Co., Sharpsville, Pa., announces the appointment of F. M. Patterson, 2 Rector St., New York City, as Eastern sales manager, succeeding R. C. Luty.

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CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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Western Editor
CHESTER H. JONES
CHARLES A. BLATCHLEY
Industrial Editors
J. S. NEGBW
Managing Editor

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Number 6

International Migration of Technical Men And the Diffusion of Manufacturing Secrets

INTERPLANT migration of technical men and diffusion of manufacturing secrets are concomitant. Business ethics limits the practice, but there are conditions where good business demands that there be some migration with accompanying diffusion. Every plant manager knows that the employee who will sell the secrets of his former employer is not a safe repository for his own carefully guarded manufacturing methods. He is convinced that he must not start the subsidizing of crookedness by bidding higher for his competitor's men. But should conditions arise within the works of his competitor that caused men to resign of their own free will and come to him seeking employment he would be a weak business competitor if he did not hire any of them he wanted.

This very condition exists today between the German and American dye companies. There are a few German chemists who, recognizing that the monopoly, and consequent prosperity, of their home industry is at an end, are seeking to escape future adversity by migrating to American plants. The German Government sees its last grasp on this important industry being broken by this movement and has ordered the frontiers guarded and all suspected emigrant dye chemists arrested. Dr. OTTO RUNGER and Dr. JOSEPH FLACHSLANDER, however, got out of Germany and into the United States and are now working for the du Pont company. Shall these men be censured for disloyalty to the discredited German system of which they have been a part in the past, or shall they be allowed to make this their country? They cannot go back to Germany and re-enter the fold. They must make good here. To do so they must not be denied any reasonable opportunity nor be hampered by feelings of individual hostility on our part. Nor is American industry to be denied the opportunity to build for the future by the aid of individuals who, through changing economic and industrial conditions in Europe, choose to seek more attractive fields of endeavor. There are many such among us already.

In this matter of anti-German thought what we need most to keep in mind is the hazard of Germans together in large groups. Individual Germans are just like other people; German-born Americans are among the best of Americans. In a few years we hope that the danger of Germans in groups will be over. Suppose 100 German chemists were *bidden* to come here, and as a body to settle themselves in our industries. Singly they would probably be all right, and in time become useful citizens. But jointly, if they were inspired or instructed with the idea that their main business was for *das Vaterland*, that while engaged here in good faith they would secretly address themselves to the advancement of *deutsche Industrie*, then the suspicion might well arise

that neither the truth nor the comity of men nor decency nor even honor itself would have weight with them. We don't want Germans "planted" in groups in this country, but if German individuals choose to recognize a new order of things and cast their lot with us they should have an opportunity to show their good faith. As for their being a menace to American industry, we may confidently leave it to our big companies to protect their own interests and those of the country.

How Much Conceit Is Beneficial?

WHEN a young man finishes college and begins work in earnest, he finds himself the object of an indirect campaign to "take the conceit out of him." His elders and business associates see to it that he gets only such work and consideration as will show him how small he is in the scheme of things. If he doesn't have good luck and get promoted within a reasonable time, he is likely to feel downcast and to be glad to cling to the industrial machine by any kind of insignificant job. Especially if he has the temerity to marry within a year or two after finishing college and before he has established himself, he loses his conceit almost entirely and becomes as meek as any employer could wish.

The question is, Should young men be bullied out of their conceit? WHITING WILLIAMS, author of "What's on the Worker's Mind?" thinks that conceit is what makes complicated and highly specialized industry possible, and he advocates that employers encourage their men to feel their individual "worth-while-ness." He explains that the mechanic comes regularly to his bench and the millionaire to his desk, and make sincere, valuable citizens because each feels that he is an important part of the industrial fabric. Each one, though he has grievances and further ambitions, is proud of what he has achieved and can do, and this pride brings him daily to his work and adds zest to what otherwise would be drudgery. As an experienced personnel-manager, Mr. WILLIAMS suggests that this self-pride or individual conceit is the very basis of the social system. Labor unrest comes rather from the neglect of employers to permit their men this incentive than from differences about wages and salaries, says Mr. WILLIAMS. There are more foremen and officials who take unnecessary joy out of life than there should be for healthy conditions, is the conclusion of his book, written after seven months spent working as a common laborer in overalls. In other words, too many of the wrong kind of bosses have been promoted, and their driving, narrow ways have brought resentment. Common laborers, as well as young engineering graduates, have been given too little opportunity to feel the sense of individual worth-while-ness that Mr. WILLIAMS recommends. After all, as so many philosophers from PLATO to HERBERT SPENCER

have pointed out, each individual is the center of his own world. Everything revolves around the ego, in spite of temporary campaigns to discredit individualism. The most important thing to each man is himself. When he feels moderately happy, great accomplishments are possible; when he is browbeaten and depressed, he is a force for evil in the world.

The nation which has most encouraged individualism is England. Just as an example, a letter to the *London Times* generally receives respectful consideration both from the editor and from a wide circle of readers; they have learned that excellent suggestions are made in that way, that national benefits accrue from permitting individuals to express themselves, as the canny ADAM SMITH long ago pointed out. In spite of the hamperings of class distinctions in British society, individual genius is probably more quickly recognized than in America. Those in control of things there are influenced by a tradition to help original thinkers who appear to possess talent of value to the nation.

In America there is, of course, what is called "rampant individualism," but it results in everyone being so busy with his own affairs or so shortsighted in his own troubles that the young man of exceptional talent is as likely to remain unrecognized as not. Why was it, for instance, that HERBERT HOOVER found more scope for his extraordinary ability in London than in America, at least until he was a well-known and successful engineer? Without doubt, if he had been a more conventional type he would have found plenty of opportunities in this country, but because his combination of gifts was of the kind that the ordinary American employer did not recognize, he found more attractive openings in British firms directed from London.

Taking a historical case, the record of BENJAMIN THOMPSON, who died over a century ago, shows that that notable scientist and administrator found instant recognition and encouragement in Europe, where he was made Sir BENJAMIN THOMPSON in England and Count RUMFORD in Bavaria. In America, although he was of an old New England family, he encountered only enmity and jealousy. It is true that he left his fortune to Harvard College, but most of his work benefited Europe, since he founded the Royal Institution in London and has a statue to his honor in Munich. It was a pity that America did not profit more by his unusual talents in both pure and applied science—such as his researches in the physics of heat and his experiments with explosives.

These are not the only Americans who have found greater success abroad than was possible in their own country. Many others could be mentioned, and many more who never had the chance to try their fortunes abroad undoubtedly would have succeeded better there than here. In other words, Europe is quicker to recognize certain kinds of talent than is America, not only in literature and art—as is commonly admitted—but also in engineering and general science. America is quicker than Europe to help certain other kinds of ability; we all know of immigrants who have amassed a fortune in short order. But the point is that it is more important to recognize ability among native Americans, such as HOOVER and THOMPSON, than to make the fortunes of Italian or Russian immigrants. The good that a great constructive thinker or critic can do is more essential to the nation than is the operation of the corner fruitstand or the business of a get-rich-quick Ponzi.

America's first consideration should be encouragement for her own young men to express themselves in ways helpful to national interest.

That young men are conceited is an excellent sign. Instead of bullying them into forgetting their ambitions, the men in control of industry should take youth more seriously and train it more broadly and more sympathetically, granting opportunities that appeal to the adventurous and eager. In Germany, before 1917, visitors remarked that when the Kaiser or his generals passed down the street, people literally held their breath. That was conceit grown unhealthy beyond all reason, but the moderate conceit that Mr. WILLIAMS advocates is healthy and beneficial.

Metallurgical Mysteries

FEW are so dull who are not at some time or other impressed with the mysterious things with which they work and the mysterious changes taking place under their guidance. In olden days, more simple minds were often overpowered by the strange and unexplainable on all sides, and saw at times the hand of Deity. Today, we more sophisticated talk about the size of the stellar system and the energy in a radium atom just as though the infinite were conceived by finite minds.

But fancy how dull and uninteresting things would be if everything was known about them—the precise facts of their constitution and the exact action under all conditions. Metallurgy may be and doubtless is dull and uninteresting to many who know hardly how to pronounce the word, but how dull it would be even to those who know most about the art if all the mysteries were solved! Real mysteries, not those pseudo-mysteries which one often meets. Such as a locked door which conceals some trade secret—more often than not a process known to many and discarded by them years ago for a better. The fence erected to keep out inquiry too often coops self-sufficiency and ignorance. Or such another myth as "body" in steel—that indefinable something which makes an octagon bar labeled in gilt better than a round one stamped in black.

Granting that the limit of human achievement is merely to push a little farther back the boundary between the known and the unknown and that there will always remain a vast residue of darkness, still it is surprising at times to take stock and find that every branch of metallurgy practices daily large-scale operations about which our precise information is pitifully small. Why do heavy mineral particles float in a Callow cell? In what way are metals entangled in slag and never recovered? Why should humidity play such an important part in the electrical precipitation of fume? What is the nature of the forces acting between white-hot metal and gas, forces underlying all steel-making processes? What is the nature of hardening or of season cracking?

Of course such problems are highly complex. A tremendous amount of work has already been spent upon them, and still there is no conclusion. Their final solution will probably call forth scientific knowledge and resources of high order. But there are many problems somewhat simpler which can be attacked with more modest equipment. As instances: Why does a copper plate prevent case carburization; is it because the thin covering is impervious to carbon monoxide, or is copper

more active than iron in extracting carbon from that gas, so that there is little left for the iron underneath? Why does cupola-melted white cast-iron require a higher annealing temperature than the same metal melted in an air-furnace; is it because of higher sulphur or finer grain? Why should either affect graphitization? Why does quenched silicomanganese steel made in the open-hearth require a draw 100 deg. higher for equal hardness than metal of the same analysis from the electric furnace? Is it due to extra nitrogen in open-hearth steel; is it due to strange carbides formed in local hot-spots under the electric arc; or is it merely due to the better separation of laminar pearlite usually found in such electric steels?

One might proceed to enumerate many such problems, all of intense importance from a commercial viewpoint. Some of them are under active investigation, such as sulphur and phosphorus limits in tonnage steels, brittleness of steel at a blue heat, and the relationship between fatigue and other physical tests. Others deserve closer attention than apparently they are getting. Why should the common alloy steels acquire "temper brittleness" if slowly cooled after drawing? Why should quenched mild carbon steels after drawing at 400 deg. C. give maximum strength, hardness and solubility in acids? The latter fact has been long known and associated with a peculiar microscopic appearance sometimes called "Osmondite," yet the phenomena do not occur in higher carbon steels. Silicon, phosphorus and aluminum all increase the grain size in steel castings. If a sound, but used, spring be given a heat-treatment similar to that which it originally received, its subsequent life is greatly shortened. Why?

Perchance some who read these lines will attack one of these problems in a systematic way. They will then find a new interest in their workaday life.

Byproduct Coking

Establishes Another Record

IN 1920 the byproduct coke production of the United States was approximately 30,700,000 net tons. This is an increase of 22 per cent above the output of the previous calendar year, the result of many influences, among others the fact that 850 new ovens were put into operation during the year. Not only was the quantity of byproduct coke greater than ever before, but also the percentage of the coke output produced in byproduct ovens increased to practically 60 per cent of all, only 40 and a fraction per cent being made in beehive ovens.

Whether 1921 will show a continued increase in coke tonnage or not will depend upon many economic factors beyond the ken or even the guess of the most learned prophets. However, it is safe to say that the percentage of coke made in beehive ovens will for some time continue to decrease. Indeed, it is to be hoped that a decidedly lower percentage will be made by this process each year until we can say that the beehive oven is only a negligible factor in the situation. Simultaneously, of course, the byproduct oven output will increase in both quantity and percentage.

It is too much to ask that all fuel be processed, for if all our bituminous coal could be treated in coke ovens, which it cannot, there would be no adequate market for many of the byproducts. We could, of course, use all of the light oil as motor fuel; in time we might absorb all of the tar as a Diesel engine fuel or as a petroleum

substitute; and too, the market for nitrogen would care for all of the ammonia produced (presumably to the exclusion of Chilean nitrate) if the fertilizer demands were carried to the limits proposed by experts in soil improvement. However, the economic conditions permitting such tremendous developments would not justify the necessary large investment in coal-processing equipment. It is well to bear this fact in mind and not be rushed off our feet by the theoretical advantages which can be so glibly recited in favor of coking on a large scale.

Reasonable encouragement should be given to the coking of coal, so that the market for byproducts may be amply supplied and inducement offered for the maximum utilization of these valuable chemical raw materials. In the meantime, however, it should be clearly recognized that the development will be gradual rather than spectacular. And through it all there should be a progress from year to year that will be most encouraging to both byproduct producers and to the industries using their products as raw materials.

Brains Applied

To Forging

DETAILS of a hundred kinds impress one with the Herculean efforts France made seven years ago to stop the German attack. Once stopped, and taking stock of her resources, she found the enemy in possession of 70 per cent of her metallurgical works. This at the very outset of a war, won undoubtedly by human courage and sacrifice, but nevertheless a war between special engines and machines of great power and wide variety!

That eminent French ironmaster EUGENE SCHNEIDER has recently made several allusions to the progress, construction and intensive production which was necessary in order that their troops could be properly supplied with munitions. In his presidential address before the 1918 meeting of the British Iron and Steel Institute he alludes to the startling savings made possible by every attention being given to eliminate unnecessary delays in fabrication. "Two compressed-steel ingots, weighing respectively twenty-one tons, were selected, as they came from the molds, to be forged into three 220-mm. Schneider mortars and one 155-mm. Schneider howitzer. Particular attention was bestowed on the former through all forging operations; the latter was left to the current routine of the gun shop. Now, whereas it took eleven and one-half days and seven heatings, plus one of annealing, to transform the former, for the latter forty-three days and nine successive heatings, plus one of annealing, were necessary. The expenditure in fuel was, therefore, more considerable for the latter, but especially there was ample scope for the elimination of the so-called dead stops."

With three-quarters of the plants gone, France of course strained every effort to construct new and modern works far to the rear of the battle zones; but waiting their completion, a close attention to operating details was evidently able to increase the apparent capacity enormously.

While he does not say as much in so many words, undoubtedly the recorder he described last fall, and briefly noted in this issue, was of great help in such a remarkable saving in time. It is a happy augury that tradition, which excludes sunlight from a forge shop, has been unable to prevent the entrance of common sense.

Readers' Views and Comments

Shall Chemists Be Registered, Certified and Legalized?

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to your editorial, "A Question That Will Not Down," in your issue for Feb. 2, I think that the views there expressed are very much to the point, and I agree with you that the scheme of listing and certifying chemists had best be tried out first in New Jersey. I question whether it is really necessary to start a new organization such as the proposed Institute of Chemistry. Could not the matter be handled by one of the existing chemical societies, either the American Institute of Chemical Engineers or the American Chemical Society? That new, live organization, the New Jersey Chemical Society, is most earnestly interested in the question, and undoubtedly can do much by trying out the idea in its own state.

The main issue, as I see it, is not only "Who is a chemist?" but "How to tell the general public who is a chemist." Members of the chemical and allied professions and industries employing chemists need no Institute of Chemistry to recommend men to them or tell them where to procure certain materials. The general public, on the other hand, have a very vague idea as to how to proceed. Their only source of information is the daily press and the *Saturday Evening Post*. Probably they have never heard of our chemical journals nor of the Chemical Catalog nor of that handy little annual published by Williams & Wilkins of Baltimore.

My suggestion is to have the New Jersey Chemical Society do some advertising. This may bring forth adverse criticism on the ground that it is unethical for a scientific organization to advertise. Nevertheless, if the advertising be done discreetly, the objections will easily be overruled. The society might insert a small notice in the *Newark News* throughout the year informing the readers that anything pertaining to chemicals or chemists can readily be ascertained through the society.

South Yonkers, N. Y.

COLIN D. FINK.

Should Start Within American Chemical Society

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to your editorial on the proposal of the New Jersey Chemical Society to organize an American Institute of Chemistry, I wish to say that I have already had some correspondence with the promoters of this plan and have strongly advised the desirability of not attempting to have the tail wag the dog, but to get the dog to wag the tail. In other words, a small society should not take upon itself the burden of starting a big institution which it would be difficult for even the American Chemical Society to start. I think it would be far better if the movement should start from the parent society and not from one of the smaller organizations, because the men of reputation in the country will hardly like to go into an august body, such as this would be, through the back door.

The origin of the Institute of Chemistry of Great Britain is along much the same line as the plan which

has been proposed recently in this country. A certain section of the Chemical Society in London was under the impression that the highbrow stuff read and published by the Chemical Society was not exactly what was needed for a consulting chemist. Several of the latter tried to get the Chemical Society to form a section through which consulting men could be known to the country as experts in certain lines. The highbrows in the Chemical Society said that any man belonging to it was guaranteed as being the finest man in his profession, to which the others replied that all that was necessary to belong to the Chemical Society was to get three members to sign a paper, and pay one's dues yearly, which any office boy could do. As a consequence a few of them got together between thirty and forty years ago and formed the nucleus of the Institute of Chemistry of Great Britain, and after they had been in existence for a time they managed to obtain a Royal Charter, which gave them power similar to that exercised by the universities—in a measure to grant a degree, which was given only after an examination. The self-appointed nucleus of this organization, being men of reputation and in most instances well known to the country at large, exercised great care and diligence that no office boy or similar person was admitted during their organization of the society. When the Royal Charter was granted all free admissions were stopped, and entrance was obtained by examination only, a practice which obtains to the present day.

The objects of this society were to raise the standards of the consulting man and generally see to the ethics of the profession; and I think I am not wrong in saying that any Fellow of the Institute of Chemistry of Great Britain is an exceedingly high-class man and can always be relied upon in any class of work which he undertakes. Should he get into work for which he is not quite competent, all he has to do is to go to one of the other Fellows who stand always ready to help him. All chemical offices of a public nature in Great Britain can be obtained only by Fellows of the Institute of Chemistry. Only in very rare instances are chemical posts given to other men, and during the war this was very much accentuated.

You will remember there was a similar movement on foot here some years ago, but instead of starting with the parent society, the American Chemical Society, a certain few broke away and started the American Institute of Chemical Engineers. I do not think that the chemical engineers are the right people to have charge of such a movement as the New Jersey Chemical Society proposes, nor do I think that the New Jersey society itself is the right place to start it. It should be done within the body of the American Chemical Society and certain selected men within that body should be formed into a section of consulting chemists, which would raise the standards of that class of chemists and would after a time institute an examination whereby only those fitted could become members. There would be a very great advantage in having such a society as this, because at the present time it is almost impossible to recommend a suitable man to a client, unless one happens to be

personally familiar with the records of a large number of men. In any event, there is no official record, and one has to trust to memory and hearsay, as to what this or the other man does or is competent to do.

A FELLOW OF THE INSTITUTE OF CHEMISTRY
New York City. — OF GREAT BRITAIN.

Register, Perhaps Certify, But Not Legalize

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to the proposal to form an Institute of Chemistry, I feel that the American Chemical Society now possesses a very good list of all the chemists in the country, though I am sorry to say that it contains the names of some who do not stand high. I would like to see the American Chemical Society's membership revised into chemists and associates, and have the former picked by a good committee. This would cover the first two points proposed in the scheme of the New Jersey Chemical Society—namely, listing and registering. As for certifying, this also might be worked in.

In the matter of legalizing, however, I am not sympathetic. I know that plumbers are legalized, but plumbers are robbers; doctors are legalized, but their patients pay for their mistakes; undertakers are legalized, but they bury the mistakes of the doctors. I believe that chemists should be able to demonstrate a high standing to such an extent that they will not need any legalizing.

New York City.

DAVID WESSON.

Need for Complete and Classified List

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to your editorial on the proposal to form an Institute of Chemistry, I am inclined to agree with your opinion. I think, however, that the plan has several good points, and suggest that Dr. Crane talk to the Council of the American Chemical Society about them.

While in Washington during the war, my work brought me in contact with chemists all over the country, and at that time an alphabetical list was made of all chemists in the service as well as out of it. I had hoped that this index might be kept up, and by combining it with the data secured by Major Breithut and the records held by Dr. Parsons, it would have been a comparatively easy matter to make a complete list of all chemists in the country and classify them according to their qualifications. I should like to see something of this kind carried out, as I believe it would be of great benefit to American chemical industries.

Brooklyn, N. Y.

ALLEN ROGERS.

Certification a Difficult Problem

To the Editor of Chemical & Metallurgical Engineering

SIR:—Replying to your recent letter regarding the advisability of organizing an American Institute of Chemistry, I would reply that the subject is a complicated and difficult one to handle. The New York Section of the American Chemical Society was troubled with the same problem about fifteen years ago, and after considerable study and discussion of the question decided that it would be inadvisable to attempt anything of the kind at that time. Of course, it does not necessarily follow that it is therefore inadvisable at the present time.

Superficially, the question appears to fall naturally into two main problems: (1) Registration; (2) certification. For purposes of registration, the proper place,

in my opinion, is the office of the secretary of the American Chemical Society, where there are already available the results of the extensive census of American chemists conducted by the Bureau of Mines during the war. In addition there is all of the material collected by the Chemical Warfare Service. The secretary's office could without very heavy financial expense function as the repository of the biographical records of all such chemists as may be willing to supply the requisite information concerning themselves.

The problem of certification is much more difficult and one which I do not feel the American Chemical Society can safely undertake without danger of disrupting its organization. The great success of our society has been due to its simple democracy, there being no distinctions of any kind attempted between the various groups of members. In years gone by such discrimination was attempted and we had active and associate members. The result was very unsatisfactory and as soon as this discrimination was dropped the society began to go forward by leaps and bounds, until it has reached its present proud position of being the largest chemical society in existence.

To undertake the creation of an Institute of Chemistry, presumably modeled along lines similar to those of the Institute of Chemistry of Great Britain, is a serious undertaking, and we must be clear in our own minds that the situation justifies it.

New York City.

MARSTON T. BOGERT.

Would Advertise Profession of Chemistry for Public's Education

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to your editorial on "Who Is a Chemist?" in which you comment on the proposal of the New Jersey Chemical Society to found an American Institute of Chemistry, I wish to say that a good many years ago I was chairman of a committee of the American Chemical Society which considered this same question and reported that in its opinion it was undesirable either to license a chemist or to form an Institute of Chemistry such as existed in England. The committee was of the opinion, however, that it would be desirable for the American Chemical Society to set up a branch of its membership which should take the place of an Institute of Chemistry and perform such functions of the British Institute as were practicable and desirable in this country.

Bearing on this subject, I have recently written to Dr. Crane of the New Jersey Chemical Society substantially as follows:

The first question one naturally asks about this matter of forming an Institute of Chemistry or of licensing chemists is, What is it designed to accomplish and what needs would such a movement fulfill? The answer seems to be that today there is nothing to prevent any man, whether he is wise or ignorant, able chemist or charlatan, from hanging out his shingle and advertising himself as a chemist. At the same time, before a man can practice either law or medicine he must have attained a fairly high standard and must have been legally recognized. Furthermore, even plumbers and chauffeurs must prove their fitness to act in their respective capacities, or otherwise we should be poisoned with sewer gas or constantly threatened with loss of life on our streets. The real question is whether the employment of a chemist involves risks to the employer that are comparable to those taken by the public in employing a

lawyer, physician or chauffeur, and furthermore, whether these risks can be removed or greatly minimized by examining chemists and thus separating the sheep from the goats.

The relation of the chemist to the public is now such a complex one, and the services now rendered by chemists and to be rendered in the very near future are so varied in character, that it is difficult to see how any examination could cover the field. If it did so adequately, few could begin to pass it, and probably the few who could do so would be by no means the best men.

So much for legislative regulation as to the fitness of chemists to practice their profession at all. The plan of forming an Institute of Chemistry which shall guarantee only that its members have in the first place an extensive knowledge of general theoretical chemistry, and, if it seems desirable, also guarantee that certain classes of its members are expert in this or that branch of chemical practice, rests upon an entirely different and surer footing as long as it does not attempt to make a closed shop of the country and deny to non-members the right to work if they can find employers. The serious difficulty between the chemists and the public today is the lack of understanding by the public of the nature of the services which the chemist can render. Restrictive legislation does not promise anything like a remedy for this, but the American Chemical Society already is doing much, and perhaps an Institute of Chemistry, if it should undertake this task, might accomplish more. The question seems to resolve itself into one of properly advertising the profession of chemistry, letting the public choose who serves it best. It is only the chemists who can teach the public that their services are necessary and valuable, and the plans outlined by the New Jersey Chemical Society may be judged by the test of whether or not they are to further this teaching.

New York City.

PARKER C. MCILHINEY.

Plan Should Be Tried on a Small Scale at First

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to your editorial on "Who Is a Chemist?" and the proposal of the New Jersey Chemical Society to start an American Institute of Chemistry, I wish to say that such an institute if started should have a small geographical scope. An organization covering the State of New Jersey probably will be large enough; perhaps a county or a few counties will be big enough for a beginning. In other words, I favor a kind of test-tube experiment first. Conditions vary so from city to city and state to state that I am convinced that the inauguration of a national body in the beginning would fail and unnecessarily delay national standardization far beyond the time at which it can be accomplished if started in small units in different states or localities. Let the New Jersey Chemical Society try to standardize things for, say, the Newark district and then spread out from there. This process would bring to light a lot of concrete facts that would help solve the national problem.

As for some of the other things which it is proposed to accomplish, why not assist the present agencies to do them better, rather than inaugurate something new? Thus in the proposal to list all chemical products, why not help out the Condensed Chemical Dictionary? And as for listing all chemical industries, why not help Dr. Lovelace keep the Annual Chemical Directory up to date

and properly enlarged instead of competing with him? It seems to me that the New Jersey Chemical Society could contribute a great deal to the subject by outlining in the form of a law the necessary requirements for the general or specific practice of chemistry. Here again they might begin with a small district, such as Newark, and then try it for the State of New Jersey and see if the state will pass such a law.

*New York City.

BERNHARD C. HESSE.

Futility of Examinations

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your editorial, "A Question That Will Not Down," in the Feb. 2 number, the sentence, "As for the certification feature . . ." brings up a very vital question, Who is really competent to judge the correctness of answers to questions dealing with industrial subjects? We have many men in the chemical, as well as in other sciences, with advanced ideas, which are not common property. A set of examination questions can easily (and quite unintentionally) ask for such knowledge, which the candidate has made a special study. If he answers to the best of his ability, he would be publishing information which others have been seeking unsuccessfully. If his answers are only on the basis of published information, they may be considered insufficient due to special knowledge by one or more of the examining board. Furthermore, technical questions are often a matter of opinion due to varying conditions. What is excellent practice at one point, due to conditions, must be condemned elsewhere.

Another phase of this question is how such an examination would be conducted. Would the candidate be compelled to rely solely on what he carries in his head or would his knowledge of where to find information also be considered? This latter source of knowledge is often much more valuable than the former, otherwise we would have very limited use for reference libraries. A recent advertisement for an experienced industrial manufacturing chemist at \$80 to \$100 per week specifying "Must pass preliminary examination without reference to handbooks" certainly expresses the opinion that only memory of facts, and not the ability to find facts, is knowledge.

Are we not treading on very thin ice?

Newark, N. J.

HERMAN S. RIEDERER.

Causes of Corrosion of Copper and Brass

At a recent meeting of the Birmingham and Midland Section of the Society of Chemical Industry, Dr. O. F. Hudson, of the Admiralty Research Laboratory, said that he believed electrochemical action was not the sole cause of corrosion in the case of copper and brass, and that in most cases, in neutral or slightly alkaline solutions, that action was relatively unimportant, the greater part of corrosive attack in these cases being due to direct chemical action. In acid liquids, and industrial waters which had a distinctly acid reaction, electrochemical action might play a more important part, but in such cases the metal—e.g., condenser tubes—failed by general thinning rather than by pitting or localized attack, which was in other cases generally the chief trouble. Electrolytic protection processes probably owed their efficiency largely to the production and maintenance of a uniform resistant scale of calcium carbonate. There was little hope of finding an alloy which would resist corrosion under all conditions.—*The Engineer*, Dec. 17, 1920.

What Chemistry Can Do in the Food Industry

A Concise Dissertation on the Broad Field of Work That Is Open to the Chemist in the Food Industry and on the Beneficent Results Derived From the Application of Chemistry to Obtain More, Better and Cheaper Food

BY R. S. HILTNER*

IN THE industry of food production, nature and science have always been true helpmeets and must necessarily be such. Since 1912 the knowledge of food and of the essential principles of animal feeding and nutrition has been marvelously clarified. Such competent investigators as Funk, McCollum, Osborne, Mendel and many others (Seidell, Morse, Talbot, Hogan) have turned a deep-penetrating searching light on the subject and have discerned many facts as to the true nature of food and the dietary requirements of the animal body. Those men and others not mentioned have shown by their discovery and study of vitamins, food accessories, that in reckoning the feeding value of food we must consider more than the mere calorific coefficients and the empirical composition, the percentages of fats, carbohydrates, protein and mineral salts. They have shown that certain natural foods—eggs, milk, green vegetables, mature fruits, for example—contain substances that are absolutely essential to growth of the animal body—dumb brute or human. Without those substances the body would soon become scurried, would wither and die, even though fed with fat and protein and sugars and inorganic salts.

They have shown that those classes of food components, though closely approximating each other in chemical composition, differ widely in their nourishing powers. We know now that all proteins are not alike in nutrient quality and digestibility. The fats and oils, while similar in their proportions of carbon, hydrogen and oxygen and in their heat values, vary widely in flavor, palatability and assimilability. Even the carbohydrates are not in agreement as to food value. The starches differ from the hydrolyzed bodies, and, what is more, the sugars having identical empirical composition are variable in value as foods. The aldehyde sugars—for example, dextrose—are not like the ketone sugars, such as levulose, in food quality. Recently it has been shown that the starches of various plants are dissimilar in chemical composition, and by inference we may conclude also that they are not quite alike in food value. We have been wont to believe that starch is starch—a carbohydrate strictly so. But starches contain phosphorus largely in carbohydrate combination¹ and in varying amounts. Potato starch contains about 0.15 per cent total phosphorus computed as P_2O_5 , while corn starch contains only 0.03 per cent.² Obviously, therefore, the sugars produced from the different starches by hydrolysis have somewhat un-uniform composition and probably variable nutritive value.

These facts—some newly discovered and some long known—possibly somewhat unrelated to the subjects are

set forth here as a framework for the answer to the question, What can the chemist or chemistry do in the food industry? The activity of the chemist in the food industry naturally resolves itself into three or more phases. Analytical control is one, technical and engineering another, and investigation and research another. All are important and it is difficult to say which is the most essential to progress and success of the industry. The analyst's part in the industry is easily understood. It is important work. The chemist-analyst is the controller of the industry. He holds forth the guiding hand. The function too of the chemical engineer is clearly defined. We look to him for results in matters of production and quality of output and for constructive suggestions relating to improvements in technique and general procedure.

What the chemist investigator can do to benefit the industry is quite another matter. It is the kernel of the inquiry. When we speak of the food industry we quite intuitively think of food manufacturing. But, strictly speaking, is there such a thing as food manufacturing or can there be? Do not the electricians' terms "transformer" and "transforming" apply more aptly? No one has ever made a fat or an oil, though the chemist has learned how to transform them and refine them and make palatable food-fats out of unpromising products. No one has ever manufactured a protein or a starch. Nature's barrage has been so dense and so baffling in this respect that few, in recent years, have had the courage to attempt to penetrate it. The production of the fundamental food elements seems to require nature's own handiwork. No true-hearted chemist should ever allow himself to cry "it can't be done," or permit himself to be checkmated, or to throw up his hands and quit while the breath of life remains in him. But thus far the "game" has been practically lost by all who have played it. The nearest approach to winning against natural forces—and this may be said for the encouragement of the chemists who will still try—is in the synthesis of a few of the sugars and of some of the organic food-acids. Despite all the efforts that have been made we are forced back into the groove of thought of chemists prior to Wöhler and are thinking and saying that nature does and must play an important part in the production of "organic" chemicals. As a matter of fact, and strictly speaking, all foodstuffs are "organic" chemicals, simple or complex compounds or mixtures. Salt is perhaps the only exception, though it is not really food. The ash, frequently spoken of as "mineral matter," derived from foods by incineration, does not exist in foods, *per se*, but in combination with organic acids, protein, etc.

The discoveries of vitamins by biological chemists recently have also served to upset the calculations of many an ambitious chemist who would produce foods

*National Canners' Association, Denver, Col.

¹Northrop and Nelson, *J. Am. Chem. Soc.*, vol. 38, p. 472, February, 1916.

²R. S. Hiltner, National Canners' Assn., and H. J. Wichmann, U. S. Dept. of Agriculture, Bureau of Chemistry; unpublished article.

artificially and synthetically and even of the less scientific and pretentious food manufacturer or transformer, if you please, who would elaborate some strange raw product into acceptable food.

NATURAL FOODS VERSUS CHEMICALLY MADE FOODS

The proof recently secured that butter fat is far superior as growth-producing food to other oils and fats is as interesting and valuable as it is disconcerting to the chemist. Who can say at present that those acids and those sugars that have been produced artificially are as good foods as those elaborated by nature? The presence of food accessories, minute in amount but mighty in force and effect, in natural foods still keeps them at a high premium above any that chemistry has elaborated. Perhaps after all it is just as well that it should be so. The kitchen is not the normal place for the chemist. Trained appetite will not willingly open its mouth for chemical food. The layman in his mind associates chemicals with poisonous acids and vile smells and wants none of them for food. God-made foods are to be preferred to man-made.

THE SCOPE OF THE CHEMIST IN THE FOOD INDUSTRY IS FOR GREATER EFFICIENCY

If, then, the chemist yield to the thralldom of Nature and admit that she is the supreme artisan and compounder of food, what is there left to him as a scientist to accomplish in the food industry? The most sensible answer seems to be that he continue his course, outward and upward, working out his schedule, striving for greater and greater efficiency. That course has never been along the smooth road marked with signposts, but off the trail into regions unexplored. His schedule in the food industry has never comprised, as an essential part, the fanciful plan of elemental construction of foods, but rather the scheme of refining natural products and finishing raw materials. Extracting foods rather than manufacturing them has been the accomplishment of chemistry.

The refining of sugar from the sugar beet and the recovery of byproducts is one of the most notable achievements of chemistry, as applied to foods production. Out of raw juice of the beet, complex in its make-up, by the use of simple and inexpensive reagents a food is recovered practically chemically pure. There is a splendid example of food chemist efficiency. Therein lies a suggestion for further work. The human appetite craves sugars; the animal body requires them. They must be extracted from raw products or else built up from other products. Substitutes there are none and can be none, any more than there can be real substitutes for butter, for eggs, or for the protein of meat. The tongue may be fooled, but the stomach never.

The demand for sugar is ever increasing. To meet it the sugar chemist should do his part. Increased production will come from closer communion and co-operation with Nature on the part of the chemist, the plant-breeder and the farmer. The scientist in the laboratory and the scientist on the farm must keep in touch. The two must study and develop species of plants now unused for sugar production. They must not overlook the starchy roots that can be converted into sugars—the “cat-tails” and sweetflag of the roadside bog may be cited, in passing. They must not forget the possibilities in other roots and tubers. The Jerusalem artichoke, the dahlia bulb, the chicory

root contain inulin, kindred to starch, capable of yielding a sugar, levulose, sweeter far than glucose.

He who takes the lead in these matters must be possessed of a fine courage, must let his fancy take flight, must be willing to risk well-earned reputation, must “take a chance.” The sugar chemist must study deeper into mysteries of carbohydrates. He must know cellulose better. That stubborn substance, the framework of plants, itself a carbohydrate closely related to starch and sugar, should be converted or transformed into sugar. Speed the day when a sack of sugar can be evolved from a bale of straw! Progress along this line has been made recently in the U. S. Forest Products Laboratory at Madison, Wis.³

WHAT THE CHEMIST CAN DO IN THE FOOD INDUSTRY

The animal continually clamors for food. In the words of the nursery jingle, “Please give us more and more and more, such hungry birds I never saw.” It is not the cry of greed, but the call of need. Chemistry more than any other science can aid in supplying that demand, especially so far as human food is concerned. The ox relishes raw cane, but man must have refined sugar; the wild animal prefers the blood and vital organs of his prey, but man chooses “dressed” meat.

The sugar chemist has a part to play in meeting that requirement; the oil chemist a part and the protein chemist a practical rôle. Many problems are yet unsolved and there is room for each to do his best.

Someone will soon learn how to make better glucose—a drier, whiter, sweeter product from starch. Someone will improve the present sugar and recover more from the raw material. Someone will develop a better process for gelatine and produce a cleaner, more wholesome article. Someone will make still further advances in transforming and refining edible oils, and make more oils fit to eat.

Chemists are learning more and more about catalysts and enzymes and ferments and will use them more in the future in producing new foods or better products.

Some day chemistry will discover the way of extracting vitamins from bulky produce and concentrate them in acceptable forms in foods. Chemistry will improve the art of preserving foods by canning, by drying, by concentrating, holding color and flavor and food quality intact. Paradoxical though it sounds, the chemist will teach us how to transform, preserve and conserve foods without the use or introduction of chemicals. For the dried fruit industry he will discover the way without using sulphur to destroy the enzymes and prepare the product so that the eye of the consumer will be pleased and the palate not offended and health not deranged. For the miller he will find a better means of bleaching and “aging” flour. For the butcher he will learn better technique in preserving meat, avoiding chemicals and dyes. For all he will constantly watch for “leaks” and devise better schemes for preventing wastes and for utilizing byproducts.

These things are not said as prophecy, but because of an abiding confidence in the ability of the chemist to accomplish whatever he diligently seeks to attain. He will answer the call for more and better and cheaper food. In his efforts to achieve these things, let him emulate the aviator, unafraid, striving for altitude records, braving the cold lonesomeness of the higher levels and minding not the withering winds of ridicule.

³See CHEM. & MET. ENG., vol. 24, No. 4, p. 160, Jan. 26, 1921.

Electrolytic Zinc Plant of the Anaconda Copper Mining Co., at Great Falls, Mont.*

Utilization of Sulphate Roast to Save Leaching Acid—Insoluble Zinc Ferrates in Iron-Bearing Calcine—Coagulation, Granulation and Filtration of Silica and Other Impurities From the Zinc Solution—Slime Purification—Dross and Residue Treatment

ABOUT six years ago the Anaconda Copper Mining Co. decided to investigate the possibility of extracting zinc from the complex ores of Butte containing so much iron and lead that the concentrate analyzed only 33 to 35 per cent zinc. After a careful preliminary study it was decided that the electrolysis of sulphate solutions was the most promising method for zinc recovery. It was soon found that to obtain a good zinc deposit an electrolyte is required free from all metals more electronegative than zinc, such as copper, cadmium, lead, arsenic or antimony, etc. Arsenic and antimony are particularly injurious, causing very small yield per horsepower when present in amounts so small as almost to defy detection—1 mg. or less per liter.

It was not found difficult to maintain an extremely high degree of purity in the zinc solution going to the cells if the iron content is thoroughly oxidized before precipitation by means of limestone or excess calcine and if sufficient zinc dust is added to satisfy the copper, cadmium and whatever small amount of lead might be present. It may be necessary to add a ferric salt to low-iron solutions to insure the complete precipitation of all arsenic as ferric arsenate. The best way to make sure of the oxidation of the iron is to maintain a small amount of manganese in solution; it becomes oxidized in the cells to permanganic acid, manganic sulphate and manganese dioxide.

An aluminum plate makes the most successful cathode and a lead plate the most suitable anode. The latter becomes coated with a brown layer of manganese dioxide and lead peroxide, but if the electrolyte is entirely free from chlorides the lead is not attacked; anodes used three years seem as good as new. Zinc starting sheets proved unsatisfactory, as the sheets warped and caused short circuits.

Forty-eight-hour sheets weighing about 20 lb. (40 lb. per cathode) are generally made. Heavier cathode deposits become roughened, due to sprouting, and also tend to break contact between sheet and the aluminum plate.

In practice the most satisfactory current density is from 22 to 25 amp. per sq.ft. Evolution of gas at the anode is then sufficient to provide the necessary agitation.

After working in the laboratory for more than twelve months a 10-ton plant was erected at Anaconda, but by making changes its output was increased to twenty-five tons per day. The plant went into commission about the first of November, 1915, and was operated with considerable profit for a year. On Dec. 13, 1915,

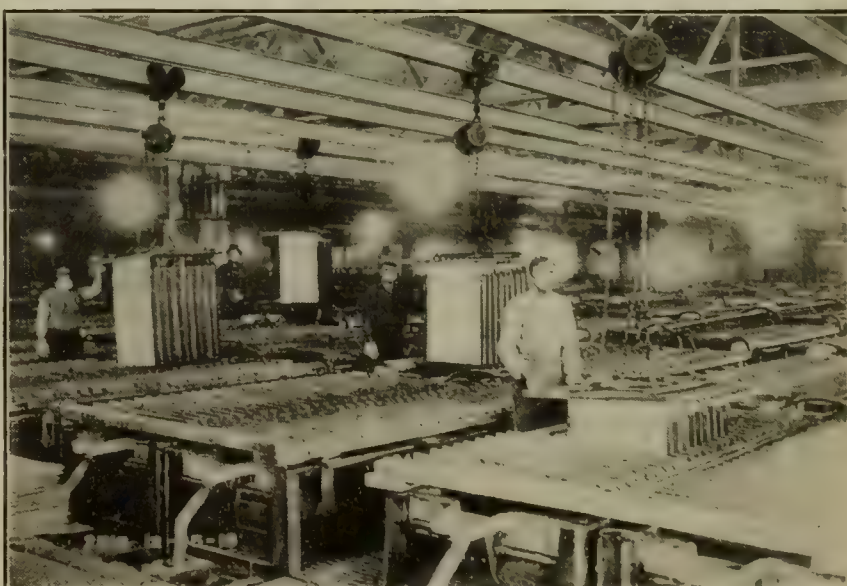
ground was broken for a 100-ton plant at Great Falls; this plant began operations on Sept. 11, 1916, and was completed in December. In 1918 the plant was enlarged to make 150 tons of zinc per day.

ROASTING DIVISION

At Great Falls there are fourteen roasting furnaces of the Anaconda-Wedge type. As the 1918 extension called for more roaster capacity than was available at Great Falls, fourteen 20-ft. McDougall furnaces at Anaconda were converted into zinc roasters. Each furnace has two fireboxes, one on each side of the seventh hearth. Powdered coal is blown into the fireboxes under 12-lb. pressure.

This plant was started on the oxide roast as developed at the Anaconda experimental plant. When the new zinc plant reached full capacity, the sulphuric acid plant at Anaconda was unable to supply the leaching acid, so it was decided to try again sulphate roasting, unsuccessful in the 25-ton plant at Anaconda. As the result of a series of tests, which demonstrated that a sulphate roast was practicable, all furnaces were put on sulphate roasting with a 40-ton feed per twenty-four hours, with results as plotted in Fig. 1. The slower speed of the rabble arms and low temperature resulted in a big reduction in furnace repairs which more than compensated for the slight increase in fuel and for handling the doubled weight of flue dust. Apparently there is a decrease in silver volatilization with sulphate roasting because silver recovery has been higher at Great Falls than at Anaconda.

Much has been said about the difficulty of roasting iron-bearing concentrates, so as to render the zinc soluble. It was found that insoluble zinc compounds are undoubtedly formed and the percentage of zinc that remains insoluble increases with roasting temperature. However, it is not difficult to



ZINC ELECTROLYZING DIVISION

Operation of lifting frames and method of cathode removal

*Abstract of a paper to be presented Feb. 14, 1921, before the N. Y. meeting of the American Institute of Mining and Metallurgical Engineers by Frederick Laist, manager Reduction Works, Anaconda Copper Mining Co.; F. F. Frick, research engineer Anaconda Copper Mining Co.; J. O. Elton, assistant general superintendent Great Falls Reduction Department, Anaconda Copper Mining Co.; R. B. Caples, assistant superintendent Great Falls Reduction Department, Anaconda Copper Mining Co.

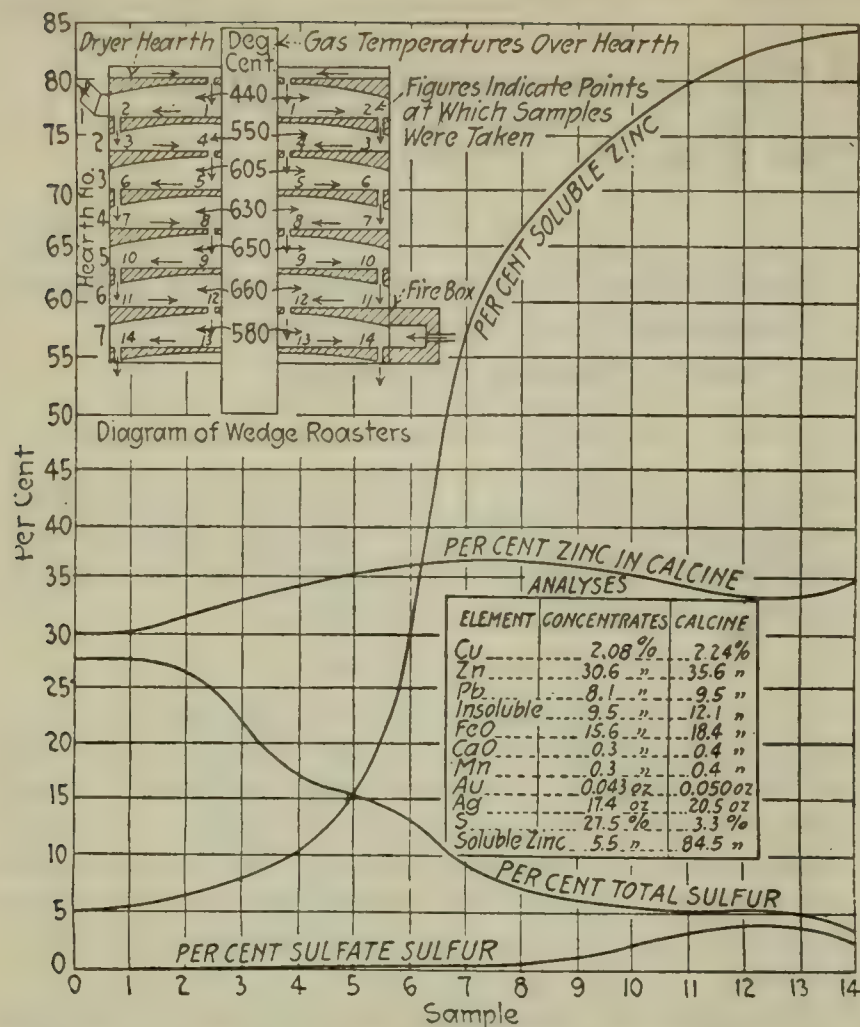


FIG. 1. ROASTING LOW-GRADE CONCENTRATES IN WEDGE FURNACE

make a calcine containing 82 per cent of its zinc soluble in 2 per cent sulphuric acid, from a concentrate that contains 33 per cent zinc and 20 per cent iron. An excessive temperature (more than 600 to 625 deg. C.) will reduce the efficiency to 60 per cent. A concentrate containing 50 per cent zinc and under 5 per cent iron will render soluble about 94 per cent of its zinc. (Fig. 2.) The temperature may be greatly increased on low-lead concentrates which do not sinter.

The McDougall furnaces at Anaconda have consistently given about 3 per cent higher solubilities than the larger Wedge furnaces; the former are equipped with dust collectors and have the firebox on the sixth hearth. The Cottrell treater, being placed just over the furnaces, precipitates sulphur trioxide with the flue dust which is returned hot to the first hearth of the furnace when the treater plates are rapped. This sulphur trioxide appears to combine with the moisture of the incoming concentrate, forming sulphuric acid on the first hearth, and producing a fuming effect. This may account for the increase in the amount of soluble zinc, since experiments have shown that soluble zinc in roasted concentrates can be greatly increased if the raw concentrates are moistened with H_2SO_4 .

LEACHING DIVISION

Leaching is continuous and in two steps: (1) A neutral leach where all the calcine and approximately one-half of the total acid is added; (2) an acid leach where the remainder of the acid is added. Operations may be followed by reference to the flow sheet, Fig. 3. A general plan of the 150-ton leaching building is shown in Fig. 4.

Solution for the neutral leach is made up with one-half the cell-acid (containing 11.5 per cent H_2SO_4 and 7.5 per cent Zn) and the partly spent leach liquor (0.6 per cent H_2SO_4 and 10 per cent Zn) from the acid leach, and run into the first of a series of seven Pachuca

tanks. Sufficient oxidized iron must be present to account for all the arsenic and antimony, otherwise they will not be removed and poor tank-room efficiency will result.

Calcine is fed into the next three Pachuca tanks in such manner that there is an average drop of 2.5 per cent acid in each tank. Nothing is added to the fifth tank, which is used as a control tank in which the acid should be nearly, or completely, spent. One-sixth of the total amount of calcine is added to the sixth Pachuca tank, together with a small amount of limestone. The excess base contained in the calcine and limerock completely precipitates the ferric iron, granulates the gelatinous silica and partly precipitates the copper. These chemical precipitates, together with the insoluble residue, carry down all the freshly formed insoluble compounds of arsenic and antimony. The seventh Pachuca is also a control tank. After the base is added it takes several minutes for the leach to coagulate. This is one of the most important steps in the process; if it is carried out too rapidly poor settling results and in a short time the rest of the plant will be blocked with

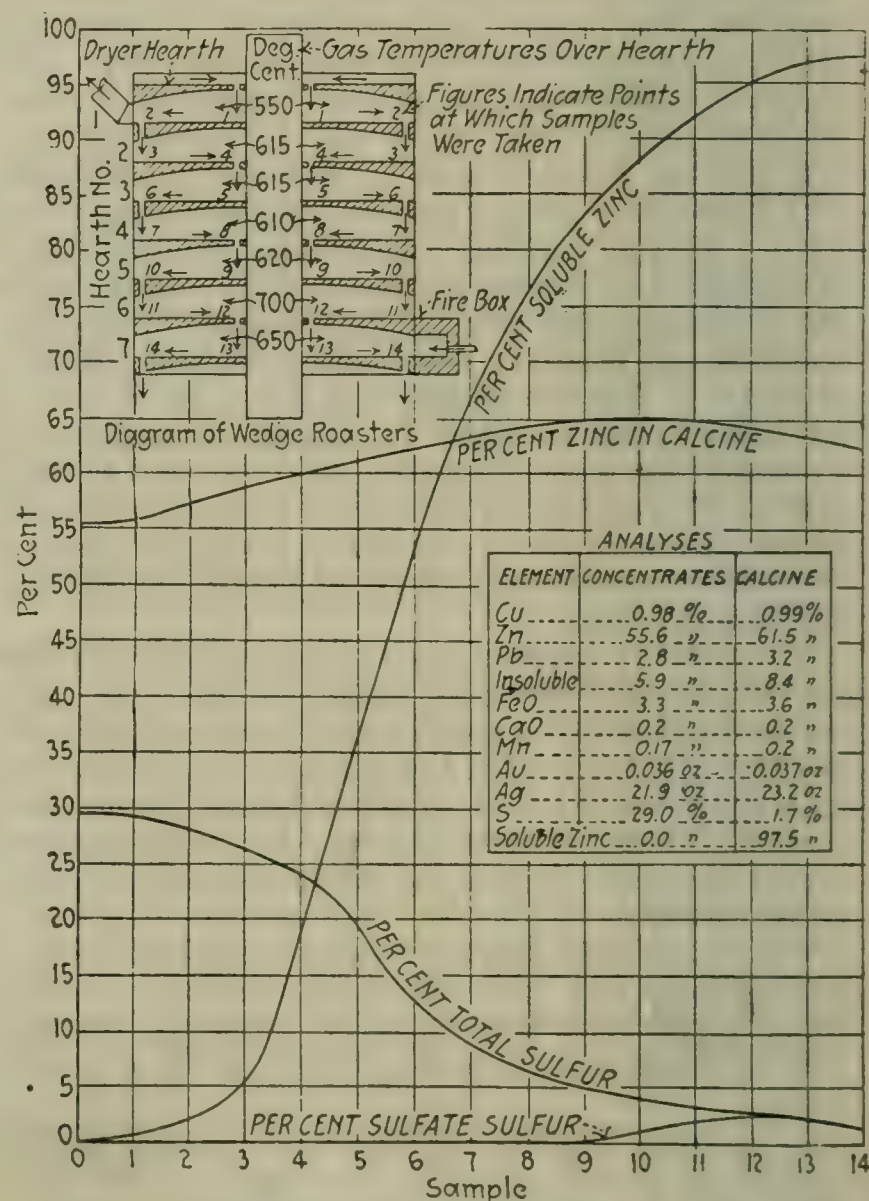


FIG. 2. ROASTING HIGH-GRADE CONCENTRATES IN WEDGE FURNACE

mud. When properly carried out each granular particle appears to be inclosed in a flake of freshly precipitated iron, lime or gelatinous silica. The solid particle forms a nucleus for the precipitate and provides the weight to carry down the flaky particles.

The discharge from the last Pachuca goes to the neutral classifiers, which remove the sand for regrinding and return for further treatment. Overflow goes to Dorr settlers, which discharge a clear liquid for the purification process, and a spigot product (50 per cent solids) for feeding the acid leach.

To sum up, in the first, or neutral, leach all calcine enters the process and approximately three-fourths of the soluble zinc is taken into solution; iron is oxidized and precipitated; gelatinous silica is coagulated by excess base and rendered granular; arsenic and antimony are completely precipitated; 80 per cent of the copper is precipitated as hydroxide by the excess base; a large percentage of the zinc is separated from the residues in a clear solution, containing 20 per cent of the soluble copper and all the soluble cadmium.

The ground sand and the settler spigot are leached in three 10 x 20-ft. Pachuca tanks with the remainder of the cell-acid and sent to the acid settlers. It is necessary only that the overflow is maintained at approximately 0.5 per cent acid. Too high acidity interferes with the settlement on the neutral side, increases the volume of solution and causes iron to circulate; too low results in poor recovery.

The spigot product of the acid settlers, containing 60 per cent solids, is filtered, the cake repulped with hot water, and refiltered. Hot wash water is used on each set of Oliver filters. If this double filtering operation is properly carried out, less than 20 per cent of the zinc contained in the residues will be soluble in sulphuric acid. If 90 per cent of the zinc in the calcine was soluble this corresponds to a recovery of 87½ per cent. Fig. 5 is a diagram used in determining the zinc-plant recovery.

Filtrate from the acid filters is combined with the acid settler overflow and goes to copper precipitation tanks, where scrap zinc from the tank room and scrap iron are added to remove most of the copper from the solution.

Summing up, the results of the acid leach are: (1) solution of the remainder of the acid-soluble zinc and copper; (2) final separation of the solids from the zinc-copper solution; (3) roughing out of the copper and chlorine; (4) solution of sufficient iron to guarantee

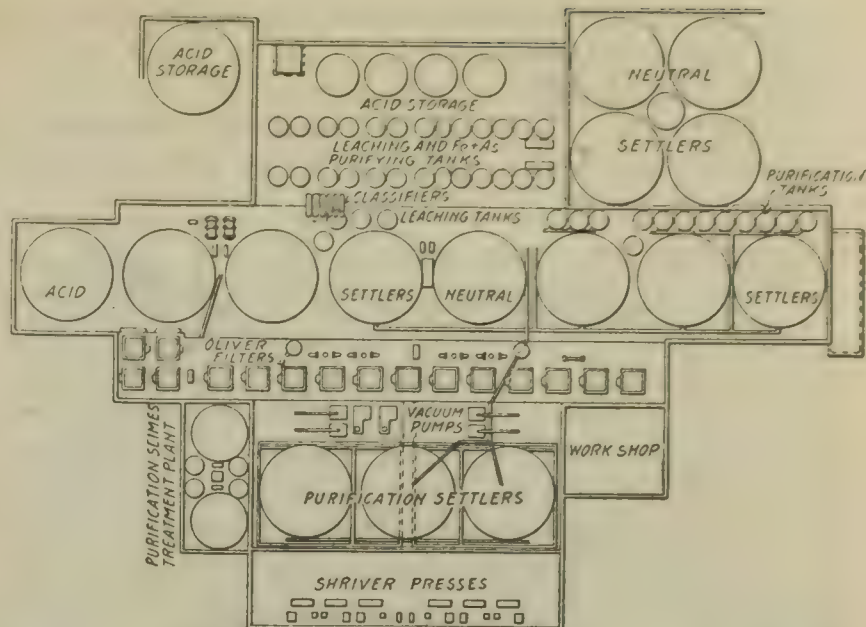


FIG. 4. GENERAL PLAN OF 150-TON LEACHING BUILDING

the removal of the arsenic and antimony in the neutral leach; (5) elimination of the arsenic and antimony partly redissolved in dilute acid.

PURIFICATION

The overflow from the neutral settlers is pumped to twelve 10 x 20-ft. air-agitated Pachuca tanks, where it is treated, first, with recovered zinc sludge from the purification classifiers to rough out the copper; second, with zinc dust, added carefully until copper cannot be detected by the hydrogen sulphide test; third, with a definite excess of zinc dust to insure that all the cadmium is precipitated. After the addition of the zinc dust, the tank is agitated for fifteen minutes and then discharged through a drag-line classifier to one of two 10 x 50-ft. Dorr settlers in series with six 25 x 60-ft. concrete settling ponds. The pond overflow supplies eight Shriver clarifying presses; the solution after it passes the presses is as clear as crystal, and is ready to feed the tank room.

Failure of the early experimenters to recognize the harmful effects of minute quantities of certain impurities is the principal reason for their disappointment. It is not safe to say that a definite amount of any impurity can be tolerated, because their harmful effects appear to be cumulative. For instance, when a small amount of copper is present (10 mg. per liter), the harmful effects of a little arsenic or antimony are greatly multiplied. Therefore safety lies in the elimination of all to the greatest possible degree. Since purification is based upon the fact that a large excess of zinc dust will completely precipitate the last traces of cadmium and

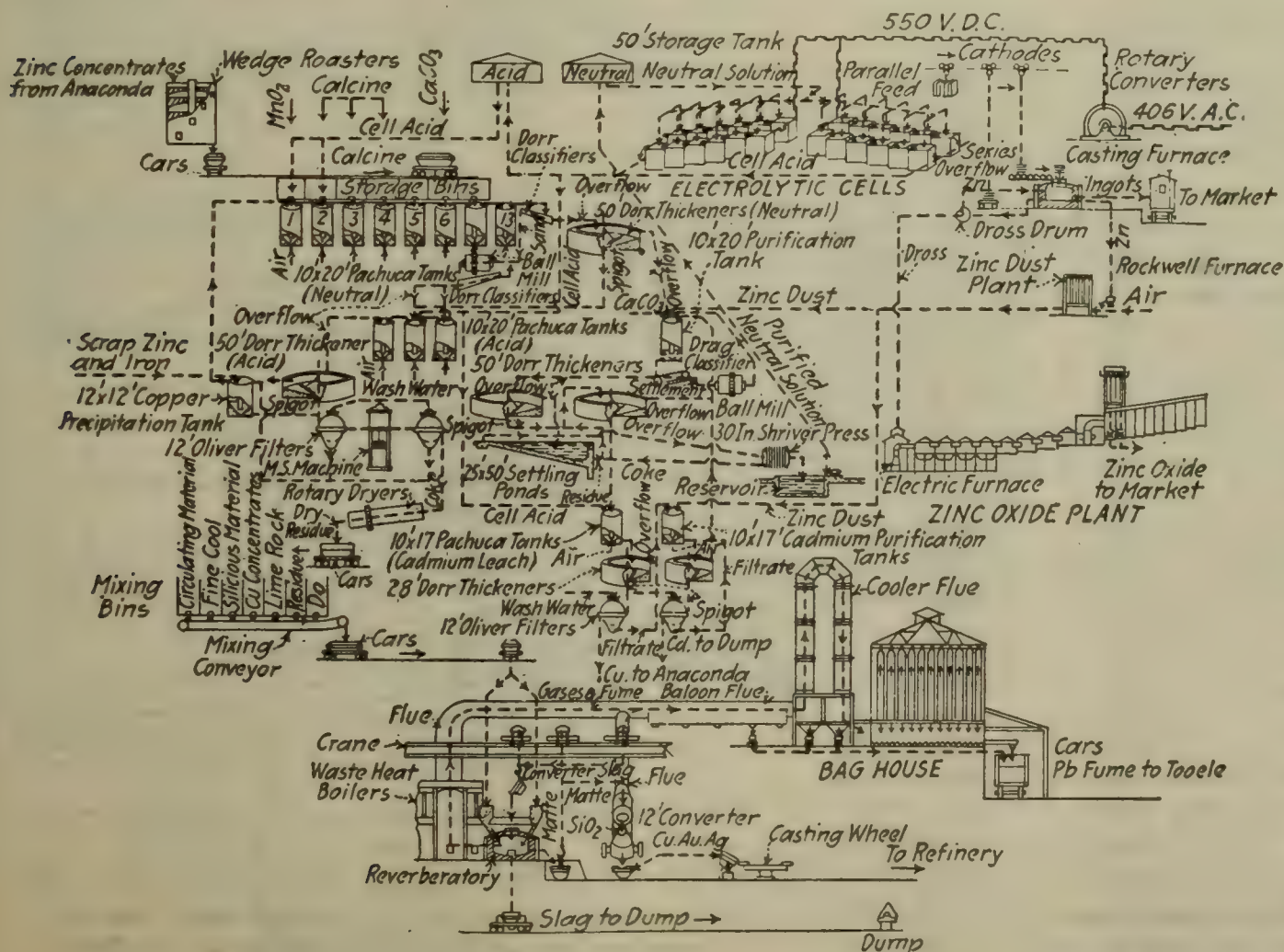


FIG. 3. FLOW SHEET OF 150-TON PLANT

copper, to get a reasonable degree of efficiency from the zinc a recovery system supplemented by a purification-slime treatment plant is necessary.

Coarse zinc dust from the drag-line classifier is brightened in a pebble mill and reused in purification.

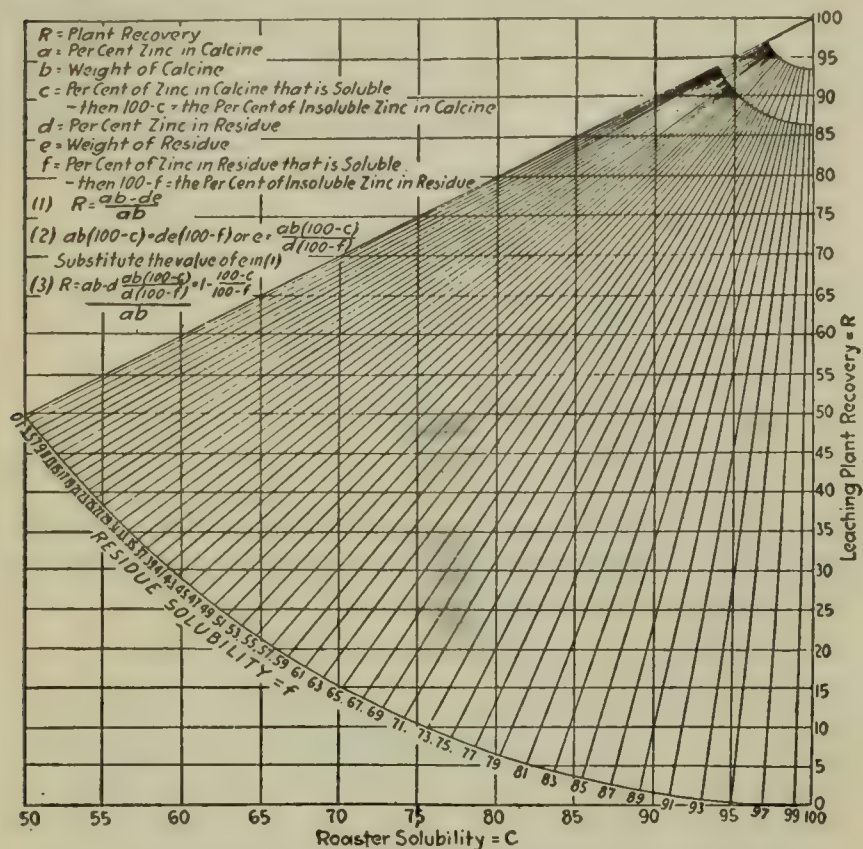


FIG. 5. GRAPHIC REPRESENTATION OF ZINC PLANT RECOVERY FORMULA

Based on the fact that insoluble zinc in calcine equals insoluble zinc in residue.

The sludge from thickeners and ponds is pumped to a scavenger settler, which receives all the spill and washings from the presses and the purification settling system and acts as a combination settler and slime storage tank. The overflow of this settler is pumped back to the purification tanks.

OPERATION OF THE SLIME PURIFICATION PLANT

The spigot product of the last-mentioned settler is pumped to two 10 x 17-ft. Pachucas until they are about one-third full, then cell-acid is run in slowly to dissolve cadmium and zinc and the solution is agitated until the copper just begins to go into solution as noted by the sodium sulphide test. The contents are then pumped to the copper settler, producing a rich slime (30 per cent copper) which is filtered on a 12-ft. Oliver filter and sent to Anaconda for smelting. The settler overflow contains cadmium and zinc; it is run to two Pachucas to which zinc dust is added in sufficient quantity to reduce the cadmium content to that of the neutral Dorr overflow.

These tanks are then discharged into a settler, the overflow being returned to the purification cycle. The spigot product contains 12 per cent cadmium and is stored for subsequent treatment.

ELECTROLYZING DIVISION

The tank house contains 864 cells 10 ft. 3 in. long x 2 ft. 10 in. x 5 ft. deep divided into six groups. Cells are made of wood, lined with lead, and each contains twenty-eight anodes and twenty-seven cathodes. Cathodes are approximately 2 ft. x 3 ft. 6 in. x $\frac{1}{8}$ in. thick, made of rolled sheet aluminum and have a copper contact bar riveted to the top so that 3 ft. of the cathode is submerged. Cathodes are spaced 4 in. centers.

Anodes are made of chemical lead and so cast that the copper contact bar is completely inclosed by the lead except at one end where contact is made with the conductor bar. Anodes have slightly less area than the cathodes and are $\frac{3}{8}$ in. thick. Distance from cathode to anode is therefore approximately 1 $\frac{1}{2}$ in. A triangular conductor bar is used and permits all of the contacts to be on the aisle side of the tank.

Each tank-room unit, or block of 144 cells, is subdivided into twenty-four cascades. Each double cascade forms a stripper unit, which is divided by a runway. Cells of each cascade are placed end to end so that the discharge of the top cells flows into the next lower cells, while the discharge of the sixth cell spills into the tail launder, which carries the spent electrolyte to storage. Solution is fed into the first five cells of a cascade; the sixth is used as a control from which hourly samples are taken and run for acid.

Current for each unit of 144 cells is supplied by a rotary converter of 5,800-kw. output at 580 volts and 10,000 amp. maximum capacity. At full load the current density is approximately 30 amp. per sq.ft. Voltage can be varied 40 volts up or down by means of a booster set. Each additional 1,000 amp. on a circuit calls for approximately 15 volts on the circuit. Figs. 6, 7 and 8 are taken from several valuable diagrams given in the paper which show current characteristics as affected by cell conditions, while Fig. 9 gives the power distribution to the whole plant.

On day shift twelve men strip the metal for each unit of 144 tanks. Nine cathodes are removed at a time and placed in a rack, which permits the stripping of adjacent sides of two plates each time one cathode is swung to the side. The bare aluminum cathodes are washed with hot water and surfaced with a wire brush

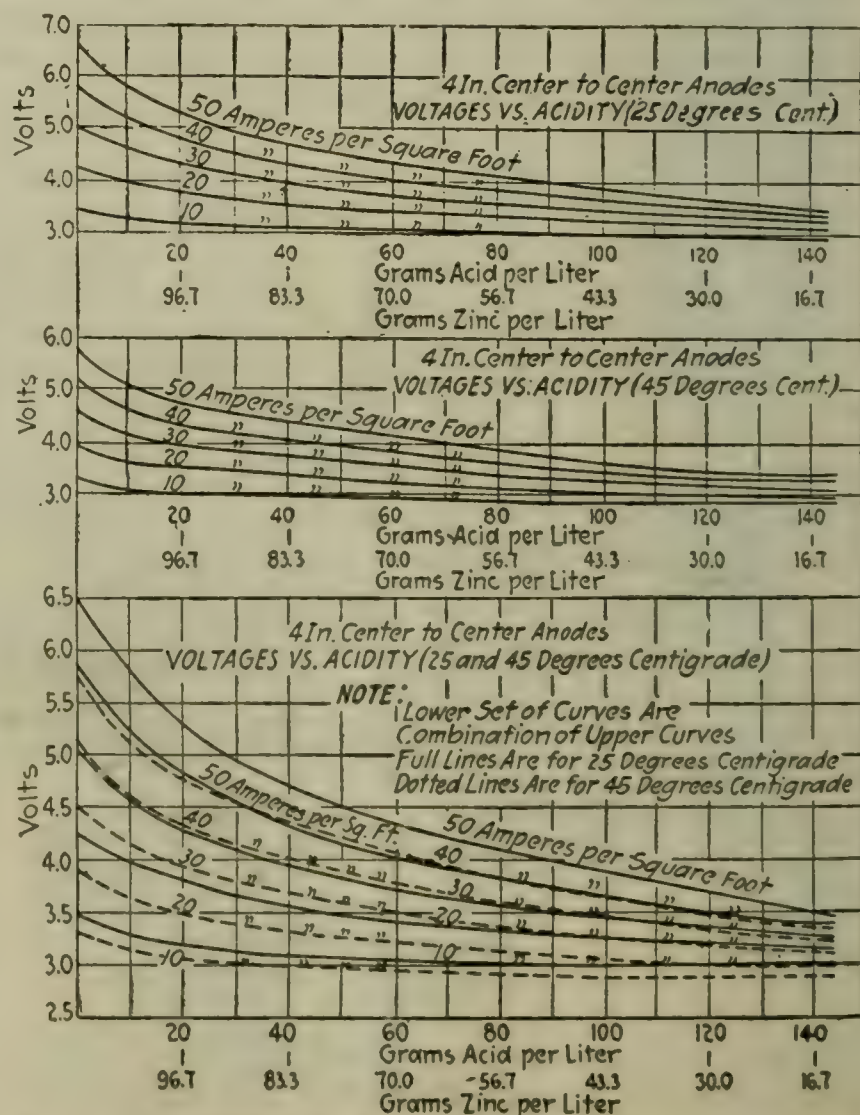


FIG. 6. EFFECT OF TEMPERATURE AND ACIDITY ON RESISTANCE OF ELECTROLYTE FOR VARYING CURRENT DENSITIES

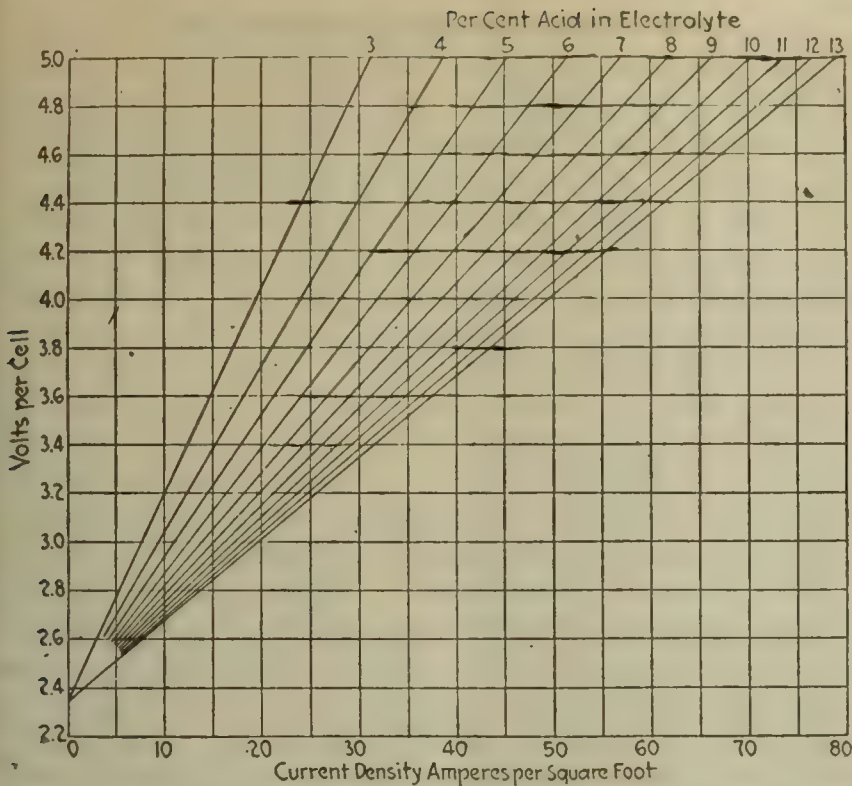


FIG. 7. VOLTS PER CELL FOR DIFFERENT CURRENT DENSITIES AND ACIDITIES FOR 2-IN. SPACING OF ELECTRODES AT 34 DEG. C.

when needed. Anodes are cleaned once each month or six weeks. Zinc sheets are not washed before they are sent to the melting furnace.

Every workman in the tank room is furnished daily with a nose and mouth mask of eight thicknesses of antiseptic gauze, to filter out the mist of electrolyte always in the air and caused by gas bubbles leaving the solution and atomizing a small amount of it.

All floors are made of wood, and are insulated from the tanks, bar lines and ground. Steel columns, to the height of a man's head, are boxed with wood. Chain blocks have a strain insulator between them and the crawl. As an added precaution against elec-

tric shock, shoes with non-conducting rubber or wood soles are furnished all men employed in the tank room.

Between 1 and 1.5 oz. (28 to 42 g.) of glue per ton of metal produced, depending upon the amount of impurities in the electrolyte, is added at two-hour intervals. The judicious use of glue gives a dense deposit resulting in better melting recoveries.

Manganese dioxide is deposited at the anode and falls to the bottom of the cell, which is designed with a storage space on the bottom to hold the accumulation for six months, which is the life of the wooden insulators. Originally dry maple blocks dipped in hot paraffine were used to support the conductor bars and dead ends of electrodes; glazed tile has been found preferable where it can be used without crushing.

MELTING DIVISION

The casting plant has two coal-fired melting furnaces with a capacity of from 100 to 125 tons per furnace per day. The firebox is large and deep and is operated as a partial gas producer giving a reducing atmosphere. At intervals the dross is rabbled free of metal with ammonium chloride; once every day it is completely skimmed and further worked while hot in a revolving concrete mixer to which oil and ammonium chloride are

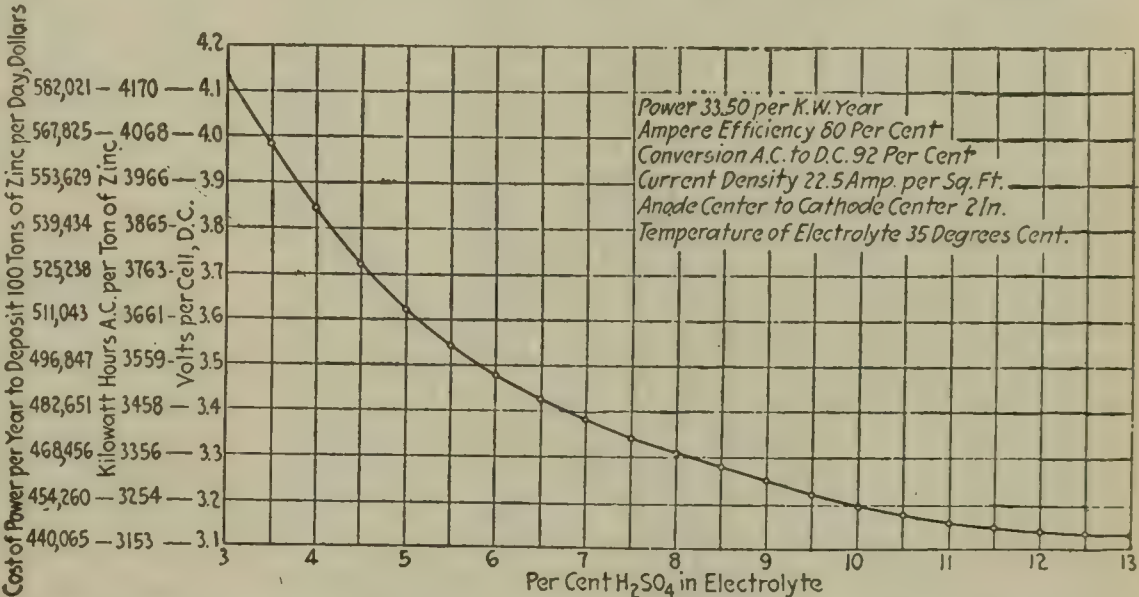


FIG. 8. EFFECT OF VARIATION OF ACIDITY ON POWER COST AT CONSTANT CURRENT DENSITY

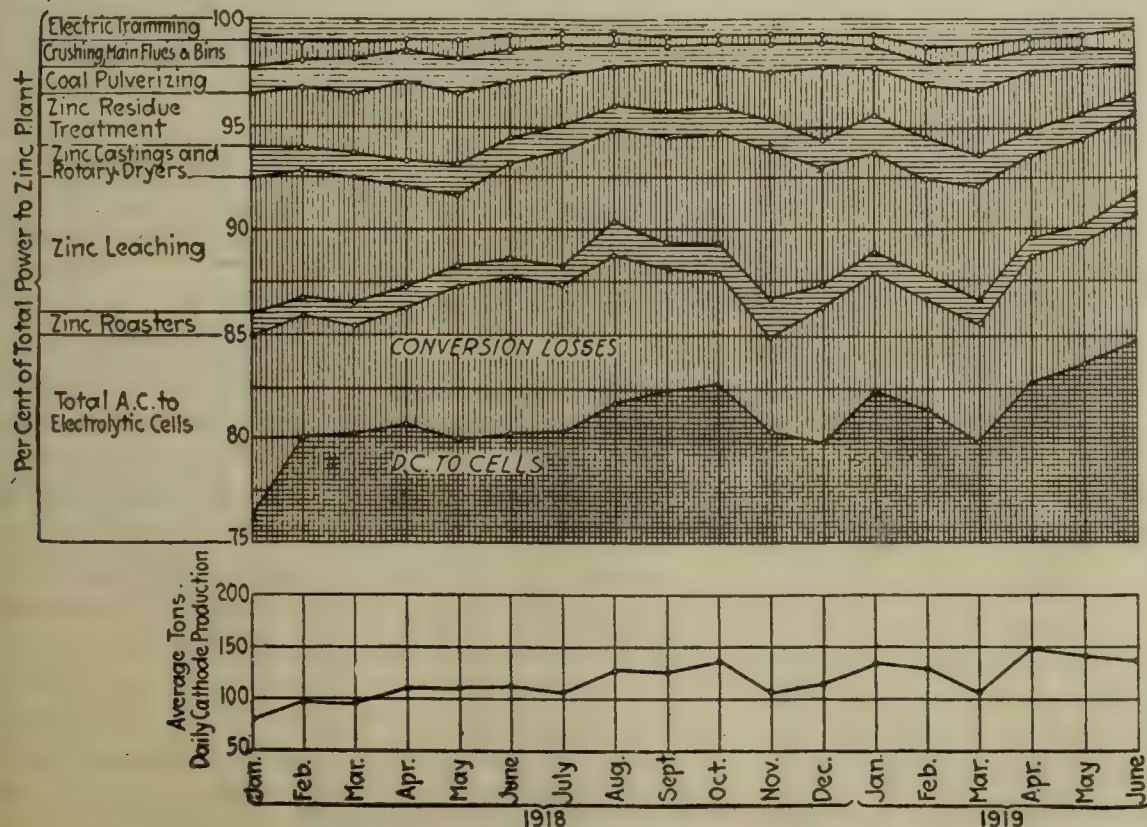


FIG. 9. DISTRIBUTION OF POWER TO ELECTROLYTIC ZINC PLANT

added, thus recovering approximately 50 per cent of the zinc.

ZINC DUST PLANT

Approximately 8 per cent of the zinc produced in the tank room is required to precipitate copper and cadmium. The zinc atomizing plant has two units, each consisting of an oil-fired Rockwell furnace, two blowing nozzles, and a settling chamber with a superimposed bag house. Air from the nozzles strikes a small hot stream of metal at right angles, atomizing it and blowing it into the settling chamber.

RESIDUE TREATMENT

The wet residue from the Oliver filters is dried in two 7 x 50-ft. Ruggles-Coles driers and three 9 x 60-ft. horizontal, single tube, rotary driers (moisture is thus reduced from 25 to 7 per cent) and then conveyed to storage

bins in 50-ton dump cars. Three 300-ton bins are used for dried residue, and one each for fine coal, siliceous ore, copper concentrate, lime rock and circulating material such as converter slag and cleanings. Each compartment discharges through a measuring chute to a belt conveyor which in turn discharges in a storage bin, supplying feed for reverberatory furnaces, and taken there by cars via local tramming system.

Furnaces are 125 ft. long x 22 ft. wide x 8 ft. high, measured from the silica bottom to the under side of the arch at about mid-length, originally built to smelt copper calcine but remodeled by lowering the bottom 2 ft., and by increasing the size of flues so as to permit as much lead fume to settle here as possible. Flue cleanings are shipped to the Tooele lead smelter for treatment. Slag is skimmed twice a shift, and stored, since it is planned to re-treat it to cover its zinc content (11 per cent Zn, 30 per cent FeO, 27 per cent SiO₂, 16 per cent CaO).

RECOVERY OF LEAD

Matte is overblown, before adding any siliceous flux, so as to expel as much of the lead as possible as volatile compounds, and the fumes are collected by flue leading to a bag house.

Fume-laden gases from the reverberatories are conducted through an 8 x 10-ft. flue to four Stirling waste-heat boilers, and thence through a 10-ft. hopper-bottomed steel flue, 1,200 ft. long, to the cooler pipes and bag house. There are thirty cooling pipes, 30 in. in diameter by 120 ft. long, arranged in parallel. Each pipe is in the shape of an inverted U and is equipped with a butterfly damper for velocity control. Whenever radiation will not cool the gases to 90 deg. C., cold air is drawn in through special doors located between the cooler pipes and the fans, which latter provide draft for the furnace and pressure for the bags. Pressure is normally about 1 in. of water. Originally the bag house contained eleven sections of 138 bags, each 18 in. x 30 ft. (45 cm. x 9 m.); in 1918 six sections were added to provide additional capacity for matte conversion. There is a cross-connection between the suction flue to the coolers and the distributor flue to the sections so that when the dampers are opened in the cross flue, a back draft results and the bags are collapsed, freeing most of the dust, and the exhaust gas from the section is forced into the bags of the other sections. However, the bags must also be shaken by hand at intervals, otherwise the fabric pores will gradually be filled. Dust is removed by screw conveyor to standard gage railway cars for shipment to lead smelters.

Thus, the object of the residue treatment is to collect the maximum amount of copper, gold and silver in a leady matte with a minimum amount of zinc, and to slag as much zinc as possible while making a fume rich enough in lead to ship as a lead product. Over a period of six months when smelting a residue of the approximate analysis 15 per cent lead, 13 per cent zinc, 2 per cent copper, 23 oz. silver and 0.07 oz. of gold per ton, 12 per cent silica, 29 per cent iron oxide, the recoveries were: copper 90.78 per cent, gold 74.05 per cent; silver 93.04 per cent; lead 72.65 per cent.

New Bamboo-Paper Pulp Plant

It is learned from Vice-Consul Thorling that a big bamboo-paper pulp plant is to be opened in the Pegu District, Burma, by F. W. Heilger & Co., managing agents for the Titaghur Paper Mills Co. (Ltd.).

Book Paper From Southern Pine*

Book paper requires for its manufacture two kinds of woods—a long-fibered wood, such as spruce, to impart strength, and some short-fibered hardwood to give the formation, finish, opacity and other printing qualities. The Southern pines are long-fibered woods, excellently suited for the manufacture of wrapping paper and fiber board, but their pitch content and the difficulty of bleaching them have heretofore been obstacles in the way of their use for white paper. These obstacles, it has been shown, can be overcome in a large measure by proper cooking conditions and improved bleaching methods. Red gum is typical of many Southern hardwoods that might be used with the pines in the manufacture of the better grades of printing paper.

The laboratory experiments indicate that one cord each of loblolly pine and red gum are capable of yielding one ton of paper, at a cost which should allow a good profit under prevailing conditions.

The utilization of the Southern pines for book paper would spread the burden of the pulpwood supply over considerable territory which is favored with a large annual growth of timber. In fact, although the bulk of the standing timber of the United States is in the far West, the bulk of the annual growth is now in the South. Pines and hardwoods are distributed throughout the Southern States in proportions well suited for the manufacture of book papers, and the forests are near the centers of paper consumption as well as the supplies of coal, chemicals and other necessary raw materials.

Margarine Industry of Hull, England

In addition to being one of the most important British centers for the treatment of oilseeds and the production of various oils, paints and colors, Hull is rapidly gaining a commanding position in the matter of the production of oleomargarine. This is practically a new industry for the district, reports Consul John H. Grout of Hull, England.

About four years ago the manufacture of compound lard was commenced, and this lard has now reached a degree of popularity that is securing for it universal use. It is generally admitted to have superseded hog lard in this district. The manufacture of margarine at Hull is a more recent development. Among the different brands produced are those intended for table use, for cake making and for pastry.

Annual production figures covering the margarine industry of the Hull consular district are at present very difficult to obtain. However, in 1915 the weekly average production of margarine in all England amounted to 2,200 tons, which was followed in 1916 by a weekly output of 2,500 tons. In 1917 the total had increased to 3,500 tons per week. In 1919 the industry made great advances, owing to the opening of new works throughout the country; the weekly production for January of that year averaged 7,500 tons, in February 6,200 tons, in March 6,400 tons, in April 6,350 tons, in May 8,500 tons, in June 6,000 tons, in July 6,000 tons, in August 4,800 tons, in September 6,350 tons, in October 5,950 tons, in November 7,500 tons and in December 5,220 tons.

From such information as is obtainable it would appear that for the year 1920 the average weekly production was in the vicinity of 7,000 tons.

*From *Technical Notes*, Forest Products Laboratory.

Pulverized Coal

ALTHOUGH experiments in the use of pulverized coal were begun nearly a century ago, the first practical application of the use of the fuel in powdered form was not made until about 1895. The cement industry, disturbed by the increasing cost of oil, sought for a low-priced fuel of high efficiency. Their plants were equipped, also, with the machinery necessary to reduce to powder cement rock or clinker and the pulverization of the less resistant fuel presented no difficulties. A series of experiments, begun in 1894, resulted in the following year in the installation of a practicable device for burning powdered coal. Its use has never been discontinued and at the present time 90 per cent of the portland cement made in the United States is burned by means of powdered coal.

Experiments with the new type of fuel were undertaken in other industries from time to time during the next fifteen years, but it is only within the last decade that the consumption of powdered coal in the United States has grown to any considerable proportions. During the calendar year 1919 it is estimated that between 10,000,000 and 12,000,000 tons of coal was pulverized for industrial consumption. Of this amount 6,000,000 tons was consumed in the making of portland cement; 2,000,000 tons was used in the iron and steel industry; copper refining consumed 1,500,000 tons, while at least 250,000 tons was used in power plants. The remaining consumption of pulverized fuel was divided among a large variety of industrial uses.

INCREASED USE OF THIS FORM OF FUEL

A better understanding of the principles involved, together with improvements in furnace design, has overcome most of the difficulties encountered in the earlier experiments, many of which were nothing more than attempts to burn pulverized coal in furnaces intended for other methods of firing. Further study of various grades of coal with a view to their suitability for use in pulverized form, as well as the design of improved machinery for reducing coal to the necessary degree of fineness, has also contributed largely to the increased use of this form of fuel. The use of pulverized coal on a large scale has been tried in Great Britain only in the cement industry, but the urgent necessity for the conservation of fuel supplies in that country is directing attention toward it as a possible means of economy. Apparatus for burning pulverized coal has been installed also in France and Japan, while Italy has recently sent a commission of engineering experts to the United States to investigate the subject.

ECONOMIC ADVANTAGES

The fundamental economic advantage in burning pulverized coal lies in the complete stage to which combustion is carried in the furnace. The contact surface between coal and air is greatly increased by splitting the coal into numerous particles of small size. A 1-in. cube has an exposed surface of only 6 sq.in., while the same volume divided into a thousand cubes of 0.1 in. has an exposed area of 60 sq.in., and if the division be carried to one million cubes 0.01 in. on a side, the exposed area in which combustion takes place is increased to 600 sq.in.

The second advantage in the pulverization of solid fuel is the fact that it floats in the air, spreads and is carried off by even small air currents. This makes the

intimate mixture of coal and air very easy. It simplifies the construction of burners and guarantees economical combustion. The finer the coal is powdered the more nearly ideal conditions for complete combustion are approached.

Where proper apparatus and methods are in use, however, other more tangible economies are effected by the use of powdered fuel. The labor cost of firing is materially lowered and losses during short periods when steam pressure is not required are reduced to a minimum. No air is allowed to pass through the furnace when firing operations stop, so that the radiant heat of the furnace is absorbed by the boiler, avoiding the losses which occur with grates or stokers through the constant burning up of fuel and incomplete combustion of the gases generated from banked fires. The time necessary to get up steam is reduced by half when pulverized coal is substituted for the same fuel in lump form. Recent experiments also show an economy in fuel consumption, which in some instances is said to be as high as 30 per cent.

LOW-GRADE COALS NOW UTILIZED

Until very recently the impression has prevailed that only certain grades of bituminous coal were suitable for powdering. Early experiments in the use of low-grade coal were nearly all failures, but as the conditions necessary for practical operation have become more thoroughly understood the low-grade coals have been utilized successfully. All the most recent developments in the use of powdered coal as a fuel for steam-generating plants have been made with anthracite culm, at one time definitely abandoned as a fuel suitable for powdering. High volatile soft coal gives best results, but mixtures of such a grade of coal with anthracite culm have proved entirely satisfactory and pulverization may be applied to any solid fuel, peat, lignite or bituminous coals of any grade, as well as anthracite and coke. All of these fuels are burnt successfully in powdered form, because the inherent advantages of exact regulation of air and combustible matter, with a proper mixture of both, may be secured. Higher temperatures than are possible with lump fuel can be maintained in furnaces fired by powdered coal because the quantity of excess air is only about 20 per cent compared with an excess of from 50 to 200 per cent with hand or stoker fired coal.

METHOD OF POWDERING

In the preparation of coal for use in the powdered condition the first operation is a crushing to lumps about one inch in size. Following the crushing the coal should be dried down, if possible, to less than 1 per cent of moisture. The crushed coal is then passed through a magnetic separator, which removes bits of steel or iron that would interfere with pulverization. Drying is desirable both for proper pulverization and to make the fuel burn freely. The coal is dried by being passed through a revolving shell, the temperature of which is maintained at a point high enough to cause the vaporization of practically all the moisture contained in the crushed fuel.

After being dried, the coal is pulverized to its final degree of fineness, such that 85 to 90 per cent will pass through an aperture $\frac{1}{100}$ in. square. The powdered fuel is conveyed directly from the pulverizing plant to the furnaces, either by a system of screw conveyors or by air pressure. It is fed to the burners through a nozzle under light air pressure.

An Engineer Who Anticipated Hoover

BY P. B. McDONALD

Assistant Professor of English, College of Engineering,
New York University

WHILE Herbert Hoover stands pre-eminent today as the type of American who won high success abroad by applying science and economics to foreign problems in a characteristically American way, he should not be thought the first of that type. To a certain extent Benjamin Franklin anticipated him by over a century, and astonished Europe by his shrewd ability and use of scientific methods. But there was another American, contemporary in part with Franklin, who won striking success in Europe but whose remarkable accomplishments are little known. This was Benjamin Thompson of Woburn, Mass., later Sir Benjamin Thompson and Count Rumford of the Holy Roman Empire, to whom England owes its Royal Institution and to whom Bavaria erected a splendid bronze statue, later duplicated at Woburn.

Benjamin Thompson was a scientist and administrator. He proved that heat is a mode of motion, not a fluid substance as it was then thought, and he determined within 10 per cent the dynamic equivalent of heat, later corrected by Joule. Since Thompson, or Rumford as he perhaps should be called, anticipated Joule by forty-two years, Dr. E. E. Slosson is justified in suggesting that the unit called the joule might better have been called the rumford. (See Slosson's essay on Rumford in "Leading American Men of Science," edited by David Starr Jordan.) But, like most practical Americans, Rumford believed in applying his knowledge of science. He improved the design of fireplaces, founded the science of interior ballistics by experiments with cannon and gunpowder, anticipated the "fireless cooker" of today, helped solve the question of the best covering for steam-pipes by observations on radiation, gave the world much-needed suggestions about clothing, contributed to the development of knowledge about lamps, colors, meteorology, the three ways in which heat travels, etc.

FOUNDED THE ROYAL INSTITUTION

As an organizer and administrator, he reformed the Bavarian army, housed the beggars of Munich and put them at useful work, and got a number of the leading men of England to contribute to the Royal Institution which he founded. This institution has done more for the advancement of science than probably any university in the world. Among its famous workers have been Davy, Faraday and Tyndall, and today it remains an active influence for research, housed in a palatial building in London. Other evidences of the foresight of this Yankee Count survive in the Rumford professorship which he founded at Harvard, and in the Rumford medal of the Royal Society of London and the Rumford medal of the American Academy of Arts and Sciences. When Rumford died near Paris in 1814, the great Baron Cuvier eulogized him before the French Institute.

But this distinguished scientist and administrator did not have things all his own way, as a record of his accomplishments might indicate. Though his family had lived in America for over a century, he left this country at the outbreak of the Revolution and fought against the colonies as a British officer. This was after he had offered his services as a brilliant young man to Washington and been refused because his enemies were

jealous of his rapidly increasing eminence. In England he found instant recognition and was made cavalry Colonel and Under Secretary of State while yet in his twenties. After the Revolution, he made the acquaintance of the Elector Palatine of Bavaria by his fine appearance on horseback, and was offered exceptional honors to stay in Munich and devote his talents to the government there. In Bavaria he became Count, Privy Councilor, Minister of War, Chief of Police, and Chamberlain to the Elector Palatine.

A PERSONALITY THAT THRIVES IN A MONARCHY

In person, Rumford had excellent manners and a ready flow of language, but he was opinionated, obstinate and disposed to have his own way, especially about little things, such as concerned his theories of clothing, cooking and household management. His unusual personality was the kind that prospers more in a monarchy than in America, because aristocracies make more allowance for eccentric geniuses than do democracies. If he had remained all his life in the land of his birth, he likely would never have risen higher than some petty job at the beck of a captain of industry. In England the Colonial Secretary of State, after one interview, recognized the ability of the young New Englander and gave him a place in the Colonial Office, making him a member of his own household. Later in Bavaria the Prince Maximilian spoke to him and invited him to dine because he liked his handsome appearance at a military parade where Rumford was a spectator. Directly afterward he was introduced at the court in Munich and was offered inducements to stay there in official capacity.

It is evident that, besides resembling Hoover in attainments in applied science and organization, he was like him also in rising from a poor American boy to an associate of kings and a great philanthropist. Hoover, however, has found honor in his own country while yet a comparatively young man, whereas Rumford has never been well known by Americans, and was even reviled as a traitor for many years until a more tolerant attitude grew up toward the Loyalists. Possibly Hoover would have become a great engineer if he had remained in America, instead of seeking his fortune in Asia and Europe; as to that, however, it is impossible to decide, for if he had never left this country his life would have been widely different. America offers prosperity to men of a certain pushful and businesslike bent, but does not confer favors on so wide a range of talents as do the older civilizations where life is more diversified and success is less standardized. Probably, just as there are Europeans who succeed better in America than in Europe, so there are particular types of Americans better adapted to succeed in Europe than in America. Such an interchange is beneficial to both continents, since it makes for distribution of ideas, and adds to the variety of minds available to help solve the problems of any one country.

Correction

In the article on "Comparison of Various Methods of Water Purification," by William Macklin Taylor, published in the Jan. 19, 1921, issue of CHEMICAL & METALLURGICAL ENGINEERING there was a typographical error. In the table on page 124 the hardness of water treated through a zeolite water softener, calculated to calcium carbonate, was given as 6.50 grains per gallon. This should have been 0.50 grain per gallon.

Costs—A Short Study of Factory Economics*

A Manager's Point of View of the Functions of and Services to Be Received From Factory Cost Departments — Factors of Interdependence of Costs — Maximum Net Returns on Groups — Distribution of Ledger Totals—Forms for Recording Operations—Statistics, Reports and Item Analyses

By A. G. PETERKIN

THE layman's idea of a cost system is a mechanical routine which month by month turns over to the sales department the cost of each of the materials which it sells. As a matter of fact, it has been attempted in many cases to put this idea into operation. I think it is true that the result has been a compilation of figures which fall under the head of "statistics" in Walter Bagehot's famous expression: "There are lies, damn lies and statistics." The problem which confronts the manager of a factory is not the mechanical grinding out of so-called cost figures, but a study in economics.

WHAT SHOULD A COST SYSTEM DO?

In the first place, a cost system should give information to the sales department which will enable its members if possible to sell the production at a profit. The sales department, however, is not able to control the market price of certain commodities, which are set by outside conditions and the selling price of other commodities. For example, if a substitute material is offered, the limitation is imposed that the selling price must have some definite relation to the price of the material substituted. In such cases, given a process of manufacture, the cost system is required to tell the price at which the raw materials must be bought to enable the material to be marketed.

It is of no less importance that the system should tell the factory management and the sales department under just what conditions the costs submitted are possible, and in what way they will be affected by changes in method of manufacture, and by increase in the individual or total volume of production.

The cost system might be required to produce a sense of financial responsibility in the heads of all the various departments, from the top down. This is particularly true of corporations or large businesses where the combination expected to give results is that of "your brains and someone else's money." The repair department, for instance, should be run as far as it is possible in the same way as a separate business which was furnishing the same service to the plant. The head of every production department will, to my mind, work to better efficiency when it is required of him that he think in terms of dollars and cents as well as in terms of men, pounds and gallons; he should run his department in the same spirit as he would were he using his own money. So far as possible, every man should be required to know how much money he is spending for every item where the discretion he uses in his daily work will influence that item.

When once reliable cost figures have been established and analyzed, it is more important to obtain information looking toward the control of the expenditures making

up the cost than to repeat the calculation of the final figures at frequent intervals to the exclusion of such information. The one method leads to irritating post mortems; the other avoids them. As in sport, so in business, watch your stroke, and let the score take care of itself.

INTERDEPENDENCE OF COSTS

In setting out to arrive at such results at least one simple principle must be kept in mind. When once a factory has been organized to turn out any given set of products, so far as cost is concerned every one of those products becomes to some extent interdependent. To get a definite cost figure on any one of them, the cost of each one of the others must be fixed at the same time. The more varied and complex the operations of the plant are the truer this is. It is least true in a factory, if such a one exists, where each one of the products is independent of the others so far as labor, raw materials and intermediate materials are concerned. In such a case as that, the interdependence lies mainly in the overhead, and the variation in cost will arise from the difference from time to time in what may be called the degree of saturation of the overhead. When the volume of production which a given organization can turn out is the maximum, the costs will be lowest, and as the volume decreases the cost of each one of the different materials will go up.

This factor of interdependence, however, in the chemical business is influenced much more by another condition than by overhead expense: If the decision is made to manufacture a certain material by a chemical process, one is almost always confronted by the necessity of producing another or even several others simultaneously. These "byproducts" may or may not be useful and valuable. The growth of the industry has largely been effected by making them so. The two or more products from such a process may have been subjected to exactly the same procedure and no more expense incurred in making one marketable than any of the others; on the other hand one or more of the products may have necessitated a disproportionate expense. Does this extra expense as an item of cost belong to the products directly responsible; or should the total expense be divided equally among the group? Assume for a moment that the expense is allotted as directly as possible among such a group of complementary materials and costs figured on this basis are given to the sales department. What naturally happens? Vigorous selling of the profitable members and an accumulation of the less profitable! Finally of course all have to be disposed of and the net result is a profit or loss on the group. The only rational basis for computing costs, and profit, is on the group considered as a unit. No arbitrary fixing of values within such a group changes the basic fact that the profit is made on the sale of the

*Read before the American Institute of Chemical Engineers, New Orleans, Dec. 6, 1920.

entire production, although the use of such values may in some cases be a convenient and good method of studying the group profit. Such arbitrary values placed on certain members may not materially affect the cost of the other members, either in amount, in variation or in both. For example, in the manufacture of nitro products, with the attendant production of "spent acid," to figure a cost and profit on the group would merely tend toward confusion. The market value of the "spent acid" can be ascertained with considerable ease; the

of the price at which a finished product from one process shall be charged as a crude to another. If such a material be marketable in the maximum volume possible to produce, it might well go into the subsequent process at its market price, since the only justification for the expense of further fabrication is a profit greater than can be obtained by its sale. The first process must then be given the credit for the profit which would have accrued had the sale taken place. If the object of further processing is to take care of an otherwise unmarketable excess, the same reasoning would lead to its being charged in as a crude at not more than actual cost.

Before going into the details of the actual work of a cost department, the relation between the bookkeeping and the cost systems should be clear. Fig. 1 shows the layout of the former; Fig. 2, that of the latter.

DISTRIBUTION OF LEDGER TOTALS

The cost system is not an essential part of the bookkeeping system; it is an analysis of the bulk cost of the operations carried out; it does not even furnish, necessarily, the value of each item of the inventory. Of course, in possibly the majority of cases, the individual inventory items are placed on the books at a value figured out by means of a more or less mechanical system, but exceptions always have to be made where such a value bears no relation to the actual market value of the material. It is an unfortunate fact that occasionally materials are manufactured at a cost which is greater than the market value, and the inventory based on such a cost would certainly be inflated by at least the difference between the two values.

To go now to the methods to be employed in compiling plant statistics, and to the finished form they shall take:

The direct charges to any product or group of products, for superintendence, labor, repair, materials, etc.,

placing upon it of such a value will throw all the cost and all the profit to the nitro product, and will clearly give the information necessary to a proper manufacturing and sales policy.

MAXIMUM NET RETURNS ON GROUP OF PRODUCTS

Possibly the best example of this phase of the subject is the case of a factory refining oils. Each crude worked may give some amounts of the same materials and at the same time products peculiar to itself. Each crude, also, can probably be worked up in various ways to produce several sets of products. The attempt to follow each intermediate step in the refining process, to find the cost of the intermediate products and so on to the finished products, results in figures which are valueless in most cases. The question here is of the proper profit on the group of products from one crude, and the most profitable group to make from that crude. Frequently every finished product has an established market price, and the price which can be paid for the crude has to be determined by taking the difference between the combined market value of the entire production, and the total working cost, freight, profit, etc.

There are many cases where evaluation of individuals is necessary in which the products cannot be evaluated by placing arbitrary values on the minor members, and dividing the remainder of the cost proportionately. A rule capable of fairly general application is to divide this remainder among the major products in the proportion of their market values. The one point which should never be lost sight of, however, is that the manufacturing and selling policy should be governed by the net return on the group.

Another phase of the same problem is the question

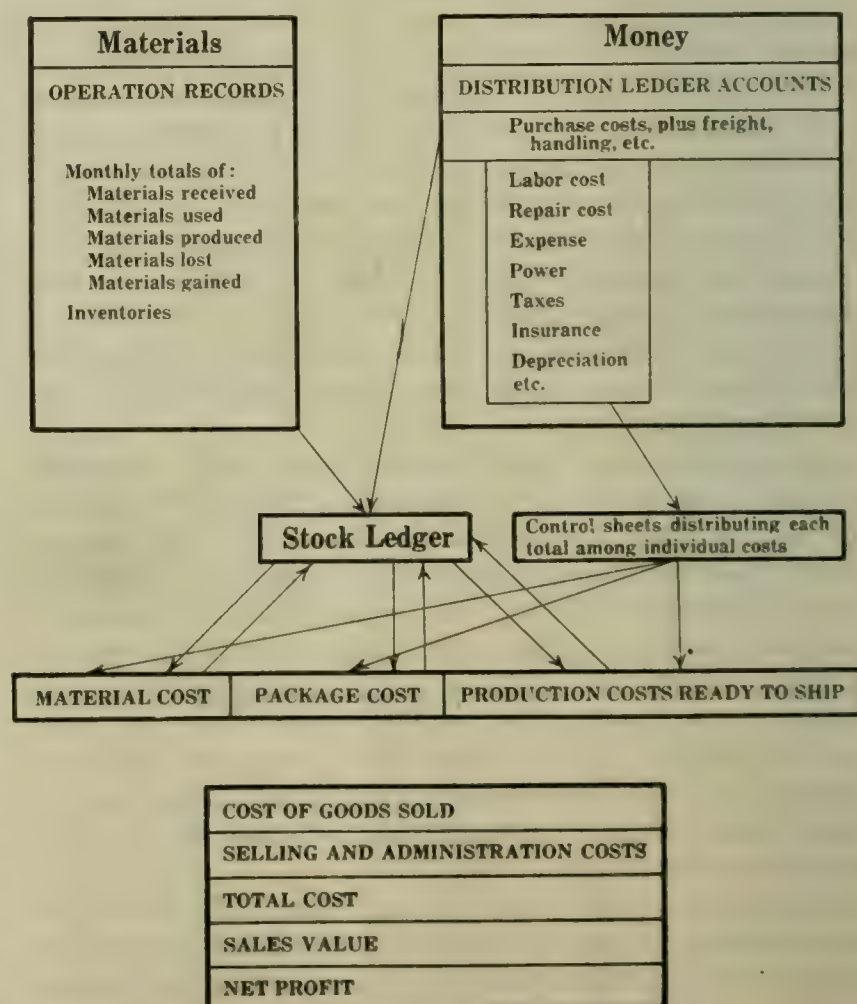


FIG. 2

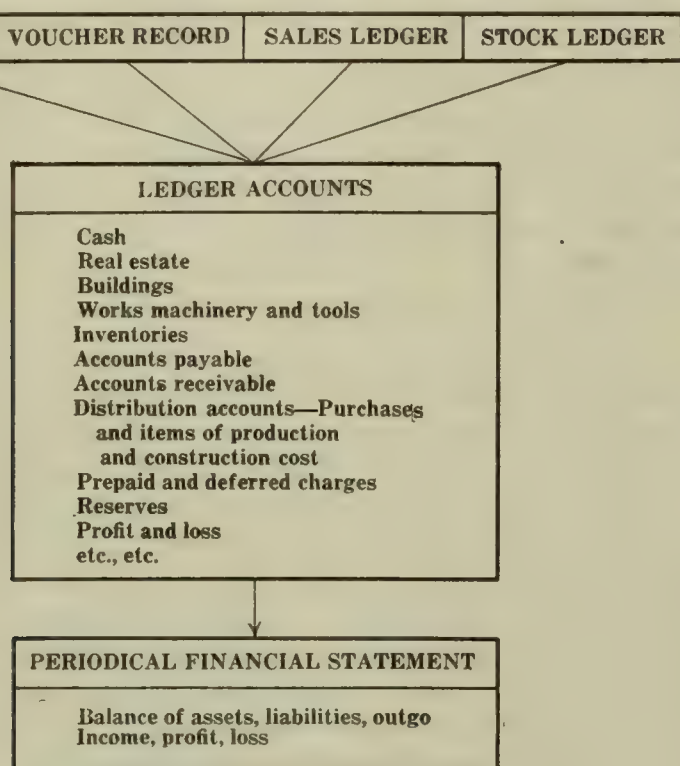


FIG. 1

RECEIVING RECORD

MANUFACTURING MATERIAL AND SPECIAL AGENTS
OFFICE FILE COPY

18920

Barrett Company
Chicago
67 M. & P. 505 164

DATE 10/20/20
QUANTITY 54 Bags 6.1 Anthracene
TANK CAPACITY
TANK NO.
TANK DATE
TANK WEIGHT
TANK MEASUREMENTS
TANK NO.
TANK DATE
TANK WEIGHT
TANK MEASUREMENTS

Weight sheet printed on the back of this sheet for shipments in bags, drums, etc.

NO. CONTAINERS 54 Bags
DATE 10/20/20
BY 909
BY 23455
James Tyson

Back of Receiving

INDIVIDUAL CONTAINER WEIGHTS

NO.	WEIGHT	NO.	WEIGHT	NO.	WEIGHT	NO.	WEIGHT	
451	18	483	15	402	17	408		
482	15	467	19	412	19	482		
415	12	403	14	472	13	452		
461	14	447	18	473	16	428		
503	17	486	19	453	17	456		
470	20	450	16	473	18	474		
419	21	438	15	402	180	2770		
431	18	413	19	433				
412	14	438	14	457				
416	17	429	13	482				
432	12	408	19	318				
443	15	428	17	398				
427	19	418	16	416				
425	24	464	18	421				
412	18	394	14	398				
418	15	403	17	437				
423	17	416	15	447				
414	14	403	19	447				
505	19	486	16	434				
421	20	401	21	457				
445	21	424	18	467				
469	18	451	15	404	10709	404	10305	
481	17	464	17	411	10785	405	10380	
426	12	414	21	394	2870	100	2770	
TOTAL	444	10305	10785	405	10380	24364	909	23455

TANK INVENTORY

Tank No. 211
Capacity 4000
Inventory No. C-4

DATE	NO.	WEIGHT	NO.	WEIGHT	NO.	WEIGHT
10/1/20	10	4000				
10/1/20	20	12000	8000			
10/1/20	20	22000	10000			
10/1/20	20	16000				
10/1/20	63	26000	9000			
10/1/20	27	15000				
10/1/20	10	4000				

PACKAGE INVENTORY

CONTAINER 150 gal drums
MATERIAL 95% Benzol
Inventory No. 24200
Card No. 1

DATE	NO.	WEIGHT	NO.	WEIGHT	NO.	WEIGHT
10-1-20	6	5269				
10-1-20	8	7620	1821			
10-2-20	1	893				
10-3-20	14	12967	12274			
10-4-20	11	10263				
10-5-20	15	14255	3892			

INVENTORY OF MATERIALS IN PROCESS

Inventory No. 24200
Card No. 1

DATE	NO.	WEIGHT	NO.	WEIGHT	NO.	WEIGHT
10-1-20	6	5269				
10-1-20	8	7620	1821			
10-2-20	1	893				
10-3-20	14	12967	12274			
10-4-20	11	10263				
10-5-20	15	14255	3892			

MEMORANDUM TO COST DEPT.

STOCK TRANSFER
No. 26401
DATE 11/20/20

MATERIAL	NO.	WEIGHT	NO.	WEIGHT	NO.	WEIGHT
Single Star Oil	18	210	200	10	1000	

are calculated by distributing the ledger totals for these items by means of the usual code system, using report blanks for record of labor-hours, etc., placed in the hands of the foremen or workmen as may be judged best.

The question of the method to be used in assigning indirect charges, superintendence and various expenses covering several departments, the plant burden, etc., is a vexed one. So far as possible, each one of the items going into any such general expense account should be spread over the products necessitating it on a logical basis applying to the individual item alone. The cost of the control laboratory, for example, can as a rule be split up and charged to the products involved, on the basis of the actual cost of the tests made for each one. Such few items as cannot be treated in this way—for example, office expense or general management—have necessarily to be grouped together and prorated on an arbitrary basis. The basis most generally used is that of "productive" labor; the products are charged with their quota of expense calculated from their proportion of the direct labor in the plant. Such a general method, of course, cannot give even an approximation of the truth, unless the labor entailed in each of the group of processes employed in the plant depends on the volume of production rather than the kind. It is obviously true that some processes requiring but little labor consume an altogether disproportionate amount of the expense of superintendence, development, etc. The "punishment must be made to fit the crime," and no rule for such prorating of overhead capable of general application can be laid down.

In general, I believe it is true that yield is the most important item of cost in the chemical industry. The first essential, therefore, in any "chemical" cost system is the obtaining from the factory of accurate figures representing the operations carried out. For that reason I shall go in detail into one method which attempts to do this in a manner which leaves no figures to the imagination.

In order to follow the path of raw materials through a process all the way from the purchase of the crudes to the output of the refined materials, it is necessary to check the weight, or volume, or both, as it is received into the plant; to check the losses or discrepancies caused by errors of measurement as it passes from one part of the plant to another and into the actual apparatus where the process is carried out; to record the amounts of materials produced, both in intermediate stages and in the containers on the railroad ready for shipment to the customers; and to record the amounts of materials in process and in stock at the inventory period. It is important that the means employed to do this should enable one to detect physical losses at the time they occur.

Form 1 of the accompanying diagram is a receiving report which is so arranged that the amount of material arriving in any kind of package can be recorded as compared with the actual amount received into the storage.

Form 2 is a continuous inventory card, by means of which the individual foreman keeps a record of each lot of each material placed under his supervision. On it he records every movement in or out of the tank, bin,

PLANT BALANCE SHEET—JUNE 1, 1920				
	May 1	June 1	Increase	Decrease
May 1:				
Asset value as per financial statement.	2,000,000.00			
June expenditures as per voucher record and journal entries.		500,000.00		
Assets:				
Cash.	\$25,000.00	\$26,000.00	\$1,000.00	
Accounts receivable.	15,000.00	18,000.00	3,000.00	
Merchandise inventories.	500,000.00	460,000.00		\$40,000.00
Stores and supplies inventory.	100,000.00	110,000.00	10,000.00	
Fuel.	20,000.00	25,000.00	5,000.00	
Real estate.	200,000.00	250,000.00	50,000.00	
Buildings.	400,000.00	500,000.00	100,000.00	
Machinery and tools.	600,000.00	650,000.00	50,000.00	
New construction.	100,000.00	25,000.00		75,000.00
Furniture and fixtures.	25,000.00	31,000.00	6,000.00	
Prepaid charges.	15,000.00	12,000.00		3,000.00
	\$2,000,000.00	\$2,107,000.00	\$225,000.00	\$118,000.00
			118,000.00	
			107,000.00	
Production cost for May.			393,000.00	
Total, expenditures.			500,000.00	

lot of drums or barrels, or whatever the storage may consist of, and in addition must show the source of incoming material, the point to which outgoing material

has been sent, and give the identifying number of the card on which the amount moved has been recorded. Each foreman is provided with a calibration card for each one of the group of tanks for which he is responsible, from which he can read directly the gallons corresponding to each of his measurements.

Forms 3 and 4 show two kinds of operation records upon which can be entered figures representing almost

WEEKLY REPORT OF CONSTRUCTION					
Appropriation No. 3169 Work Improvements and Additions Code No. 36-1657			Amount \$22,000.00 Plant		
1920	Cash Expenditures	Liability	Total for Week	Total to Date	Balance Unexpended
May 24	\$1,842.87	\$165.00	\$2,007.87	\$2,007.87	\$19,992.13
May 31	1,084.11	12,210.37	13,129.48	15,137.35	6,862.65
June 7	337.61	779.64	1,117.25	16,254.60	5,745.40
June 14	69.96	347.83	417.79	16,672.39	5,327.61
June 21	158.53	914.78	1,073.31	17,745.70	4,254.30

any kind of operation. For a discontinuous operation, the charge and corresponding production are recorded on the upper and lower halves of the same card. For a continuous operation two forms are used, one for recording the successive charges, and the other the successive productions. The latter has a space on which

PRODUCTION COST				
Opening inv. naked materials.		\$748,108.74	Closing inv. naked materials.	\$860,378.88
Purchases.		314,932.64		
Cost of plant operation:				
Process labor.	\$38,602.49			
Salaries.	1,500.00			
Fuel and power:				
Labor.	\$4,309.07			
Materials.	28,837.67			
	33,146.74			
Team, cart. and loading:				
Labor.	332.41			
Materials.	332.41			
	664.82			
Repairs:				
Labor.	\$18,000.00			
Materials.	12,000.00			
	30,000.00			
Expense:				
Labor.	\$15,675.00			
Materials.	11,825.00			
	27,500.00			
Rents.	200.00			
Taxes.	966.30			
Insurance.	4,534.15			
Depreciation.	9,531.92			
	146,646.42			
	\$1,209,687.80			
Cost of materials packed.				349,308.92
				\$1,209,687.80
Opening inventory:			Closing inventory:	
Packed material and empty packages.	\$156,848.91		Packed material and empty packages.	\$143,877.38
Packages and ship. material purchased.	22,660.66			
Cost of packing and shipping:				
Shipping labor.	\$3,791.02			
Team, cart. and loading:				
Labor.	\$990.00			
Materials.	1,044.49			
	1,994.49			
Expense:				
Labor.	\$1,364.03			
Materials.	909.35			
	2,273.38			
	8,058.89			
Cost of materials packed.		349,308.92	Cost of materials shipped.	393,000.00
		\$536,877.38		\$536,877.38

ANALYSIS OF PROFIT								
Month June, 1920								
Process or Crude	Factory Cost	Sales and Administration Cost	Total Cost	Total Return	Profit	Loss	Six Months January to June Profit	Loss
1	\$25,000.00	\$2,500.00	\$27,500.00	\$32,500.00	\$5,000.00		\$35,000.00	
2	10,000.00	1,000.00	11,000.00	13,000.00	3,000.00		15,000.00	
3	75,000.00	7,500.00	82,500.00	80,000.00		\$2,500.00	2,500.00	
4	122,000.00	12,200.00	134,200.00	150,000.00	16,000.00		100,000.00	
5	2,000.00	200.00	2,200.00	2,500.00	3,000.00			\$10,000.00
6	180,000.00	18,000.00	198,000.00	190,000.00		9,000.00		42,000.00
7	200,000.00	20,000.00	220,000.00	250,000.00	30,000.00		150,000.00	
Totals	\$614,000.00	\$61,400.00	\$675,400.00	\$718,000.00	\$57,000.00	\$11,500.00	\$302,500.00	\$52,000.00
Net profit					45,500.00		\$250,000.00	

COST SHEET																		
Month	Process or Crude																	
CHARGE																		
Expenses		Raw Materials					Intermediate Materials					Finished Products					Total Cost	
		Name	Gal.	Lb.	Unit Value	Value	Name	Gal.	Lb.	Unit Value	Value	Name	Gal.	Lb.	Unit Value	Value		
Labor.....							Intermediate materials usually form an element of uncertainty, particularly when the cost period is short. Their use and production tend to obscure yield; their value or cost is usually a matter of judgment.											
Salaries.....																		
Fuel and power.....																		
T. C. and L.																		
Repairs.....																		
Expense.....																		
Rents.....																		
Taxes.....																		
Insurance.....																		
Depreciation.....																		
Totals.....																		
PRODUCTION																		
																	Sales Values	

EXPENSE				
Month June, 1920				
Analysis		Summary		
Purchasing dep't.....		\$1,200.00		
Traffic dep't.....		1,300.00		
Accounting dep't:				
Production cost.....	\$1,000.00			
Construction cost.....	650.00			
Finance and accounting.....	600.00			
Paymaster and timekeeping...	1,000.00	3,250		
General office:				
Repair and construction.....	\$500.00			
Stenographic.....	1,000.00			
Mail and messengers.....	500.00	2,000		
Management.....	500.00			
Stationery, postage, telegrams.....	800.00			
Traveling expenses.....	150.00			
Janitors and washers.....	500.00			
Telephone.....	300.00	Office	\$10,000.00	
		Lunch club	250.00	
Salaries—routine, samples, office.....	\$5,500.00			
Salaries—research, not charged direct.....	3,300.00			
Stores and stationery.....	500.00			
Janitors and washers.....	500.00			
Miscellaneous.....	200.00	Laboratory	10,000.00	
Plant nurse and hospital bills.....	\$350.00			
Plant doctor.....	250.00			
Dispensary supplies.....	200.00			
Payments to injured.....	311.67			
	\$1,111.67			
Received from insurance company.....	111.67	Medical	1,000.00	
Guards.....	\$2,000.00			
Safety, employment, advertising.....	1,000.00			
Taxes, water, gas.....	1,000.00			
Janitors, towels, stationery.....	1,500.00			
Pension.....	150.00			
Team hire.....	100.00	Works	5,750.00	
		Miscellaneous	200.00	
Total.....			\$27,200.00	

to record at monthly intervals the amount of material in the apparatus at the end of the month, so that the production corresponding to the charge for the period can be calculated.

Form 5 shows a form arranged for record of transfer of material from one part of the plant to another, where such material is not going through a process, and enabling a record of discrepancies between delivered and received amounts.

Form 6 contains a complete list of all apparatus under the charge of each process foreman, on which to record the material charged to the apparatus, the production from which is incomplete at the time of the inventory.

Form 7 is used to determine the inventory of each material in the plant at the end of the month, or at the end of whatever the cost accounting period may be. The figures on this inventory card are posted from the running inventory cards kept by the foreman.

From these reports, properly checked and recapitulated, a complete ledger statement can be made up, which, if the records have been accurately kept and carefully checked, should give an exact balance. Inasmuch as every amount of material moved has been recorded on one or the other of these forms, and the movement checked by the cost department, there is no possibility except through human fallibility (that troublesome factor in all "systems") of any quantity of material not being on the cost department records.

ANALYSIS OF REPAIRS									
Department—Light oil—Oils									
Job	Description	Week June 1, 1920		Week June 8, 1920		Week June 17, 1920		Charge No. 6-A-1 Week June 24, 1920	
		Labor	Material	Labor	Material	Labor	Material	Labor	Material
1	New bottom in still 443.....	\$100.00	\$50.00	\$75.00	\$30.00	\$150.00	\$25.00	\$50.00	
7	Repair flow box still 441.....	5.00	3.00						
9	Repair line to pump 165.....	1.50		10.00	4.50				
21	New cock on catchall tank 3.....	2.50	10.00						
23	Repair brickwork on still 450.....			35.00	100.00	75.00	15.00		
24	Repair steam leaks at tanks.....			4.00	1.00	10.00	1.50	15.00	3.50
Material charged directly to dept. (Oils, waste, ice, clogs, etc.)...			48.00		27.00		10.00		25.00
Total labor and material per week.....		\$109.00	\$81.00	\$124.00	\$162.50	\$235.00	\$51.50	\$65.00	\$28.50
Total labor and material as above.....						\$865.00			
Direct purchases (from distribution ledger).....						150.00			
Overhead (from distribution ledger).....						155.00			
Total.....						\$1,170.00			

NOTE.—Repair costs should be so kept that such detailed analysis as this can be furnished readily on request, to explain, for example, unusual fluctuation in department total.

LABORATORY COST SHEET

Month June, 1920		Analysis	Summary	
Salaries.....	\$4,200.00			
Supplies from laboratory stores.....	800.00			
Supplies from stationery stores.....	50.00			
Supplies from repair stores.....	25.00			
R. & C. labor and supervision.....	50.00			
Crude materials from stock.....	5.00			
Finished materials from stock.....	50.00			
Containers from stock.....	15.00			
Advertising.....	10.00	Routine	\$5,205.00	
Salaries.....	\$4,800.00			
Supplies from laboratory stores.....	225.00			
Supplies from stationery stores.....	5.00			
Crude materials from stock.....	2.00			
Finished materials from stock.....	2.00	Research	5,034.00	
Salaries.....	\$150.00			
Supplies from laboratory stores.....	10.00			
Supplies from stationery stores.....	1.00			
Finished materials from stock.....	150.00			
Containers from stock.....	25.00	Samples	336.00	
Janitors' and bottle washers' wages.....	\$500.00			
Salaries.....	800.00			
Supplies from stationery stores.....	60.00			
Traveling expenses.....	35.00			
Laundry.....	30.00			
Gas.....	25.00			
Electric power.....	100.00			
Manufacturing insurance.....	85.00			
Manufacturing taxes.....	75.00			
Manufacturing depreciation.....	300.00			
Water consumed.....	65.00			
Repairs to building and equipment.....	350.00	Service, etc.	2,425.00	
Total cost.....			\$13,000.00	

Let us turn now to the consideration of the statistics which should be obtained from a cost department to control properly the operations in a chemical factory.

The manner in which the figures are presented, if they are to be used, is important. First, no matter whether one is studying the whole plant or any particular part of the plant, one should go from the top down. The first figures examined should represent a summary of the expense of the operations under examination; they should omit detail and present a birdseye view. It is not difficult to remember, say, twelve items going to make up a total, nor to understand and remember the relation between twelve such figures. If it is attempted to study a total comprising 144 items, the average mind merely becomes confused, arrives at no decision, and no picture of the operations represented by the figures remains. Condense the 144 figures, however, into twelve sub-totals, the relations between these are easily grasped and they furnish a definite picture. Analyze each one of the twelve items further into twelve more, and each of the subdivisions becomes clearer and more intelligible as its detail is studied. The twelve principal subdivisions then become mental pegs on which to hang the remaining 132 of the figures in easily comprehended groups. Skillful summarization is the secret of useful statements. Diffuseness is the curse of cost accounting.

The total list of reports submitted, each covering

REPAIRS 1920

	January	February	March	April	May	June
Dept. 1...	\$8,473.23	\$8,732.74	\$11,655.98	\$6,570.78	\$9,866.89	.....
Dept. 2...	2,340.85	1,390.46	2,116.37	5,116.62	5,308.05	.....
Dept. 3...	2,349.95	3,219.46	3,527.78	4,555.02	2,131.17	.....
Dept. 4...	1,115.20	1,769.93	2,709.23	1,397.20	1,243.10	.....
Dept. 5...	454.76	98.33	482.05	229.86	152.02	.....
Dept. 6...	3,023.10	2,345.91	2,759.09	3,889.46	3,391.90	.....
Dept. 7...	7,919.71	9,881.38	8,410.23	8,954.38	10,641.59	.....
Dept. 8...	919.20	3,640.71	3,505.93	5,253.94	6,557.24	.....
Dept. 9...	6,123.99	6,702.45	14,203.04	11,824.40	18,013.47	.....
Dept. 10...	32.44	114.82	1,108.38	1,138.17	228.18	.....
Dept. 11...	965.13	3,423.14	1,410.00	2,941.49	3,505.01	.....
Dept. 12...	447.69	3,073.85	315.91	794.90	344.29	.....
Total...	\$34,165.25	\$44,393.18	\$52,203.99	\$52,666.22	\$61,382.91	.....

monthly or longer intervals, might be somewhat as follows:

1. Complete balance sheet showing all the money spent during the month, and the main departments where the expense was incurred.
2. Analysis of profit.
3. Analysis of the total cost of all production under a few headings of direct expense.
4. The volume of production from, and cost of the working of individual processes or crudes. (The form of this report should be particularly noted. It does not provide for the computation of the costs of intermediate materials; these are supposed to be estimated by the technical staff. By estimating the value in finished products of the intermediates used and produced, the yield on the entire process can be calculated. The attempt to get a cost on each operation of a process is usually more expensive than the results are valuable.)
5. Analysis of the plant expense.
6. Analysis of cost of repairs.
7. A detailed statement of sales, giving volume and value for each commodity. This form is not illustrated.

COST ANALYSIS

These, together with a more or less detailed analysis of each, should constitute the bulk of the cost department's work. Much attention should be paid to the arrangement of data on the books so as to facilitate the preparation of such analyses as may be necessary from time to time to explain unusual fluctuations. It is much better to submit comparatively few summaries and to be prepared to furnish analyses of any of them quickly than to attempt the regular periodic compilation of many detailed statements.

The statement "Analysis of Repairs" is an example of a report gotten out upon request to explain an unusually large repair charge. That headed "Weekly Report of Construction" is a report for the use of the engineer on a construction job, which enables him to compare the amount of money spent to date on his work and the money appropriated to complete it. The "Laboratory Cost Sheet" is a monthly report to the chief chemist who may well be required to work under a budget; it includes all the expenditures for which he is responsible.

In presenting cost figures to the sales department month by month, one very general condition experienced is fluctuations in cost, due to the fact that repairs and other expenses are not incurred equally month by month. It is sometimes attempted to equalize such expenses by setting up on the books deferred charges, so that a very heavy expense is not charged to the operations going on in the month wherein the expense was incurred, but is spread over a period of several months, or even a year. Such a method as this leaves so much to the judgment as almost always to lead to confusion, and possibly also to embarrassment; no one likes to have deferred charges on his books. In my opinion, the better way is to charge all such expense to the operations when incurred, and to flatten out the cost figures by averaging them over periods of say six to twelve months. This would mean that in January the cost submitted would be the average of the past six months of the old year and the first one of the new, and so on until the end of the first six months of the year is reached, when the cost may become cumulative from the first to the end of the year.

The money spent on costs covering the ground indicated here need not exceed 0.5 per cent of the payroll; the difference between good management and the best possible is, I should guess, about 10 per cent. The one almost universal trouble experienced with cost departments and systems is their tendency to spend more

money on statistics than the use of the figures they submit can possibly save. Coupled with this is the tendency to attempt to turn out mechanically, month by month, large volumes of significant figures. The number of figures which a cost department is asked to produce each month should be cut down to the very minimum, and these should be only such as can be turned out by a mechanical routine and wherein as few elements of judgment enter as possible. Analysis beyond this point should be done by the technical staff of the plant, or by a department of cost analysis run, not by bookkeepers, but by men whose judgment is based on a real, solid understanding of the processes. The fewer and more simple the figures which the ordinary cost department run by bookkeepers and clerks with no operating experience and the greater the insistence that the technical staff of the plant take the figures, analyze and interpret them the more likely it is that valuable results will be obtained. An adding machine cannot think. It will say, for example, that a certain product is unprofitable; its manufacture, therefore, is discontinued. To your surprise, however, instead of saving the loss, a still greater loss is incurred. Shutting down the plant has not decreased outgo as much as it has decreased income. Depreciation, insurance, taxes, still continue; the plant begins to deteriorate and assets to drop; the overhead allotted to the plant cannot all be cut out and has to be carried by other processes. In general, the only safe way to determine whether a production shall be discontinued, increased or diminished is to disregard the individual cost figure, and to sit down and figure the effect the proposed change will have on the total income of the plant on the one hand and the total outgo on the other. Not until that is done can one be in a position to say whether the proposed change will result in greater profit, or in the least possible loss.

CHEMISTS AND ENGINEERS OUGHT TO BE FAMILIAR WITH ACCOUNTING METHODS

In the Philadelphia *Public Ledger* of Feb. 18, 1918, a statement was made in one of the editorials that 95 per cent of the businessmen of Germany are expert accountants. The continual association of values with materials and effort is an essential in the education of a successful chemical engineer. Of necessity it is omitted from his college training. The opportunity for doing it should be freely given in the industries.

The chemists and engineers in charge of our factories must be familiar with accounting methods. The economics of the factory must come within the scope of their activities. They must be able to use the help of the accountant. The officials of a corporation must be able to rely upon their technical men for sound advice, not only in the realms of physics and chemistry, but in economics also. Webster says that "economics is the art of regulating receipts and expenditures so as to insure a proper profit." Surely this is an art we need to acquire and not leave to a bookkeeping department.

What Otto Witt said in 1887 is truer than ever today: "The success of a process is no longer, as formerly, dependent upon the careful preservation of manufacturing secrets, but above all upon businesslike control, both within and without."

Chemical Department,
The Barrett Company,
Frankford, Philadelphia, Pa.

Development of the German Chemical Industry During 1919

A recently published report on the German chemical industry for the year 1919 contains some interesting data concerning the development of this important branch of industry.

The following figures show the number of plants in operation during 1919, and number of workmen employed:

District	Number of Plants	Number of Workmen, Full-time and Part-time	Decrease in Number of Full-time Workmen From Preceding Year, Per Cent
Berlin.....	2,518	68,393	7.31
Breslau.....	1,235	26,377	20.84
Hamburg.....	2,043	72,859	27.89
Cologne.....	2,562	121,537	31.85
Leipzig.....	2,648	125,559	12.04
Mannheim.....	1,325	50,615	12.80
Frankfort.....	1,081	51,198	2.70
Nuremberg.....	1,648	27,623	13.35
Total.....	15,060	544,161	18.18

From these figures it appears that the greater part of Germany's chemical plants are located in the Leipzig, Cologne, Berlin and Hamburg districts. There were 15,204 plants in operation in 1918, while the total had fallen to 15,060 in 1919, a decrease of 1.95 per cent. This decrease is due chiefly to the fact that the chemical plants in Alsace-Lorraine were eliminated from consideration in 1919. The number of working days credited to the 294,766 full-time workmen reached a total of 88,231,447 against 107,835,679 for 1918.

WAGES PAID AND NUMBER OF PLANTS IN OPERATION

The total amount of wages earned by workmen and employees in the chemical industry in 1919 amounted to 1,131,682,109 marks. If one uses as the basis of comparison the number of plants in operation, the number of full-time workmen, the wages earned, together with the annual compensation received, the figures for the single years during the period 1913 to 1919 show a generally upward trend.

Year	Number of Plants	Number of Full-time Workmen	Total Amount Wages Paid, Marks	Average Annual Compensation of Full-time Workman, Marks
1913.....	15,042	227,629	351,520,206	1,266
1914.....	15,014	245,980	313,508,108	1,273
1915.....	14,914	219,646	295,217,251	1,344
1916.....	14,998	256,420	382,783,261	1,493
1917.....	15,129	334,851	652,877,501	1,950
1918.....	15,204	360,256	889,141,025	2,468
1919.....	15,060	294,766	1,064,782,786	3,612

A slight decrease is to be observed in the number of plants in operation during the period 1914 to 1916. In 1917 the number of plants was larger than for the year 1913, and the increase continued in 1918. In 1919, however, there occurred the slight decrease previously noted. The number of full-time workmen employed in 1919 exceeded by 17,000 the number employed in 1913. The year 1918, with its total of 360,256, marks the high-water point in full-time workmen employed.

It is interesting to observe that compared with 1913 the amount of wages received in 1919 has tripled. The highest point in the total wages paid was reached in 1919. Hand in hand with this growth went the increase in the average annual compensation of the full-time workman. In 1913 this figure amounted to 1,266 marks, while in 1919 it had risen to 3,612 marks. Everything points to a heavy increase in the 1920 average against that of 1919. In the course of the present year workmen in the chemical industry have been paid such amounts as would indicate that the average annual wage might reach a total of 18,000 marks or even more.

Pulp and Paper Production in Quebec, Canada, During 1919

The total quantity of lumber cut in the province was 814,455,900 ft. b.m., as compared with 931,462,800 ft. in 1918. In 1919 there were sixteen pulp mills in Quebec Province, with an aggregate daily production of 1,300 tons, and twenty-seven combined pulp and paper mills producing 1,600 tons of paper daily. A conservative estimate gives the year's production of pulp of all kinds as 800,000 tons and of paper and paper products as 450,000 tons, the greater part of the pulp being consumed in the manufacture of paper within the province. The selling value of the entire output was \$65,000,000, an increase of \$13,294,217 over the figures of 1918 and of approximately \$23,000,000 over those of 1917. Most of the products are sold in the U. S.

Reconstructing French Chemical Industry

France has made notable progress in setting her chemical industry on its feet again. The 17 per cent of the chemical plants of all kinds in France which were located in the devastated departments were almost entirely destroyed. The departments of the Nord and of the Aisne suffered particularly, supporting 70 per cent of the total damage, which is estimated according to 1914 values to be 128,840,208 francs.

The Ministry of Liberated Regions, which has taken a census of the various plants that can be classed under the heading "chemical industry," announces that on Oct. 1, 1920, 111 out of 142, or 78.1 per cent, had resumed operation wholly or in part. The greatest proportion in resumption of operation is found in the Lille region (89.3 per cent). These 142 plants in 1914 employed 21,210 workmen. On Oct. 1, 1920, 54.2 per cent of this number, or 11,512, were employed in production. The nearest approach to normal is found in the Department of the Meurthe et Moselle. A year ago, or on Oct. 1, 1919, only 18.7 per cent of the 1914 personnel was occupied at production. Since that date there has been a steady increase, the proportion from Jan. 1, 1920, increasing from 34.7 per cent to 54.2 per cent above mentioned.

The production in 1914 of the plants which can be classed under the heading chemical industry proper was estimated at 850,000 tons. The present production is between 200,000 and 300,000 tons. Under this heading are included plants manufacturing sulphuric acid, nitric acid, hydrochloric acid, sodium sulphates, iron, copper, sulphites, superphosphates, ammonium salts and various fertilizers. No figures are yet available on the production of chemical byproduct factories, either for 1914 or at present. Under this heading are classed all factories which handle chemical products already prepared, such as salt refineries, the preparation of sodium crystals, hypochlorites, pharmaceutical and hygienic products, photographic materials, etc.

The chemical industry in general throughout France has received great encouragement as a result of the war. Prior to 1914 the industry was of relatively minor importance, French manufacturers preferring to import the necessary supplies from Germany, which for years had specialized in this branch of industry. However, once the German supplies were cut off and the war showed the immense value of chemicals in the successful prosecution of hostilities, the French Government and private enterprise began to turn their attention seriously to the development of the industry in France.

The manufacture of powder, which is an important branch of the industry, is in the hands of the government, it being, with tobacco, matches, etc., a government monopoly. It will only be necessary to cite a few figures on this one product to show what pre-eminence the chemical industry attained in the eyes of the French General Staff. The plan of French mobilization in 1914 included the following estimates:

Quantity of powder to be produced during the war, 24 tons a day.

Quantity of other explosives to be produced during the war, none.

No one then supposed that the quantity of explosives on hand would not be sufficient for any war purposes. However, after the first battle of the Marne, the pressing need of chemicals for powder and explosives began to develop. It was necessary to create factories almost over night to meet the ever-growing demands of the army. The original provisions, cited above, were doubled many times over, so that by June 25, 1917, the estimates of army needs were the following:

Quantity of powder to be produced, 640 tons a day.

Quantity of other explosives to be produced, 1,100 tons a day.

All this productive capacity, no longer needed for war purposes, can be utilized to build up the chemical industry to a position where France will be independent of foreign sources of supply.

Clay Storage Within the Factory

The December issue of the *Journal of the American Ceramic Society* contains an original article by T. W. Garve, embodying the essentials of adequate storage space and material-handling equipment within the factory, with numerous sketches to illustrate definite layouts.

"To insure continuity of operation it is necessary to have a supply of crushed and ground shale or clay on hand to bridge over breaks and delays and to keep the machinery running ahead of the bin. It is well for the superintendent, and for the men, to know in the morning that there is enough clay supply on hand within the factory to see the day through for production. Besides, any further handling and storing of clays will improve the quality of the clay by intermixing of the particles and their exposure to air.

"Bins employed for such purposes are usually built overhead. This will put the storage out of the way and allow for passage below and for the installation of feeders at the bottom for continuous and automatic feed to the grinding or pugging machinery.

"For delivering raw shale or dry lumpy clay to the factory it is well to dump the contents of the car into a pocket at the bottom of which a plate feeder is operating to insure a steady uniform charge of material to the crusher (or dry pan).

"If a crusher is used ahead of the dry pan, it is proper to place a storage bin between them for keeping crushed material on hand. The crushed material can be fed out of such a bin by means of a reciprocating plate feeder as before or by a disk feeder. The ground material should be stored again above the pug mill with a disk feeder to permit of fine adjustments."

The principles covered in this paper involving storage capacity for raw material and product of machines may well be applied to chemical plants where considerable material is involved in the daily operations.

Nickel Brasses

A Summary of the Work of Leon Guillet Published in "Revue de Metallurgie"
of 1913 and 1920 on the Important Role Played by Nickel in the
Manufacture of Low-Copper Ternary Brasses

AS A RESULT of a systematic study of special brasses¹ it appeared that only nickel, iron and manganese, of several other elements, raised the "fictitious composition" of the ternary alloy. That is to say, whereas most of the alloying elements acted as though they replaced zinc, these three seemed to replace copper. Nickel was much the most powerful in this action, and it appeared desirable to investigate these alloys in detail² in the hope that desirable commercial alloys might be discovered. Theoretical considerations expounded in the former articles¹ led to the expectancy of alloys which could be hot-worked, even though very low in copper, and cold-worked, though relatively low in copper. With approximately normal copper, a little nickel would doubtless increase the elongation, and therefore the ease in cold-working, drawing or stamping. It can readily be seen that if a cheap addition metal could be discovered whose coefficient of equivalence were sufficiently small, a very much cheaper alloy might probably displace the ordinary brasses.

COEFFICIENT OF EQUIVALENCE

Four series of alloys were studied, of 50 and 55 per cent copper, sand- and chill-cast respectively. In each it was desired to replace successively 0.5, 1.0, 2.0, 5.0 and 10.0 per cent of the zinc by nickel. Virgin metal of highest purity was used, so that the resulting bars analyzed only traces of tin and lead. Actual contents of copper, nickel and iron are tabulated.

To determine the coefficient of equivalence the 55 per cent copper brasses of Series I (Table I) were selected. Since t had previously been determined¹ to be less than 1, if one started at the upper limit of β a little nickel would give microscopic field of $\alpha + \beta$. Experimentation quickly indicated that annealing the castings at 750 deg. C. for two hours was necessary in order to normalize the structure and permit accurate microscopic analysis.

As seen in the table, t , the coefficient of equivalence, lies between -1.1 and -1.4, -1.2 being the average. Series II, of practically the same analyses, cast in sand, gives limits and average (-1.4) slightly higher. On the whole, -1.3 seemed to be the most probable value. Series III and IV were available to check this figure, which, within the available limits, was quite close. See especially alloys Nos. 16 and 22. Nos. 17 and 23 are good, considering the high amounts of nickel present.

Alloy 21 (Cu 49.52, Ni 2.28) gives a single microscopic constituent, whether a raw casting or annealed. It is notable, however, that it develops a coarsely polyhedral grain on reheating following no working of any kind, a phenomenon long regarded by many metallurgists as extremely rare if not impossible. Fig. 1,

alloy 23 after annealing, shows the β constituent clearly in a fine eutectoid, a structure never found in ordinary brasses.

MECHANICAL TESTS

All the melts described were subjected to the ordinary static tension and Brinell test. Impact results on notched specimens are also tabulated in Tables I to IV inclusive. Hardness was determined on unannealed castings. The figure for elastic limit is doubtful in almost all cases on account of the well-known difficulty in determining the limit of proportionality in brass specimens. Contraction is also difficult to measure on account of irregularities in the necked area.

EFFECT OF NICKEL ON 50 AND 55 COPPER BRASSES

Inspection of the tables shows that nickel betters the mechanical properties of these brasses if the fictitious composition is sufficiently high. Especially in the 50 per cent copper brasses, Alloys Nos. 15 and 21 (2 per cent nickel) show a very great increase over similar melts containing half as much. Five per cent nickel gives an even greater advantage, while the 10 per cent nickel alloys are quite remarkable.

Comparison of alloys 16 and 22 with Nos. 6 and 7 shows that in general the properties of the ternary alloys correspond fairly well with those of a real alloy having a composition approximating the fictitious composition of the former. However, the important specific effect of nickel can be seen most notably in increasing the strength. Alloys of the same fictitious composition, yet containing widely varying amounts of nickel, will for the same reason also show variations in properties; compare alloys 2 and 22. For this reason, predictions based upon microscopic study and fictitious compositions



FIG. 1. SAND-CAST ALLOY NO. 23. 49.13 Cu, 10.07 Ni. $\times 60$.

¹Revue de Metallurgie, Memoirs, 1905, p. 97, and 1906, p. 242. Summarized in CHEMICAL & METALLURGICAL ENGINEERING, VOL. 24, No. 4, p. 177, Jan. 26, 1921.

²Revue de Metallurgie, Memoirs, 1913, vol. 10, p. 1130.

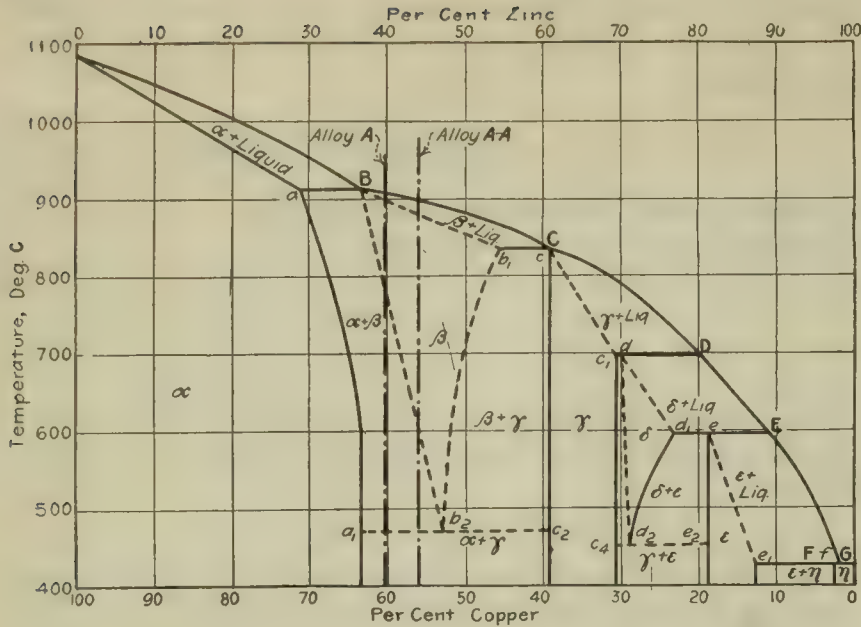


FIG. 2. EQUILIBRIUM DIAGRAM FOR COPPER-ZINC ALLOYS
After Gulliver, "Metallic Alloys," p. 267

must be made with circumspection and a good knowledge of the effect which the third element will exert by its own right.

Yet it could be expected that since nickel increases the elongation of brasses relatively low in copper, a brass with a little nickel could be worked or drawn better in the cold, an expectation abundantly verified in practice. Again, if nickel be added to a binary brass which can be worked hot and whose constitution is $\alpha + \beta$, but nearly all α (say a 62:38 brass), all the β is suppressed and it may be rolled hot only with difficulty. This change may be much intensified in commercial production, owing to the temptation of remelting nickel-plated ware whose base might be anything, thus

introducing many unknown impurities into the mixture. Inspection of the table shows that remarkable strength, ductility and toughness are had in 49:41:10 alloys³ but more especially in 54:41:5 (alloy No. 10). Rolled and annealed metals of composition 55:43:2 and 50:45:5 were found to have ultimate strengths of from 64,000 to 71,000 lb. per sq.in., an elongation of from 33 to 45 per cent, resiliency of 10 kg.-m. on grooved 10 x 10-mm. test-piece, and Brinell hardness of 100. The war stopped researches along these lines, and the first commercial production of 55:43:2 appears to have been undertaken in the United States. However, even before the war the following results were obtained in French practice:

Type A		Type B	
Cu.....	56.7	Cu.....	55.15
Zn.....	39.74	Zn.....	42.3
Ni.....	3.35	Ni.....	2.24
Pb.....	0.0	Pb.....	0.0
Fe.....	0.12	Fe.....	0.09
Mn.....	0.05	Mn.....	tr
Al.....	tr	Al.....	0.05
Sn.....	tr	Sn.....	tr
Microscopic Cu.....	60.5	Microscopic Cu.....	58.0
Calculated ($t = -1.3$).....	61.5	Calculated ($t = -1.3$).....	58.4

	A		B	
	Casting Annealed 2 Hr. at 750 Deg. C.	Cold- Drawn Bar	Casting Annealed 2 Hr. at 750 Deg. C.	Cold- Drawn Bar
Ultimate strength.....	67,200	75,900	64,800	72,400
Elastic limit.....	21,800	50,200	20,200	37,600
Elongation.....	43.0	33.3	33.0	29.0
Contraction.....	51.7	50.7	4	4
Impact strength.....	18.1	14.8	12.9	9.3
Brinell hardness.....	97	144	116	151

³Copper analysis given first, then zinc, then nickel.
⁴Unknown, but very great.

TABLE I—SERIES I. CHILL-CAST BRASSES WITH 55 PER CENT COPPER										
Alloy No.	Chemical Analysis			Microscopic Analysis Copper	Calculated t	Tension Tests				
	Copper	Ni	Fe			Ultimate	Elastic Limit	Elongation	Contraction	Brinell Hardness
1	55.10	0.59	0.23	55.7	— 1.1	58,800	20,800	14.0	...	113
2	55.14	1.02	0.13	56.5	— 1.4	36,300	18,900	6.0	...	139
3	55.95	2.03	0.14	58.5	— 1.2	46,700	19,900	12.0	...	113
4	55.41	5.02	0.15	62	— 1.1	50,600	19,300	27.0	...	90
5	54.62	10.57	0.17	> 63	.....	41,400	19,300	37.00	...	79
TABLE II—SERIES II. SAND-CAST BRASSES WITH 55 PER CENT COPPER										
Alloy No.	Chemical Analysis			Microscopic Analysis Copper	Calculated t	Tension Tests				
	Copper	Ni	Fe			Ultimate	Elastic Limit	Elongation	Contraction	Brinell Hardness
6	55.17	tr	0.05	55	.....	49,200	.....	13.0	...	126±
7	54.37	0.61	0.06	55	— 1.5	58,500	.....	17.0	...	140±
8	54.19	1.23	0.06	56.0	— 1.5	55,200	.....	13.0	...	140
9	54.37	2.31	0.06	57.5	— 1.4	57,400	.....	19.0	...	119
10	53.85	5.14	0.06	59.5	— 1.1	54,800	.....	46.5	...	94
11	54.13	9.87	0.11	> 63.0	.....	.....	.....	.....	...	.....
TABLE III—SERIES III. CHILL-CAST BRASSES WITH 50 PER CENT COPPER										
Alloy No.	Chemical Analysis			Microscopic Analysis		Tension Tests				
	Copper	Ni	Fe	Found	Calculated	Ultimate	Elastic Limit	Elongation	Contraction	Brinell Hardness
12	49.26	.....	0.08	> 54.7	49.9	23,600	.....	1.0	1.5	163
13	49.46	0.50	0.07	> 54.7	49.9	26,500	.....	1.5	...	151
14	49.17	1.00	0.10	> 54.7	50.3	26,100	.....	3.0	4.5	129
15	49.47	2.02	0.11	> 54.7	51.8	55,600	.....	12.5	...	143
16	49.48	5.02	0.39	55.5	55.9	60,200	.....	10.0	8.0	153
17	49.24	9.81	0.39	62	63.5	54,900	.....	23.5	...	112
TABLE IV—SERIES IV. SAND-CAST BRASSES WITH 50 PER CENT COPPER										
Alloy No.	Chemical Analysis			Microscopic Analysis		Tension Tests				
	Copper	Ni	Fe	Found	Calculated	Ultimate	Elastic Limit	Elongation	Contraction	Brinell Hardness
18	49.21	.....	0.08	> 54.7	49.5	16,500	.....	.....	...	156±
19	49.08	0.62	0.06	> 54.7	49.5	19,900	.....	1.5	1.5	151
20	49.23	1.16	0.11	> 54.7	50.6	23,600	.....	2.5	4.5	138
21	49.52	2.28	0.10	> 54.7	52.2	47,000	.....	11.0	...	146
22	49.41	5.15	0.17	56.2	56.0	56,400	.....	9.0	...	143
23	49.13	10.07	0.31	62	63.8	50,500	.....	42.0	...	89

* Kg.-m. on notched 10 x 10-mm. test-piece.

TABLE V. SERIES V. HIGH-NICKEL BRASSES

Alloy No.	Chemical Analysis		Microscopic Analysis	
	Copper	Nickel	Calculated Copper	Observed
24.....	50.32	4.15	55.5	55
25.....	50.34	6.70	59.4	59
26.....	45.32	8.34	55.9	β
27.....	46.35	10.35	60.6	58
28.....	46.03	12.56	64.6	62
29.....	40.25	12.87	56.9	β
30.....	40.46	14.42	60.4	57
31.....	41.10	16.54	66.1	62
32.....	36.15	17.70	60.9	56
33.....	36.18	19.58	65.4	59
34.....	36.26	21.82	72.4	62
35.....	35.86	23.49	77.4	α
36.....	30.57	22.70	63.8	56.5
37.....	25.01	24.81	58.1	β
38.....	25.74	27.76	70.8	56.5

When next approaching the study of these brasses,⁵ it appeared desirable to discover whether the properties of a 50:45:5 brass (strength, toughness, incorrodability and pleasing color) could be had by decreasing the copper and increasing the nickel.

A series of test-pieces of the compositions given in Table V were prepared, attempting to add nickel in such proportions as to maintain the fictitious compositions between about 55 and 58 per cent.

Fictitious compositions of the alloys formed of $\alpha + \beta$ constituents were determined microscopically to within 0.5 per cent and results tabulated. It is evident that there are important differences between the fictitious compositions when determined microscopically and calculated. Calculating back with the formula

$$t = 1 + \frac{100}{q} \left(\frac{A - A'}{A'} \right)$$

it is found to vary between -0.9 and -1.2 , the smaller when the copper content is lower.

It may be noted that the color of the alloys is as follows:

Alloy No.	Color
24.....	Pale gold
25.....	Pale gold
26.....	Yellowish white
27.....	White and yellow, changeable
28.....	White and yellow, changeable
29.....	Silver white

ROLLING TESTS

To discover the possibility of forging and rolling, tests were made on all brasses under the same conditions—namely, temperatures of 650 to 750 deg. C., same rolling mill and passes at same velocity and pressure, starting with 80-mm. diameter ingots and ending with 20-mm. round bars.

The results obtained in rolling tests are noted in Table VI.

TABLE VI. ROLLING TESTS ON HIGH-NICKEL BRASSES

Alloy No.	Results
24.....	Easy to roll and without defects
25.....	Easy to roll and without defects
26.....	Very difficult to roll. Cracked
27.....	Easy to roll without defects
28.....	Difficult to roll without defects
29.....	Difficult to roll without defects
30.....	Easy to roll without defects
31.....	Small cracks when rolled
32.....	Cracks badly from start
33.....	Breaks in pieces from the start

Alloys 27 and 30 appeared worthy of thermal investigation, since they have unique ductility when hot. There should be an intimate relation between the correct

temperature for forging, the transformation temperatures and variations in mechanical properties. Their microstructure is given in Figs. 3 and 4.

The alloys tested and the results obtained are given in Table VII. Fusion points have been determined with the Coste apparatus; transformation points with the Saladin-Le Chatelier double galvanometer.

While the transformation points in the ternary brass approximate those of binary alloys with the former's

TABLE VII. THERMAL ANALYSIS

Alloy No.	Chemical Analysis			Microscopic Analysis	Liqui-dus	Solid-us	Transformation Points	
	Cu	Zn	Ni	Cu			On Heating	On Cooling
27	46.35	43.16	10.35	58.5	...	...	660-810	760-660
30	40.46	44.95	14.42	57	...	...	470-730	730-375
..	60	40	...	...	890	875	445-780	740-450
..	55	45	...	...	875	850	445	450
..	46	54	...	...	850	840	450	450
..	40	60	...	...	840	840	470	450

fictitious composition, it is evident that these temperatures are raised by nickel, but the elevation is not directly proportional to the nickel content.

EFFECT OF ADDED METAL

In a general way when a third element is added to a copper-zinc alloy the following may take place:

(a) A special constituent may be formed, consisting of the isolated added element, or of a combination of this element with copper or zinc, or of a new solid solution. For instance, lead appears as a special constituent (rounded globules) when present to the extent of 1 per cent or more.

(b) The eutectoid point may be displaced to the right or to the left, creating a fictitious composition when determined microscopically, which may be respectively above or below the copper content of the actual chemical analysis. It has already been shown that aluminum, tin, silicon and magnesium, having a coefficient of equivalence for zinc greater than 1, move the β eutectoid (point b_2 in Fig. 2) to the left and at the same time the brass assumes a fictitious composition in copper less than the real. On the other hand, iron, manganese and nickel, having $t < 1$, move b_2 to the right, and the fictitious copper content is higher than shown by chemical analysis.

(c) The eutectoid point may be displaced not only horizontally but vertically—i.e., the eutectoid horizontal may be lowered or raised. In this case extremely important variations from the normal constitution of the fictitious binary alloy may result. In a general way, if the point is sufficiently lowered (probably to about 350 deg. C.) the structure after slow cooling becomes martensitic. Such a phenomenon is indicated by Robin's work on bronzes, and by the structure of many special steels. If the transformation point was lowered to below ordinary temperature, the structure would be polyhedral (austenitic in steels). If, on the contrary, we consider a non-resolved eutectoid—as is the case for brasses—and the added element raises the eutectoid temperature, the two constituents of the eutectoid will have opportunity by time and high-temperature mobility to coalesce and appear, especially when the rise in temperature is sufficiently important.

Data on thermal analysis given in Table VII show one important rise in the location of the eutectoid temperature; whereas for normal brasses this transforma-

⁵Revue de Métallurgie, July, 1920, p. 484.



FIGS. 3 AND 4. BRASSES NOS. 27 AND 30 RESPECTIVELY, SHOWING GREAT DUCTILITY

tion on cooling takes place at 450 deg. C., when 10.35 per cent nickel it occurs at 660 deg. C.

In a slowly cooled sample of alloy 27 or 28 one would therefore expect to see both the α and γ constituents under moderate magnification, an expectation confirmed by Fig. 5.

This has already been noted by Carpenter. Further studies to be described later show that the resolved eutectoid appears under circumstances which can be predicted if the rise of the transformation point is known. This is a very remarkable fact from the point of view of the general theory of hardening.

MECHANICAL PROPERTIES AT ORDINARY TEMPERATURE

Tests were made on cast and rolled metals as shown in Table VIII, determining the ultimate strength, elastic limit, per cent elongation after breaking, contraction

(which is defined by the relation $\frac{S - s}{S} \times 100$), impact strength of notched 10 x 10-mm. bar, and hardness. For tension tests the pieces were 13.8 mm. diameter (0.54 in.) and 100 mm. (3.94 in.) between punch marks.

The alloy which has the most remarkable mechanical properties is the No. 27 (Fig. 3), analyzing 46.3 per cent Cu and 10.3 per cent Ni, but it possesses a yellowish glint, and this might be a hindrance for some uses.

Alloy No. 30, 40.4 per cent Cu and 14.4 per cent Ni

(Fig. 4), is of an exceptionally white color and has very interesting mechanical properties.⁶

From the study of the data it can be seen: First, that if we consider the relations between fictitious compositions and mechanical properties, the most interesting alloys are those whose fictitious compositions lie between 57 and 60 per cent. It is well to remember that this is also the case for the binary brasses which give relatively high value in this range (ultimate 46,000 to 54,000 lb. per sq.in., and elongation 35 to 40 per cent).

Second, there are a number of alloys which present the microscopic aspect of ordinary brasses ($\alpha + \beta$) and which do not have any interesting properties. This is a new fact which has not been brought out in previous tests on special brasses, due perhaps to the fact that the work was not done on sufficiently various compositions. An instance is Fig. 6 of alloy 36.

There is no question that when nickel is sufficiently high it alters the properties of the solid solutions considerably, or at least of the β solution, which becomes extremely fragile (alloy No. 37; see also Table V).

INFLUENCE OF COLD-DRAWING

It is evident that the brasses which can be rolled could also be cold-drawn if they possess sufficiently high elongations. But it is to be noted that the greater part of these alloys having a high ultimate strength also possess a high elastic limit—at least higher than those of ordinary brasses—and, due to this fact, the speed of drawing has to be small.

In general, it is not easy to determine the elastic limit.

Table VIII also shows the influence of drawing on the mechanical properties of three of the alloys. The figures have been obtained after one draw on a 20-mm. (0.79-in.) round bar, reducing it 2 mm. (0.08 in.) in diameter.

INFLUENCE OF LEAD

It is known that lead greatly facilitates working ordinary brasses and that all the alloys for machine-finishing contain from 1 to 3 per cent lead. As noted

⁶The alloys containing less than 50 per cent of copper have been patented by the Société Métallurgique de la Bonneville.

TABLE VIII. PHYSICAL PROPERTIES OF CAST AND WORKED BRASSES

Alloy No.	Condition	Tensile Tests				Stock Tests		
		Ultimate Strength	Elastic Limit	Elongation	Contraction	Strength	Angle of Rupture	Brinell Hardness
24	Cast	52,500	28,500	9.0	14.2	5.6	167	143
	Rolled	62,600	29,900	9.0	49.7	9.5	149	151
	Cold drawn	81,000	...	4.0	11.5	6.2	162	197
25	Cast	62,900	23,600	31.0	44.3	7.5	149	109
	Rolled	72,000	25,100	46.5	14.2	11.3	144	118
	Cold drawn	82,600	...	27.5	50.7	7.5	160	176
26	Cast	27,300	28,200	0.5	1.4	1.8	180	160
	Rolled	49,800	36,000	3.0	3.1	2.5	180	156
	Cast	68,700	26,900	31.0	30.7	11.0	151	128
27	Rolled	80,600	36,700	45.0	57.5	13.2	142	137
	Cold drawn	101,800	19,900	...	22.0	5.0	172	207
	Cast	54,000	34,200	17.0	11.5	9.7	146	121
28	Rolled	67,200	32,700	49.0	52.7	13.7	135	116
	Cast	7,000	...	1.0	...	...	...	159
	Rolled	43,200	40,200	1.0	1.4	1.5	180	170
30	Cast	91,700	57,000	7.0	10.1	4.3	168	190
	Rolled	86,500	44,500	18.5	19.4	7.8	166	170
	Cast	92,500	81,100	...	...	2.5	179	255
31	Cast	72,300	54,900	2.5	4.5	3.0	173	191
	Rolled	77,200	51,200	5.5	7.3	5.0	178	187
	Cast	90,000	71,000	2.0	3.1	3.1	178	217
34	Cast	77,600	77,600	1.0	0.0	2.5	179	241
	Cast	93,600	93,600	1.0	0.0	2.1	177	262
	Cast	35,400	21,200	0.0	0.0	1.2	179	210
37	Could not be machined into a test piece							
	Cast	8,500	8,500	0.0	0.0	1.2	179	228



FIG. 5. SLOWLY COOLED BRASS CONTAINING 46.0% Cu, 12.5 Ni

TABLE IX. EFFECT OF LEAD ON NICKEL BRASSES

Alloy No.	Chemical Composition				State	Tension Tests			Impact Test			
	Cu	Ni	Pb	Zn		Ultimate Strength	Elastic Limit	Elongation	Contraction	Strength	Angle of Rupture	Brinell Hardness
39	50.55	6.55	0.18	42.57	Rolled	57,700	.....	41.0	43.3	11.3	142	141
40	49.65	6.72	2.25	40.96	Rolled	67,300	.....	30.0	29.5	7.5	156	135
41	44.70	10.90	0.16	44.07	Rolled	78,200	.....	31.0	30.7	8.1	158	168
42	44.80	10.96	2.23	41.70	Rolled	74,000	.....	35.0	41.1	5.6	161	132
43	39.64	14.38	0.21	45.56	Rolled	78,200	.....	6.0	8.7	4.4	172	181
44	45.2	10.2	1.0	.....	Cast	61,700	27,200	14.0	15.5	5.3	160	127
					Rolled and annealed	77,200	29,900	41.0	36.6	10.6	152	137
45	45.3	10.3	2.0	.....	Cast	53,400	26,500	11.5	11.5	4.4	166	117
					Rolled and annealed	73,700	30,700	45.5	42.2	9.4	152	126
46	45.4	10.4	3.0	.....	Cast	54,000	24,600	26	22.0	5.3	167	107
					Rolled and annealed	70,000	31,500	50.5	48.6	9.4	156	119
47	45.1	10.4	4.0	.....	Cast	59,600	25,000	30.0	15.5	4.4	169	105
					Rolled and annealed	64,900	30,300	26	24.7	5.9	158	112

above, this element retains its individuality in the alloy, forming an inclusion which renders the turnings more fragile and less harmful to the edge of the tool. However, this isolated lead lowers other mechanical qualities of the alloy.

Alloys starting with 45 Cu, 45 Zn, 10 Ni were tested, with which 1, 2, 3 and 4 per cent of Pb were substituted for zinc. Microscopical examination showed the presence of globules in quantities increasing with the lead content.

From the inspection of Table IX one might think that some results have been confused, but this is not the case, and the tabulated figures have been verified with the greatest care. It can be seen that lead up

is low, especially alloy No. 30 (40 Cu, 14 Ni), the addition of lead lowers these properties even more and the products obtained clearly show fissures even after the first pass. Thus the alloy 41.52 Cu, 14.48 Ni, 2.25 Pb, 14.48 Zn could not be rolled.

MACHINING QUALITIES

Appreciation of the machining qualities of a metal varies from shop to shop and even from machinist to machinist.

A series of opinions on alloys of the three types 50:44:6, 45:45:10 and 40:46:14 collected from different plants proved that these alloys can easily be machined in all cases, although not as easily as ordinary brasses. The presence of lead undoubtedly facilitates the machining; the chips in this case are short and easily separated from the tool.

VARIATION OF THE PROPERTIES WITH VARIATIONS IN TEMPERATURE

Some alloys were studied at high temperatures which had been found to be quite difficult if not impossible to roll.

It resulted that the hardness diminishes rapidly as the temperature increases, reaching a value of about 50 at 500 deg. No reliable results could be obtained for temperatures above 700 deg. C.

Variations in resiliency are much more interesting and the harmful influence of lead is very marked. In alloys without lead the resiliency is increased remarkably at about 700 to 800 deg. C. (from about 2 kg.-m. to about 9), and it can be surmised that such alloys might be rolled if it were done at between 700 and 850 deg. C.—i.e., at a temperature higher than that used for brass. This fact has also to be taken into consideration when stamping nickel brasses. High-lead samples showed little change in impact-strength with temperature.

CONCLUSIONS

The results indicate the great value of nickel in the manufacture of low-copper brasses. From the industrial point of view, this study describes some alloys of exceptional qualities possessing ultimate strength up to 90,000 lb. per sq.in. with 20 per cent elongation and a resiliency of 8 to 10 kg.-m., very interesting variations in color from white to gold yellow, and a high resistance to atmospheric corrosion.

It can be expected that nickel is destined to play the same important rôle in the manufacture of copper alloys as it does in that of steels.

It is to be noted, however, that brasses with very high nickel contents can exhibit good microstructure ($\alpha + \beta$), yet not have any valuable special property.

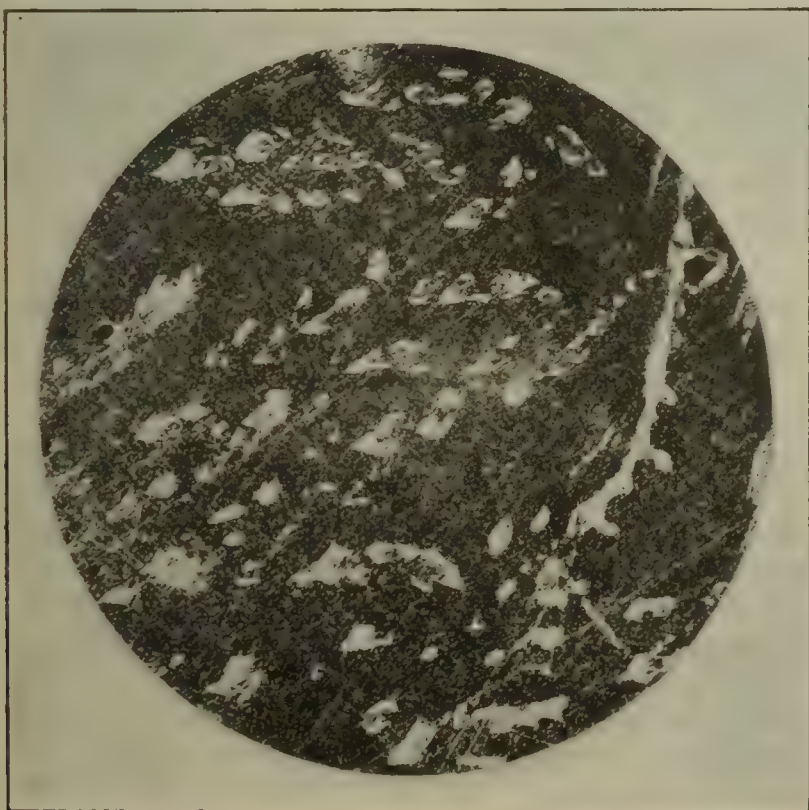


FIG. 6. BRASS NO. 36 (Cu 30.6, Ni 22.7). $\times 200$

to 3 per cent is in reality quite harmless to the mechanical properties of the alloys. Compare especially alloys Nos. 44, 45, 46 and 47 with alloy No. 27.

DIVERGENCE BETWEEN THE PROPERTIES OF AN ALLOY WHEN ROLLED AND WHEN CAST

Special attention is called to the pronounced divergences between the properties of the alloy when rolled and when cast. This is due to the fact that the reheating followed by mechanical work renders the microstructure of the metal more homogeneous.

No particular difficulty has been noted in the rolling of these alloys; it was as easy as the same operation on products not containing lead. But when the original alloys are rolled with difficulty, or when the elongation

Ownership of Highways and Streets

BY CHESLA C. SHERLOCK

RECENT press dispatches contain a very interesting account of a dispute between the Nichols Copper Co. and the Borough of Queens in New York City over the ownership of a street running through the factory grounds. The press account states:

"The disputed street is about ten blocks long and extends from Creek St. to the Newtown Creek waterfront. The Nichols company owns the land on either side and its property is partly improved and partly a place for the storage of coal. Down the middle of the street runs the narrow-gage plant railway and it is fringed with heaps of old iron, lumber and other materials. Residents of the Newtown section, complaining that access to the waterfront was denied them, besought Borough President Connolly to do something."

As soon as Mr. Connolly was advised that the company was putting up iron gates across the street to shut out the public, he gathered a force of 100 borough laborers and proceeded to tear up the railway and to clear the street of debris, claiming that it belonged to the city. There was no clash, the company contenting itself with court action and giving notice that the borough would be held responsible at law for all damage done to what it claims to be its private property.

There is probably no subject which has called for as much attention from the courts as that of the ownership of streets and highways.

TEST OF OWNERSHIP OF A WAY

The test of the ownership of a way, according to Ruling Case Law and backed up by numerous decisions of the courts, "is whether it is an open public way or one for the exclusive benefit of an individual or certain individuals. It is the right of travel by all the world, and not the exercise of the right, which constitutes a way a public highway, and the actual amount of travel upon it is not material. If it is open to all who desire to use it, it is a public highway, though it may accommodate only a limited portion of the public or even a single family, or though it accommodates some individuals more than others. Giving a private way a name, however, does not make it a public highway or thoroughfare."

This expression may be said to lay down the general principles governing in general cases. Seeking to apply it to the facts in any particular case, however, it is necessary for us to delve still deeper into the law.

Highways generally are established in two ways: First, by affirmative act under a statute giving that right; second, by long-continued usage as such. The latter principle applies in most jurisdictions; in some it is expressly abrogated by law.

It is quite apparent that the street in controversy had been used as a public way by some of the Newtown residents and that the company gradually assumed control of it for private purposes, at last attempting to shut out the public entirely.

HOW STREETS MAY BE DISCONTINUED

Streets may be discontinued at law only by abandonment. This does not mean by simply ceasing to use them, but it means by the affirmative act of publicly abandoning them.

There is a maxim in highway law which reads, "Once a street, always a street," and it holds good unless the

street is legally discontinued by the method prescribed in the statute relating to such matters.

In a New York case, it was held that a street was not discontinued or destroyed where an abutting property owner constructed a wharf upon said street.

In a Rhode Island case, which seems to be squarely in point with the borough case mentioned above, it was shown that a riparian owner had platted his land into streets, lots, squares, one of such streets being below high-water mark; the street was subsequently filled out, and the adjoining lots were sold to another party, who sought to use the street for private purposes just as the Nichols company attempted to use the street mentioned above, and not only that, but this owner attempted to close the street to the public. The court held that "the fact that the title to the several lots over which the highway runs becomes vested in the same owner does not extinguish the way, or justify such owner in closing it up, where it is appurtenant to other lots, as when it leads from other lots to tidewater."

In this Rhode Island case it was held that one lot owner had the right to keep that street open in the name of the public, because the closing of it cut him off from the waterfront.

Private individuals or private companies have no right to obstruct public ways, to lay tracks upon them or to close them up, except by express grant from the public. In case of the discontinuance of a public way, it cannot be assumed or inferred from the fact that it is seldom used by others than those owning property on both sides of the street; it can be a fact only by the affirmative act of the public in the method set out by law.

United States Has Over One-Quarter Million Producing Oil Wells

According to the figures compiled by the United States Geological Survey there were 258,600 oil wells in the United States with an average daily production of 4.98 bbl.

Pennsylvania ranked first in number of wells (67,600), but lowest in average daily production (0.3 bbl.); Oklahoma followed next with 50,700 wells with an average daily production of 6 bbl. Texas, Louisiana, California and Wyoming and Montana, although possessing fewer wells, had a greater daily average production, of 27, 31.8, 32.3 and 55 bbl. respectively.

The following table gives the district, number of wells and the average daily and actual output in the United States:

	No. Producing Wells	Daily Average Output, Barrels	Nov. Actual Output, Barrels
Texas central and north ...	9,400	22.9	6,714,000
Gulf Coast	1,700	49.7	2,775,000
Total, Texas	11,100	27.0	9,489,000
California	9,490	32.3	9,340,000
Oklahoma	50,700	6.0	9,031,000
Kansas	15,700	7.4	3,578,000
Louisiana	2,700	31.8	2,615,000
Wyoming and Montana ...	1,000	55.0	1,432,000
Illinois	16,800	1.7	846,000
Kentucky	7,800	3.2	734,000
West Virginia	19,500	1.1	656,000
Pennsylvania	67,600	0.3	603,000
Ohio	39,600	0.5	602,000
Indiana	2,400	1.1	81,000
New York	14,040	0.2	75,000
Total	258,600	4.98	39,090,000

Drying Storage Battery Plates

Low production cannot always be attributed to the inefficiency of labor, as seems to be the tendency these days. Very often it is due to antiquated equipment and obsolete methods of manufacture, which become the limiting factors in production, and no matter what speed is obtained up to this point the output of a plant is limited to the slowest operation in the process of manufacture.

Ninety per cent of all materials made must be dried at some stage of their manufacture, and generally speaking the drying operations require considerable time, varying from the fifteen minutes required for drying



MACHINE FOR DRYING STORAGE BATTERY PLATES

cotton and wool stock to from one to two weeks for high-tension porcelain insulators.

In the manufacture of storage batteries, the positive plates are formed by pasting a mixture of ammoniacal red lead into specially molded metallic lead grids, and the negative plates by pasting a mixture of lead peroxide into grids of the same type, the plate then being dipped into dilute sulphuric acid. Both positive and negative plates must then be thoroughly dried, since after the drying operation the plates are charged with electricity by the usual method and if there is even a small amount of moisture remaining in the plate the charging will cause the active material to crumble away from the grid and the plate must be discarded.

After the pasting process, the plates are inserted in racks preparatory to drying. Under the old system of drying the racks containing the plates were put into closets to dry. These closets were huge affairs of wood construction occupying a great amount of floor space and heated by means of steam coils which also formed the shelves for holding the racks containing the plates. As each rack was filled with wet plates, it had to be carried from the pasting table to the shelves on the closet. Here it required from twenty-four to forty-eight hours for the plates to dry, depending on the humidity of the surrounding atmosphere and with no certainty of uniform results or definite length of time to dry.

The length of time required to dry the plates by the old method and the lack of uniformity of results presented a serious obstacle to one of the largest storage battery manufacturers in this country when large-scale production was desired. The difficulty was practically

overcome by the use of a Hurricane drier of the tunnel truck type, manufactured by the Philadelphia Drying Machinery Co., Philadelphia, Pa.

This machine is constructed of angle-iron framework to which panels are clamped, consisting of two sheets of steel, beveled and fastened together on the edges, thus forming an air-cell and providing insulation for the drier. The machine is divided into two compartments, one holding the steam coils which provide the heat for the drying, the other holding the trucks of plates being dried. The drying is accomplished by the circulation of large volumes of hot air by fans located in the partition between the two compartments.

After the plates are pasted and inserted into the racks, they are loaded on to a waiting truck and when fully loaded the truck is run into the drier. Here the plates are dried in a few hours, the time required depending on the area and thickness of the battery plate.

The drier is built to hold six specially constructed trucks in the drying chamber at one time, and as a truckload of wet plates is pushed into the machine at the feed end, a truckload of dry plates is removed from the delivery end, thus reducing labor and floor space to a minimum with the assurance that the material will be dried in a definite time.

Multiwhirl Subcooling Condenser

The construction of the multiwhirl subcooling condenser designed for use in oil refineries, particularly for the condensing and subcooling of gasoline, kerosene or any other vapors is shown by the accompanying cut.

The vapors to be condensed enter the tubes at the top and are condensed and cooled in their passage through the tubes. The resulting distillate is taken off at the bottom, the tubes being arranged single pass. The condensing and cooling water enters the shell at the bottom and travels upward through the helical path and leaves the condenser at the top, this arrangement insuring contraflow operation.

The unusual feature of this condenser, built by the Griscom-Russell Co. of New York, is the patented helical baffle, which insures a maximum length of water path for a given length of shell and a minimum water pressure loss. The helical baffle directs the water in its flow through the shell without appreciably retarding its progress.

The multiwhirl design permits a given size condenser in a much smaller space than has hitherto been possible because the efficiency secured by the use of the helical baffle permits the use of a much smaller amount of condensing and cooling surface than is ordinarily required. The efficient operation of the cooler permits delivery of the given cooling and condensing duty, using about one-third to one-quarter the condensing water required with other types of apparatus, with corresponding reduction in pumping costs. The high efficiency of



SECTION PHOTOGRAPH OF CONDENSER

heat transfer results in a temperature of distillate within a few degrees of the condensing water supply. The helical baffle has been used for the past four years and is, therefore, a tried-out design which has been fully proved in other fields. The entire tube bundle may be removed from the shell, provided such removal is necessary for inspection and cleaning. The tubes are expanded into the tube plates without the use of sweated joints. The upper tube plate is rigidly attached to the shell, but the lower tube sheet floats and is free to move, thus preventing any expansion strains on tube joints. The floating head is outside packed and this construction prevents any possible leakage of water into the oil through faulty packing.

The condenser is made standard with shell of close grain cast iron, water head of cast iron or cast steel, and floating head of cast steel with floating head cover of either cast iron or steel. The tubes are of $\frac{5}{8}$ -in. O. D. No. 16 B.W.G. seamless drawn steel expanded into tube sheets of rolled steel. The helical baffle is of brass. These materials of construction are varied to suit the requirements of the particular installations.

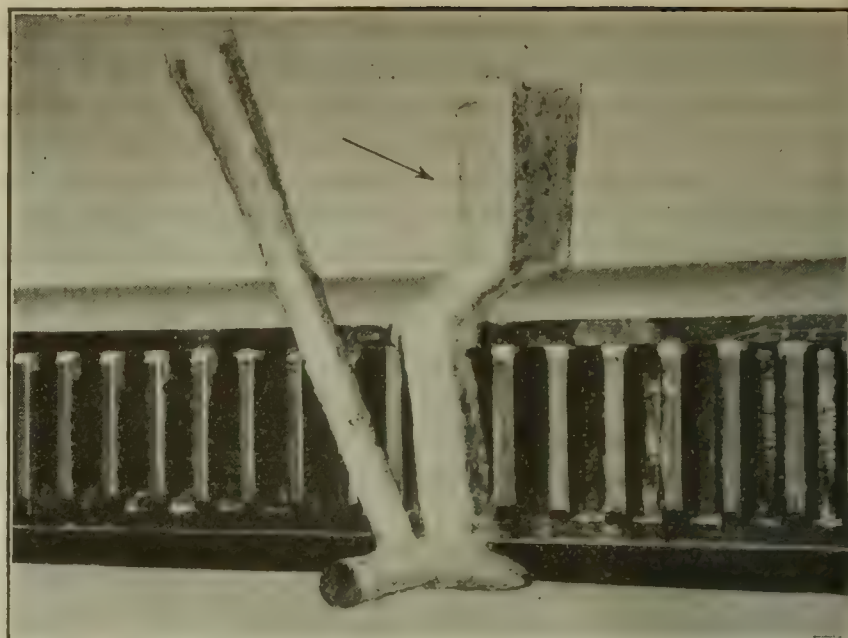
These condensers are built for both low or high pressure operations. They are especially well adapted to various cracking and topping systems. In making estimates on equipment installation, the following data should be had:

1. Pounds of vapor to be condensed per hour.
2. Gravity of liquid—degrees Baumé.
3. Latent heat of liquid.
4. Viscosity of liquid in Saybolt seconds.
5. Boiling point of liquid at working pressure.
6. Working pressure of vapor.
7. Inlet temperature of vapor.
8. Desired outlet temperature of condensate.
9. Per cent of non-condensable gases in vapor.
10. Can non-condensable gas be vented to atmosphere and if not what provision is made to take care of same?
11. Is steam present in vapor; if so how much?
12. Quantity of condensing water available per hour.
13. Temperature of water.
14. Water pressures—pounds per square inch.
15. Fresh or salt water?
16. If fresh, is it hard or soft?

Long Cast Sections Made by Welding Smaller Units

Ingots stripper plungers are extremely difficult to cast, owing to the fact that the cylinders, while 18 in. in diameter and 25 ft. or more long, have walls only 1 in. thick. Inasmuch as it is almost impossible to obtain a perfect core and then anchor it so as to prevent floating, the thickness of the steel is often reduced on certain sides, thereby weakening it and resulting in frequent breakages.

It has been found, however, that these castings can be made much more easily and of more uniform thickness by casting each cylinder in three separate parts about 10 ft. in length each, instead of in one piece, and then welding the parts together by means of thermit welding. All three welds can be machined off at the same time, and as the outside of the cylinder must be machined anyway, practically no more machining is required than if the plunger were cast in one piece. Plungers have been successfully welded in this manner for the past ten years and the welds have stood up perfectly in service.

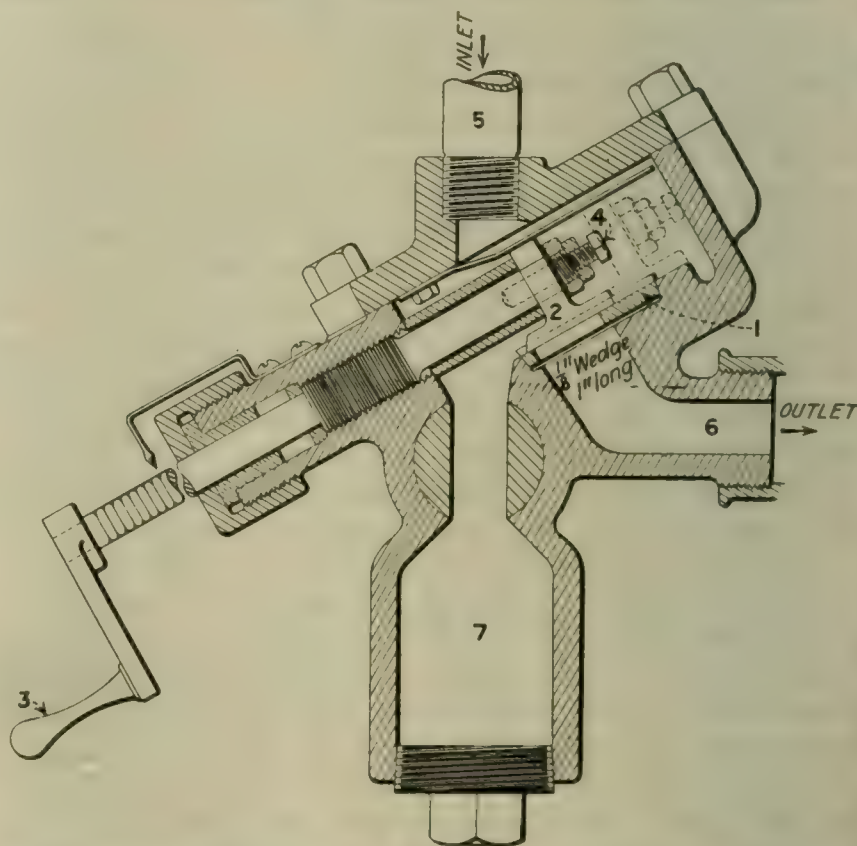


FRONT VIEW OF THERMIT WELDED INGOT STRIPPER PLUNGER AFTER HAVING BEEN CAST IN SMALLER SECTIONS

In the same way locomotive frames of unusual length for small foundries and other long sections which are difficult to cast in one piece can be cast in shorter lengths and these sections welded together. Welding may also be similarly used for building up shafts and other large sections in inaccessible places distant from transportation or underground in cramped quarters.

Flow-Regulating Valve for Viscous Liquids

The valve sectioned in the accompanying illustration was devised by A. V. Rigby, of the Carnegie Steel Co., and has given general satisfaction on open-hearth and reheating furnaces burning byproduct tar. A regulating orifice in the shape of a wedge 1 in. long and $\frac{1}{8}$ in. wide at its base is cut in the valve seat 1.



A slide valve 2, actuated by hand wheel 3 and limited by an adjustable set screw 4 closely regulates the effective area of the opening through which the liquid must pass from inlet 5 to exit 6. In case the opening should be clogged, the slide 2 is brought forward, pushing the obstruction into the trap 7, while material sheared off by the under surface of the slide is washed out by the flow of liquid when the valve is reopened. Bailey-Lewis, Inc., of Pittsburgh, has the selling rights for this regulator.

Synopsis of Recent Chemical & Metallurgical Literature

Forge Press Operations.—A paper, very important to engineers responsible for forging operations, was presented by EUGÈNE SCHNEIDER before the autumn (1920) meeting of the British Iron and Steel Institute, entitled "An Investigation of Various Forging Operations Carried Out Under Hydraulic Presses." In it the author describes a recording instrument developed at the Creusot works, gives an illustration of the autographic and derived curves for a heavy forging job, and finally a diagram summarizing information on stamping thirty different calibers and designs of shells. By means of such graphs it is possible to predict confidently the proper treatment for strange forgings; hitherto, only a "cut-and-try" process had been the guide.

Fig. 1 shows a photograph of the recorder. A strip of paper is wound around drum A by means of wire B connected to the ram and wound in turn about the drum-end C, made slightly conical to compensate for the thickness of the overlapping paper. A pipe, as large and short as possible, connects the press cylinder to manometer D; pressure moves the pointer, and through the agency of a light sheave and silken cord, drives a tiny counterweighted pen carriage E at right angles to the paper-travel. Such a curve as that shown on the drum

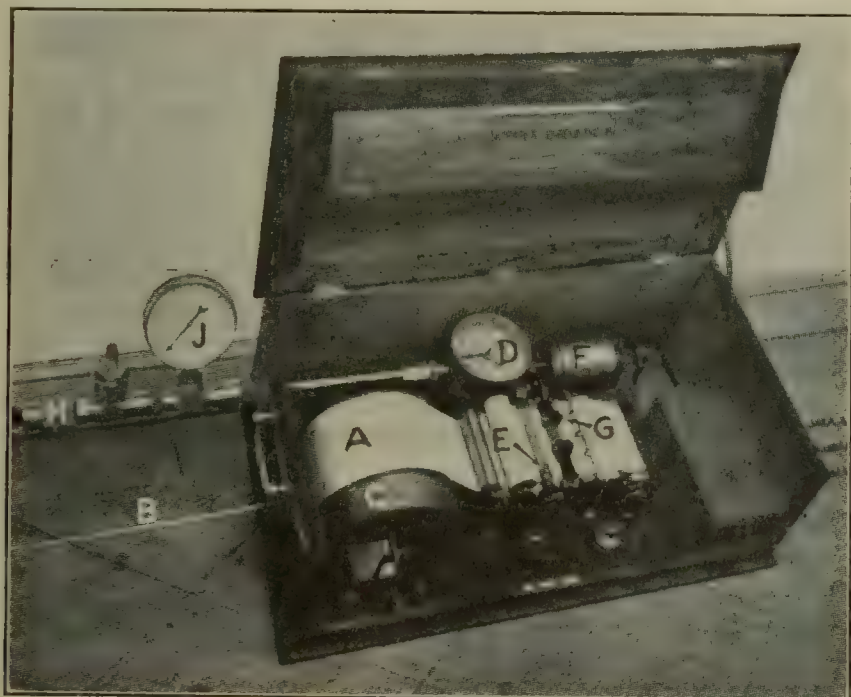


FIG. 1. RECORDING INSTRUMENT FOR FORGING PRESSES

evidently records the position of the ram and the pressure in the cylinder at any instant. Times corresponding to these movements are recorded in a unique manner. A constant-speed-motor F drives an endless chain at right angles to the paper-edge. To this chain is attached pencils G, one of which is always making a mark on the paper. Since the transverse speed of the pencil is uniform, the slope of its trace is a measure of the speed with which the paper (that is, the ram) moves.

In order to record both up and down ram-movements on paper constantly moving in the same direction, wire B is pulled by a second drum, mounted on the same shaft as a fine-toothed ratchet wheel. To right and left of the latter and loose on the same shaft are mounted

TABLE I. SYNOPSIS OF PUNCHING

No.	Type of Forging	Weight in Kg.	Nature of Blank Employed—Diam. in mm.	Lgth. in mm.	Thickness of Bottom in mm.	Depth of Punching in mm.
1	75 mm. shrapnel.....	5.6	Round, 82.....	138	22	116
2	H.E. 75 mm. shell.....	7.8	Round, 82.....	190	30	160
3	Howitzer shell 58 mm.....	4.8	Round, 82.....	117	20	97
4	105 mm. shrapnel.....	13.3	Round, 115.....	165	30	135
5	155 mm. cartridge.....	17	Round, 172.....	95	22	73
6	H.E. howitzer shell, 120 mm.	28	Round, 138.....	240	30	210
7	H.E. howitzer shell, 105 mm.	23	Round, 115.....	285	40	245
8	H.E. howitzer shell, 155 mm.	56.5	Square, 145; diag., 186.	360	35	325
9	H.E. howitzer shell, 145 mm.	50	Round, 162.....	310	35	285
10	H.E. howitzer shell, 155 mm.	63	Round, 180.....	317	35	282
11	H.E. howitzer shell, 190 mm.	110	Round, 230.....	340	70	270
12	H.E. howitzer shell, 149 mm.	59	Round, 178.....	305	45	260
13	H.E. howitzer shell, 279 mm.	270	Square, 265; diag., 320.	540	70	470
14	Hydrogen gas shell.....	82	Square, 230; diag., 280.	210	20	190
15	H.E. shell, 293.4 mm.....	345	Round, 320.....	545	80	465
16	H.E. shell, 279.4 mm.....	270	Square, 270; diag., 365	480	70	410
17	H.E. shell 240 mm.....	210	Square, 230; diag., 280	550	70	480
18	H.E. shell, 270 mm.....	195	Square, 250; diag., 335.	410	70	340
19	Example of punching.....					
20	H.E. shell, 279.4 mm.....	290	Square 280; diag., 350..	475	70	405
21	H.E. shell, 274.4 mm.....	305	Square, 265; diag., 320.	595	70	525
22	H.E. shell, 320 mm.....	485	Square, 280; diag., 350	820	80	740
23	H.E. shell, 370 mm.....	650	Square, 368; diag., 430	665	75	590
24	H.E. shell, 370 mm.....	530	Square, 268; diag., 430.	555	75	480
25	H.E. shell, 340 mm.....	630	Square, 320; diag., 430.	795	90	705
26	H.E. shell, 400 mm.....	800	Square, 368; diag., 430.	820	110	710
27	Torpedo tube.....	1,510	Octagon, diam., 480.	1,015	130	885
28	H.E. 520 mm.....	1,250	Square, 465; diag., 550.	790	130	660
29	H.E., 520 mm.....	1,800	Square 465; diag., 550.	1,130	130	1,000
30	H.E.....	1,400	Octagon, diam., 580..	970	130	840

sprockets carrying counterweighted link chains fixed to the ram, but reeved oppositely. Thus when the ram is going down, the right sprocket ratchets the drum forward, and when the ram is being raised, the left sprocket ratchets the drum forward, the right sprocket then idling.

Calibration is effected by attaching a hand pump to H, holding a certain pressure, indicated by the standardized manometer J, and drawing the paper forward slightly. The time is checked by measuring with a stop watch the time necessary for, say, twenty complete circuits of the first pencil G, and computing its speed.

The diagram in Fig. 2 assembles information on forging of thirty different types of shells and tubes listed in Table I. Many different factors affect the work of forging T (defined as the necessary pressure in kg. per sq.mm. of the greatest diameter of the punch). After temperature—which is held constant at 1,050 deg. C.—the greatest influence is exerted by the thickness of the walls e (Fig. 3) and the diameter of the punch. The ratio between the area of the side wall (an annulus with thickness e and inner diameter d) and the area of the punch is noted by Y and is called the coefficient of spread.

$$Y = \frac{4e(d+e)}{d^2} \text{ and } Y \propto \frac{1}{T}$$

If the diameter of the punch d is constant, the work of forging T evidently decreases with increase in wall thickness e. If the wall thickness e is constant, the work of forging decreases with the diameter of the punch. Therefore, Y has been computed for each forging and plotted below the horizontal axis. Three general classes have been distinguished, the dotted lines referring to thin walled forgings ($Y = 0.76 \pm$), the continuous lines to medium-walled forgings ($Y = 0.95 \pm$), and the dot-and-dash line to thick forgings ($Y = 1.2 \pm$). Heavy lines below the axis also connect corresponding punch-diameters. Values of Y and d not falling near the curves such as for forging 24 present in general no anomalies.

The length of the stroke is of influence chiefly on account of the time the metal is pressed and cooled

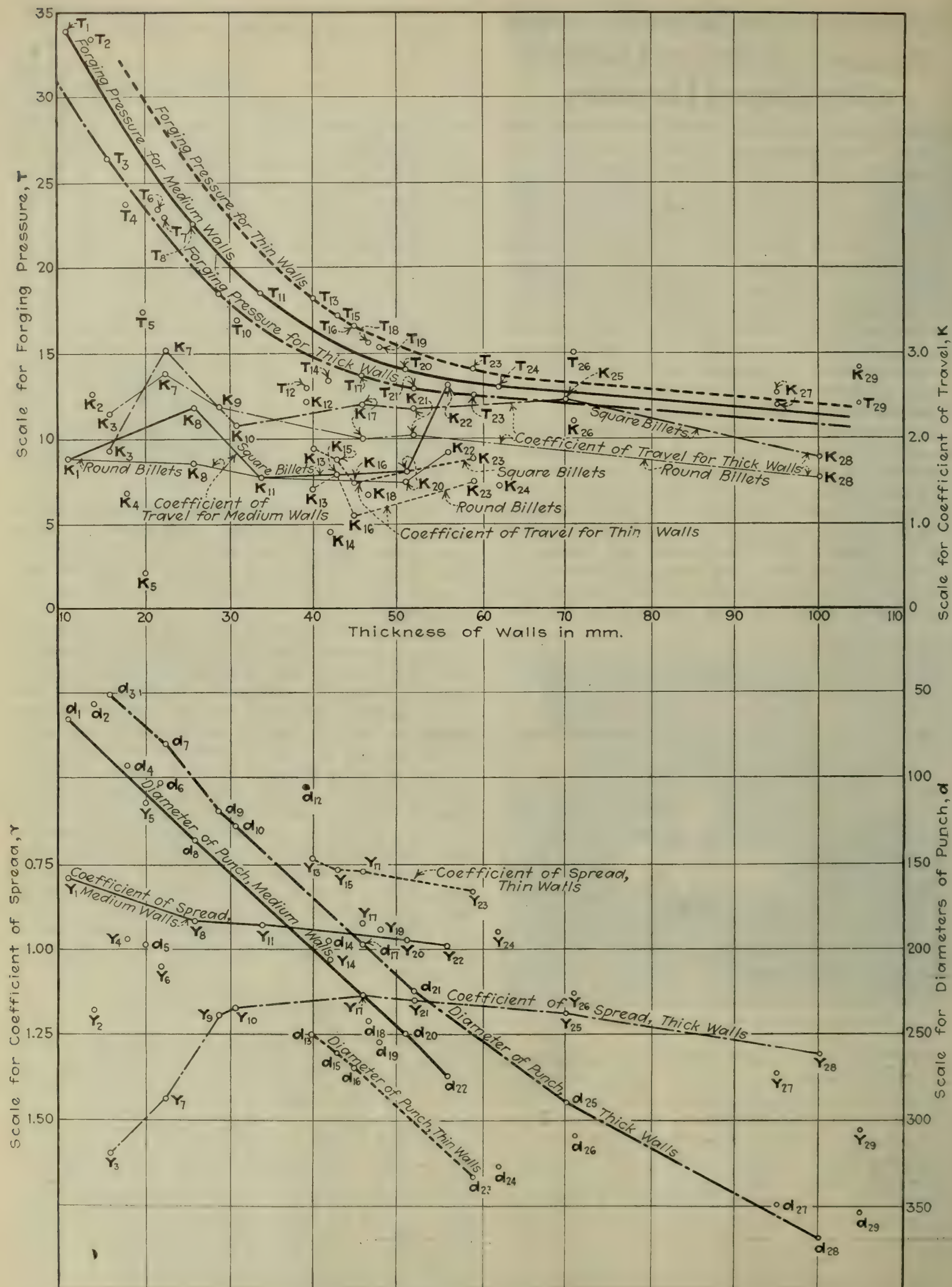


FIG. 2. DATA ON WORK REQUIRED FOR A PUNCHING OPERATION

Relationship between forging pressure in kilograms per square millimeter, diameter of punch, coefficient of spread and coefficient of travel for various operations, grouped in three classes.

against the die. The coefficient of travel K is defined as the ratio of length of stroke to diameter of punch, and is plotted above the horizontal axis, both for round and square billets, the latter being the higher. Other variables which have been eliminated are the shape and surface condition of punch and die, the speed of the press, the "spread" (or $e \div E$, see Fig. 3), the temperature of the tools, and the lubrication. Finally, the graph contains what is doubtless the most important information, viz., the work of forging, each point T being an integration of all these factors for a particular job, as determined with the aid of the recorder described above.

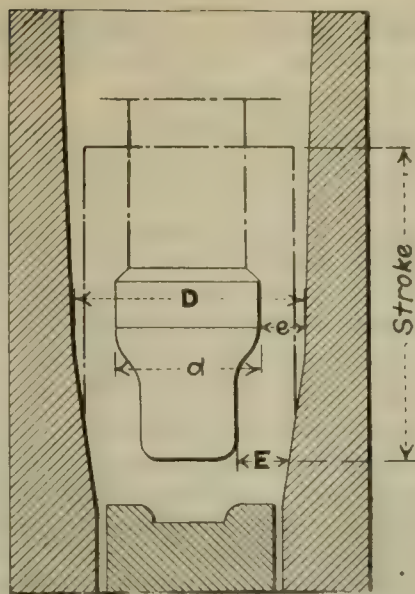


FIG. 3. SKETCH OF PUNCH AND DIE

(a) What pressure will be required to make a forging with $d = 255$ mm. and $e = 48$ mm.? Y is figured to be 0.89, consequently the work would be between that required for thin and for medium forgings. Running up ordinate 48, the required pressure is found to be about 15 kg. per sq.mm.

(b) Suppose a forging with $d = 255$ mm. is required and only a 650-ton press is available (a press which gives a maximum pressure of 12.8 kg. per sq.mm.). Running across abscissa 12.8 to its intersection with the curve T for thick forgings shows that a wall thickness of at least 60 mm. must be provided, and the die must evidently have a diameter not less than 375 mm. Y figures 1.16, consequently our assumption that the forging would lie in the "heavy" class is justified.

Other instruments may evidently be substituted for the manometer D (Fig. 1) and the working of a pump, machine tool or other machine can be studied. When applied to presses, it has furnished data for proper conversion of steam-driven pumps into electrically-driven pumps, and, as remarked above, for the solution of all forging problems connected with the scientific management of that department, enabling the production to be largely increased.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Electrodes for Electric Arc Welding and Cutting.—In the manufacture of electrodes for the electric arc welding and cutting of metals the electrode covering consists, in addition to calcined magnesite, powdered aluminum and sodium silicate, of calcium carbonate and either graphite, iron peroxide or ferrous silicate, or graphite in conjunction with iron peroxide or ferrous silicate. The electrode is thus rendered suitable for overhead or vertical welding or welding in confined positions where the electrodes have frequently to be bent, and also allows for the variability of the carbon and silicon contents of the metal core. In an example a powder is made consisting of 100 g. of calcined magnesite, 100 g. of calcium carbonate, 33 g. of powdered aluminum, and 33 g. of graphite, which is made into a paste by adding 11 to 12 fluid oz. of a solution of silicate of soda of strength indicated as 40 deg. on Twaddell's scale. The proportion of iron peroxide when used may be 75 parts by weight and of ferrous silicate 66 parts by weight. (Br. Pat. 152,257, H. W. BOORNE, London; Dec. 22, 1920.)

Treating Complex Ores.—Complex ores or their products are roasted with an alkali chloride at about 400 deg. C. or lower with access of air so as selectively to chloridize the lead and silver or at similar or higher temperature so as to chloridize all the metals, and the product is then leached with hot alkali chloride solution to dissolve the lead and some silver, and afterward, if desired, with a solution of sodium thiosulphate to extract the silver. The first leaching solution is treated with metallic zinc, galvanized iron, aluminum or the like to obtain the lead and silver, and the deposited metal may be compressed under water to avoid oxidation, and is finally melted down. The second leaching solution is mixed with a sodium chloride solution and similarly treated to obtain a richer argentiferous lead; or the metals may be obtained from both solutions electrolytically.

The residue from the leaching is treated by the "acid-oil froth process" to obtain a zinc concentrate. (Br. Pat. 152,289; not yet accepted; H. J. E. HAMILTON, North Broken Hill, New South Wales; Dec. 22, 1920.)

Artificial Marble.—Artificial marble is produced by making several separate mixtures of different colors and consistency, superimposing the mixtures in layers, and stirring them together with or without shaking in such a manner as to avoid complete mixing. A dry mixture of 1 part portland cement, $\frac{1}{2}$ part silver sand and $\frac{1}{2}$ part pulverized marble is moistened with water to which is added coloring matter free from sulphuric acid to form a comparatively thick mortar. "Flame markings" are produced by mixing a similar composition of different color with a larger proportion of water, and the composition for veins with less water. These mixtures are superimposed and turned over with a trowel or the like to mingle the colors. The mass is then shaken in molds without compression, and after drying the face layer is ground off. For reinforced concrete, the marble mass is placed in the mold, and while still moist the reinforced concrete is superimposed. (Br. Pat. 152,359; not yet accepted; D. JAGER, Amsterdam, Holland; Dec. 22, 1920.)

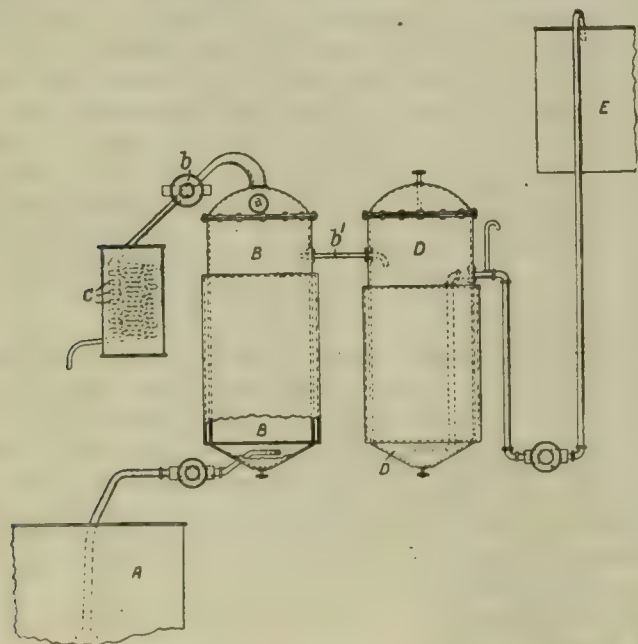
Alkali Percarbonates.—Solid alkali percarbonates are obtained by treating sodium carbonate with hydrogen peroxide in presence of sufficiently limited quantities of water to produce the solid product directly, and of sodium chloride for salting out the product. A previous calcination of the sodium carbonate and the addition of anti-catalyzers such as sodium silicate, magnesium chloride and magnesium-sodium silicate are advantageous. (Br. Pat. 152,366; DEUTSCHE GOLD & SILBER-SCHNEIDEAUSTALT, VORM. ROESSLER, Frankfurt on Main; Dec. 22, 1920.)

Phenol-Aldehyde Condensation Products.—The condensation of phenols with formaldehyde or its equivalents is effected in the presence of a very small proportion of nitrocellulose or cellulose acetate; the maximum amount of cellulose ester used is about 0.8 per cent reckoned on the phenol. The use of nitrocellulose renders the product odorless, while cellulose acetate also confers increased toughness. In an example, cresylic acid, formaldehyde, caustic soda, and cellulose acetate (0.00025 per cent) are employed; the liquid product is boiled down, baked at atmospheric pressure, and may be further treated in an autoclave. (Br. Pat. 152,384; A. W. WELLER and W. T. ROBINSON-BINDLEY, both in London; Dec. 22, 1920.)

Chromium and Its Alloys.—A process for obtaining chromium from chromic oxide or a mineral such as chromite, for the production of chrome-iron or chrome-steel alloys, comprises the thermo-reduction of the oxide of chromium with calcium carbide in the presence of an alkaline earth oxide, with or without the presence also in the mixture of one or more other reducing agents such as calcium silicide or aluminum. The alkaline-earth oxide is preferably present in proportion at least equal molecularly to that of the calcium carbide. The reaction may be carried out within molten steel and the mixture may be inclosed in thin sheet-iron cases to be immersed in the molten steel. (Br. Pat. 152,399, W. B. BALLANTINE, London; Dec. 30, 1920.)

Anhydrous Magnesium Chloride for the Manufacture of Magnesium and Magnesium Alloys; Magnesium Chlorate.—Hydrated magnesium chloride is converted into the anhydrous body by partial dehydration in a voluminous current of heated air, preferably dried, until the fusion point is raised above 150 deg. C., followed by treatment with a slow current of hydrochloric acid gas to complete the dehydration. During dehydration, fusion of the mass is to be avoided, and the product obtained is porous if a temperature of 500 deg. C. is not exceeded, and of a partly crystalline texture if the temperature is allowed to rise to incipient fusion, 650 deg. C. After dehydration, the product may be fused. The magnesium chloride is preferably employed in the form of needle crystals such as are obtained by cooling a solution having a strength of 80 deg. Tw. from 50 deg. C. to atmospheric temperature. (Br. Pat. 152,401.) The fused anhydrous magnesium chloride, free or practically so from other substances, is used as electrolyte in both a primary and secondary cell. (Br. Pat. 152,402.) The chlorine obtained as a byproduct is absorbed in magnesium oxide emulsion producing magnesium chloride and chlorate, which are separated by crystallization, and the magnesium chloride is again used in the process. To render the process continuous, an additional supply of chlorine is admitted to the absorber. (Br. Pat. 152,403, E. A. ASHCROFT, London; Dec. 30, 1920.)

Acetic Acid, Methyl Alcohol; Acetone.—In order to recover the acetic acid, methyl alcohol and acetone formed by the destructive distillation of wood in suction gas plants, the wash water from the suction-gas scrubbers is passed



over chalk or barium carbonate until a sufficient concentration of acetate is obtained, and at the same time the methyl alcohol and acetone are withdrawn by means of vacuum. The wash water contained in the tank A is pumped into the vessel B, provided with a heating jacket, where it passes through lumps of calcium or barium carbonate and overflows through the pipe *b'* into the vessel D, which also contains calcium or barium carbonate and is fitted with a cooling-jacket. The methyl alcohol and acetone are drawn off from the heated wash water in the vessel B by means of the pump *b* into the condensing coil C. The liquid issuing from the vessel D is pumped into the tank E, from which it can be run back to the scrubbers of the suction-gas plant. The process is repeated until the content of calcium or

barium acetate is sufficient to justify its recovery by evaporation. (Br. Pat. 152,420, J. C. ROBERTS, Hull, England; Dec. 30, 1920.)

Coloring Wood.—In coloring wood black or gray by means of a solution of iron and a solution of tannin, the wood is dried between the successive impregnations and is finally treated with ammonia or other alkali. Logwood extract may be used instead of, or in addition to, tannin, to modify the color. Impregnation may be effected with the aid of vacuum and pressure, and the process may be carried out in the cold or with the application of heat. (Br. Pat. 152,427, R. E. SLADE, London; Dec. 30, 1920.)

Intermediate Products; Dyes.—4-Nitro-2-naphthol is obtained by diazotizing 2:4-dinitro-1-naphthylamine with nitrosyl sulphate or sodium nitrite in concentrated sulphuric acid, pouring the diazo solution into water to precipitate 4-nitronaphthalene-1-diazo-2-oxide, and heating this diazo-oxide with ethyl alcohol, alone or in the presence of a metallic catalyst such as zinc, copper, aluminum or a zinc-copper couple, or a reducing agent such as hypophosphorous acid.

2:4-Dinitro-1-naphthylamine is prepared either by heating 2:4-dinitro-1-naphthol with alcoholic ammonia at 200 deg. C., or by dinitrating an acyl- α -naphthylamine or arylsulphonyl- α -naphthylamine—e.g., aceto- α -naphthalide or *p*-toluenesulphon- α -naphthalide—and hydrolyzing the product—for example, by heating with sulphuric acid.

Azo dyes are obtained in substance or on the fiber by coupling diazo or tetrazo compounds with 4-nitro-2-naphthol; the following products are specified: A dark red wool dye from diazotized sulphanilic acid; an orange dye from diazotized *p*-nitraniline-*o*-sulphonic acid; a purple cotton dye from tetrazotized 4:4'-diaminostilbene-2:2'-disulphonic acid; a purple cotton dye from diazotized safranin; and azo dyes on the fiber from *p*-nitraniline (bluish-red), 2:4-dinitraniline (red), dianisidine (dark blue), and primuline (reddish-brown). (Br. Pat. 152,437, G. T. MORGAN, Birmingham, and BRITISH DYESTUFFS CORPORATION, London; Dec. 30, 1920.)

Purifying Benzene.—Sulphur compounds are removed from benzene and other light oils by treatment at 30 to 90 deg. C. with sulphuric acid of 60 to 85 per cent strength, as by boiling the oil with acid of 73 to 82 per cent strength, or by passing the oil vapor through acid of 70 per cent strength at 84 deg. C. In an example, 500 gal. motor benzene are agitated with 50 gal. acid of 82 per cent strength for about two hours at 83 deg. C. in a sulphonator fitted with a reflux condenser, and the purified benzene is separated by distillation or gravity. (Br. Pat. 152,470, SOUTH METROPOLITAN GAS CO., E. V. EVANS and H. HOLINGS, London; Dec. 30, 1920.)

Solder for Aluminum and Aluminum Alloys.—A solder for aluminum or its alloys is made from 6 lb. of tin, 2 lb. of zinc, 1½ lb. of aluminum, ¾ lb. of lead and ¼ lb. of an alloy of equal parts of copper and aluminum. The ingredients are melted in a graphite crucible with cryolite and lithium fluoride, and the product is fluxed with manganese chloride and run into bars. In use, the solder is applied to the heated aluminum surface; the coated surface may then be united to another similarly treated surface, or may be soldered by means of ordinary soft solder. (Br. Pat. 152,486, H. J. ANSELL, London; Dec. 30, 1920.)

Tanning.—Material to be treated by any tanning, impregnating or like process is submitted to a preliminary treatment consisting in subjecting it to the action of an electric current in pure water. This is stated to shorten and render more economical the subsequent process and also to have a deliming effect. The preliminary treatment in pure water may be conducted with diaphragms or the hide, etc., may be suspended between two poles and subjected to the electric current. The subsequent treatment may comprise electro-osmotic tanning or mechanical tanning or a combination of these processes. In an example, an oxhide delimed with dilute formic acid is electrically treated in pure water for ten hours, being then electro-osmotically tanned in chestnut wood extract of 2 deg. Bé. and subsequently mechanically tanned with a similar extract of 3 deg. Bé. (Br. Pat. 152,641; not yet accepted; ELEKTRO-OSMOSE AKT. GES., Berlin; Dec. 30, 1920.)

Current Events

in the Chemical and Metallurgical Industries

Nitrogen Corporation Bill Sleeping in Committee

At this writing there is apparently little chance for the bill providing for the formation of the U. S. Fixed Nitrogen Corporation. After passing the Senate the bill was referred to the Committee on Military Affairs of the House. Hearings were announced to begin on Feb. 3, but subsequently it was stated that the witnesses, each of whom favored the passage of the bill, had withdrawn their requests to be heard.

There is general feeling that the friends of the bill still have a card or two to play. The effort probably will be made to attach the bill to an appropriation measure as a rider.

Significance is attached to the fact that the Senate Committee on Appropriations has added to the sundry civil bill the \$10,000,000 appropriation for the continuance of work on the dam at Muscle Shoals. The Committee on Appropriations of the House refused to embody this item in the bill it formulated. An effort to put the item in on the floor of the House was unsuccessful.

Chemical Warfare Service Appropriation

Instead of the \$8,000,000 requested by General A. A. Fries for the Chemical Warfare Service during the next fiscal year, the Committee on Appropriations has embodied \$1,500,000 in the Army appropriation bill, which was reported to the House Jan. 29. While the estimates of all War Department activities were reduced one-half on the average, there is a very decided feeling on the part of many members of Congress that the importance of chemical warfare is entitled to more than the committee has reported, which is less than one-half of 1 per cent of the funds made available in the Army appropriation bill.

General Fries states that the appropriation is entirely inadequate and that under it the Chemical Warfare Service not only will lose much ground but will be handicapped in its efforts to keep abreast with other nations in the study of war gases.

In explaining to the Committee on Appropriations the need for a larger appropriation, General Fries pointed out that he needed no less than \$1,754,000 for his investigatory work alone. He revealed that fifty-two separate lines of investigation have been approved by the War Department. Some of these are subdivided so that one item has as many as a dozen subdivisions. Seventy per cent of the amount appropriated, General Fries stated, goes for the salaries of technical employees and the wages of common laborers. To cut the appropriation, General Fries told the committee, means that the work will require twice or three times as long as would be the case were the desired appropriation allowed.

"We worked this over with extreme care," said General Fries, "to get it down as low as possible. We do not want to build up a big force, but we do feel that we are charged with the defense of the entire Army against all chemical warfare materials. These materials affect every man in the Army from the commanding general down to the last private.

"We are operating eleven plants at Edgewood. These expenses at this time are at the rate of \$1,000,000 per annum. In addition, we have the proving ground at Lakehurst, N. J., and we are operating sixteen salt wells at Midland, Mich., from which we get bromine. The Chemical Warfare Service sank these wells and built the plant to connect them up during the war. The brine is turned over to the Dow Chemical Co. to manufacture bromine salts. The manufacture of the salts into the bromine itself is done by us at Edgewood. The company has a contract to furnish 1,000,000 lb. of these salts. The net cost is 30c.

a lb. Delivery will be completed before the end of the current fiscal year."

General Fries told the committee that at the present time the service consists of fifty-nine officers and 900 men out of a total authorized allowance of 100 officers and 1,200 enlisted men. The quota of officers has not been filled, because commissions in the service are unattractive to men possessed of the proper qualifications.

In regard to the chemists employed by the service, General Fries submitted a list of his civilian chemists as follows: One at \$6,000, one at \$4,500, three at \$3,600, one at \$2,100, one at \$2,000, one at \$1,800, one junior chemist at \$2,400, three junior chemists at \$2,000, twenty junior chemists at \$1,800, one junior chemist at \$1,760, one junior chemist at \$1,740, one junior chemist at \$1,700, four junior chemists at \$1,620, two junior chemists at \$1,500, five associate chemists at \$3,000, two associate chemists at \$2,800, one associate chemist at \$2,700, three associate chemists at \$2,600, five associate chemists at \$2,500, one associate chemist at \$2,475, thirteen associate chemists at \$2,400, one associate chemist at \$2,300, one associate chemist at \$2,290, one associate chemist at \$2,220, two associate chemists at \$2,160, seven associate chemists at \$2,100.

Oil From Pennsylvania Shales

Experiments to determine the amount of oil obtainable from Pennsylvania coals and black shales were begun in 1918 by Charles R. Fettke. A preliminary report on this work has been issued recently in mimeographed form by the Pennsylvania Geological Survey. Yields of oil, ammonia and gas (all based on a ton of 2,000 lb.) are given in tabulated form for eighty-four samples. There are also given for comparison results of tests made in the same way on cannel coals of other states and on rich Western oil shales.

The data show that Pennsylvania is not well supplied with rich oil-producing coals or shales. The conditions that produced the valuable anthracite in the eastern part of the state and the high-carbon coals in the eastern part of the bituminous fields drove the oil and gas out of the black shales of those regions, so that good results were obtained only from the coals and black shales in the extreme western and northwestern counties of the state.

Connecticut Valley Section, A.C.S., February Meeting

An interesting program is promised for the next meeting of the Connecticut Valley Section of the A.C.S., which is to be held at the Hotel Elton, Waterbury, Conn., on Feb. 14. Dr. John S. Shearer, professor of physics at Cornell University, will give an illustrated lecture on "Some Recent Applications of X-Rays in the Study of Metals."

Chemical Warfare Service Resolution to Be Submitted to the A.C.S.

A resolution deploring the limitations being placed upon the appropriations for the Chemical Warfare Service and the lack of sympathy shown for this service within the military establishment of the Government probably will be submitted to the American Chemical Society at an early date.

Refractory Plant of Baker Steel Co. Destroyed by Fire

Practically the entire reduction plant of the Basic Refractories, Inc., a subsidiary of the Baker Steel Co. of Pennsylvania and located in Natural Bridge, N. Y., was destroyed by fire on Jan. 24. The loss was \$100,000.

Hearings Against Shadyside-Edgewater Plants Postponed

On Jan. 29 an adjourned hearing was heard in New York City before Herman Biggs, Commissioner of Health of the State of New York, to hear the complaint of the West End Association and the city against certain chemical manufacturers with plants in the State of New Jersey.

The concerns involved are: The Barrett Co., the General Chemical Co., the Corn Products Refining Co. and Spencer Kellogg & Sons, Inc. As these corporations all do business in New York State, these hearings have been held to give the defendants an opportunity to explain their actions. Chapter 292, Laws of 1917, provides an amendment to the General Corporation Laws of the state, whereby offending corporations may be prevented from doing business within the state, if they continue to commit such nuisances as that in question. Action was begun in 1918 by a group of persons who live in Riverside Drive and the western part of New York City. It was claimed that during periods of a west wind the fumes given off by these four plants rendered the air foul and made life miserable for the residents. The defendant companies were given until Jan. 1, 1921, to install fume-, gas- and stench-consuming devices in their plants, and shortly after that date the chief engineer of the New York State Department of Health made an investigation.

The General Chemical Co. had been accumulating residues from the distillation of acetic acid. These had been stored in tanks and had been covered with ashes in order to prevent the diffusion of the fumes. The Barrett Co. operates a felt saturating machine on its property and has now installed hoods over the machines so that the fumes may be led to a scrubber. The Corn Products Refining Co. has on its premises a corn-grinding plant, and it proposes to lead the fumes from the grinding mill under the boilers so that they may be consumed. It was found necessary to line the flues with Monel metal, as all other linings were corroded by the fumes. The Spencer Kellogg Co. has on its property a plant for boiling or "aging" linseed oil. Experiments have been conducted in leading the vapors through or over slaked lime; they were also led through a scrubber. More recently the company has planned to lead the fume under the boilers and the tall smokestack so that they may be burned.

As all the defendants had shown a sincere desire to overcome the objections, they were given until March 19 to complete their fume-consuming devices. On that date a final hearing will be held in the New York Academy of Medicine. The interests of the city were looked after by Russell Tarbox, of the office of the Corporation Counsel, while the citizens' association was represented by W. H. Page.

The chemical plants involved in this complaint are all located at Shadyside-Edgewater (Bergen County), N. J., on the Hudson River opposite 125th St., New York.

Importance of Scientific Research

Saturday noon, Jan. 29, Dr. C. E. K. Mees, director of the Research Laboratory, Eastman Kodak Co., lectured before the City Club of Rochester on the importance of scientific research. The speaker pointed out the great advance in comfort and in the standard of living which had taken place in the last hundred years. This does not necessarily carry happiness with it; happiness comes from the spirit, but in material comfort, in material wealth, great progress has been made.

This gain in comfort and safety and wealth has come from the accumulated knowledge which is used by the technical men to produce at relatively low cost the roads and the railroads, the windows and the heating, the improved houses and the better food distribution.

The knowledge used by the technical men is applied science, and the science that is applied was made in the laboratories. Cheap glass came from the chemical laboratory in its final origin; it cannot be made without cheap alkali, and cheap alkali could not be made without an understanding of the chemistry of the alkaline metals which were first discovered by Humphry Davy. Electricity, which

plays so great a part in modern life, is generated by the rotation of wire coils in a magnetic field, and it was Faraday in his laboratory who first found that electricity could be produced in this way. All war waged on disease is based on the knowledge that disease is produced by micro-organisms, and the existence of these micro-organisms was discovered by Pasteur; so that the history of every advance is that there is first a discovery in a laboratory, and then other discoveries are made which extend and parallel it, and then it is developed in its own and other laboratories, and then it is applied experimentally, and finally there comes the industrial development of its application. Each step involves the introduction of other knowledge from the common stock of knowledge—sometimes other parts of the same science, sometimes knowledge from another science. Modern industry, then, and all modern civilization are built on science.

If the standard of comfort is to be further increased in the future the most obvious thing to do is to use the means that have proved successful in the past and to attempt by the development of more knowledge to gain more wealth. The inventions which have been made in recent years, especially in the field of electricity, show what could be done in this direction. Vast savings have been made by the development of improved electric lamps and refined and cheapened methods for telephones and telegraph transmission. The great electric companies are spending millions on scientific research, but the speaker believes that the application of research on a large scale to industry has only just begun and may easily be extended enormously.

The greatest field for research is in directions which seem at first sight to offer no prospect of immediate profit. The X-ray was discovered in the course of an investigation of some very obscure actions of minerals on photographic plates. One of the greatest discoveries in lighting technique came during a study of the absorption of gases in an evacuated lamp. A study of the emission of electric corpuscles from a hot wire produced the new types of waves which are so important in connection with wireless. It is possible that by a study of the chemical atom and of the way in which it breaks up in certain cases it may be possible to produce artificially the breaking down of atoms and thus to get power from their disintegration which would far transcend anything that has been available before. Should this prove successful its possibilities for industrial and social development would be limitless.

"Journal of Electricity and Western Industry"

Enlargement of the editorial scope of the *Journal of Electricity* and a change in its name to *Journal of Electricity and Western Industry* were announced at a dinner given on Feb. 1 in the Palace Hotel, San Francisco. The date marked the thirty-fifth anniversary of the *Journal of Electricity*, which has been one of the McGraw-Hill publications since September, 1919. Robert Sibley will continue as editor of the enlarged paper.

The *Journal of Electricity and Western Industry* will devoted to the upbuilding of the West as an industrial section, and it will interpret Western progress through the application of electric power, light and heat in industries and homes. In its enlarged scope the publication will record the progress of the far West not only of the electrical industry as such but also of all industry dependent upon electrical energy. The fullest editorial support will be given to financing the huge building programs of the Western electrical utilities in the development of hydro-electric power, as this is held to be the greatest single asset of the West.

Another Big Refinery for Wood River, Ill

The Wilcox Oil & Gas Corporation, of Tulsa, Okla., plans the erection of a large oil refinery at Wood River, Ill. H. F. Wilcox, president of the corporation, announces that the refinery will have a capacity of 20,000 bbl. and will be connected with the mid-continent fields by a pipe line. The Standard Oil and Roxana Petroleum companies already have refineries at Wood River, and the Empire Refineries, Inc., has more than 400 acres there for a similar purpose.

Trade Trip to Caribbean Ports

A formal call to commercial and financial institutions in the Central West to join in the trade schools to the West Indies and Central America has been issued by the Mississippi Valley Association, Harry H. Merrick, president. The cruise will start March 12 from New Orleans and will occupy a term of three weeks in visiting Caribbean points.

Personal

A. E. ANDERSON, general manager of the Ivorydale plant of the Procter & Gamble Co. at Cincinnati, Ohio, was elected a vice-president and is succeeded by FRANK K. SKILLMAN as general factory superintendent. Mr. Skillman served the company in various positions for over eighteen years at the Port Ivory and Kansas City plants.

WALTER BENEKE has resigned his position as instructor of chemistry at Cooper Union to accept a position as chemist with the Monsanto Chemical Works, St. Louis, Mo. Prior to his connection with Cooper Union Mr. Beneke was with the Organic Salt & Acid Co. of Newark, N. J.

Colonel G. A. BURRELL has returned to New York City after spending three months in Europe investigating matters relating to petroleum.

JOHN DISARIO, chemist and metallurgist, is now in charge of the laboratory, electric furnace and heat-treating of the Joliet Casting & Forgings, Ltd., Joliet, Que.

Major R. C. DITTO has been transferred from the Infantry to the Chemical Warfare Service.

W. A. DUNKLEY, who has been a gas engineer on the staff of the Illinois State Geological Survey, has accepted a position with the U. S. Bureau of Mines and will be acting in charge of the Urbana Station of the Bureau. Mr. Dunkley will continue there the work on fuels processing with which he has been associated for some years past.

Dr. OTTO KRESS, for the past four years in charge of the pulp and paper work at the Forest Products Laboratory at Madison, Wis., left Jan. 25 to join the staff of the Consolidated Water Power & Paper Co., at Appleton, Wis. He will be engaged with technical problems in connection with the control and development of pulp and paper products. Dr. Kress graduated as doctor of philosophy and chemistry at Columbia University in 1909 and engaged in pulp and paper mill work with various companies, joining the Bachische Co., New York City, in 1912, where he remained until he took charge of the work at Forest Products Laboratory. He is one of the founders of the Technical Association of the American Pulp and Paper Industry.

R. B. LADOO, a mineral technologist on the staff of the Bureau of Mines, is inspecting deposits of non-metals in the South.

D. A. LYON, chief metallurgist, E. A. HOLBROOK, chief metal mining engineer, and H. E. MYER, chief clerk, of the U. S. Bureau of Mines, are in Berkeley attending a conference of the superintendents of the Bureau's Western experiment stations and the deans of the various mining schools with which the Bureau is co-operating.

Major C. W. MASON has been transferred from the Infantry to the Chemical Warfare Service. He will be assigned to the command of a battalion of gas troops at Lakehurst.

W. W. ODELL, who has been conducting fuels carbonization investigation at the Urbana Station of the U. S. Bureau of Mines, has been transferred to the Washington offices, where he will assist in lignite carbonization studies.

W. R. SMITH, professor of chemistry, Lewis Institute, Chicago, spoke before the Chicago Chemists' Club recently on "Why I Believe in Ions."

W. M. WEIGEL, a mining engineer who has been in the employ of the Missouri Cobalt Co., has been employed by the Bureau of Mines to specialize in non-metallic matters. He will be stationed at Tuscaloosa, Ala.

Current Market Reports

The Chemical and Allied Industrial Market

NEW YORK, Feb. 7, 1921.

Although numerous inquiries for various chemicals reached the market during the past week, actual business was not large and transactions were confined mostly to small lot trading. It is believed that the steady expansion in inquiries is a forerunner to an increase in business. The acute declining tendency of the market during the past few months, however, has created a feeling of extreme conservatism among the domestic consumers, and the apparent disposition is to operate for the present on a hand-to-mouth basis.

Speculative interests have gradually got out of the market and those close to the pulse of trading assert that conditions will be more normal by spring.

Prices on *solid caustic soda* have not varied materially during the week. It seems reasonable that as soon as resale spot supplies are exhausted, producers will come into their own in both caustic and soda ash. The general quotation heard in leading quarters ranged from \$3.85@ \$3.95 per 100 lb. Moderate resale lots of *soda ash* in single bags were offered at \$2.10 per 100 lb., spot New York. The movement in this commodity was quiet throughout the week, with the tone, however, quite steady. Odd lots of imported *chlorate of potash* are on the market at very attractive prices. Some are of the opinion that the supply is relatively small and that a few good buying orders will probably clean up stocks. Quotations in the local market are heard from 8@18c. per lb., depending upon the brand, quantity and seller. The inside figure is for foreign material, while the outside price is named by leading producers f.o.b. works. It is stated that a few large orders are in the hands of exporters, but the wide variance in prices has retarded any actual business.

Moderate quantities of resale *bichromate of soda* continued to reach the market at 8½@8¾c. per lb. Reports were current that slightly under this could be done in some quarters on firm business, but dealers in general were not inclined to shade the inside price. Second hands quoted March shipments at 9@9½c. per lb. Demand for *salt cake* seems to be holding well, with some export business noted. With glass manufacturers ready to resume more normal operations, the outlook for this commodity seems bright and prices are expected to strengthen materially. Quotations on spot range from \$33@ \$35 per ton in bulk. Lower prices on *nitrate of potash* have been established by leading producers. The extreme range for pure double refined extends from 9½@12c. per lb., depending upon the grade and quantity. The inside price is for double bags of granulated and the outside figure for barrels of large crystals.

Lower prices are now effective for the different grades of refined *sulphur*. Sulphur flour, 100 per cent, pure sublimed, is offered at \$2.50@ \$3 per 100 lb. in barrels. Bags are obtainable at \$2.25@ \$2.75 per 100 lb., depending upon quantity. Sulphur roll, 100 per cent pure, ranges from \$2@ \$2.70 per 100 lb., depending upon containers and quantity. Moderate quantities of resale *bleaching powder* were offered by second hands at 2¾c. per lb. in large drums f.o.b. Niagara Falls. Spot material was quoted at 3c. per lb. The market looked quite steady, with a marked improvement in inquiries and orders.

COAL-TAR PRODUCTS

While business in general in the coal-tar products market has been on a limited scale throughout the week, the tone has shown considerable improvement. Color manufacturers have not changed their attitude in regard to prices and the quotations heard at the beginning of the week were largely in force at the close. Good reports from various mills keep coming in showing a resumption in operations, with full time in some quarters. Resale lots of intermediates, while mostly in small quantities, are again a little more freely

offered. The crude market is showing somewhat more activity on some items, while others are still quiet.

Benzene is moving in better volume and prices continue steady around 30@36c. per gal. The consuming demand for *anthracene* is improving, but the supply is limited. Producers of prime white *naphthalene* flakes are firm in their prices at 9@10c. per lb., while resale lots are heard in various directions at 8@8½c. per lb. Producers' prices on U.S.P. *salicylic acid* are quoted around 27@30c. per lb. Business has been very limited of late, owing to the lack of interest shown by domestic consumers. Prices on *aniline oil* on spot are rather weak at 21@21½c. per lb. Producers' prices are still at variance and range from 23@28c. per lb. Resale lots are plentiful on the market and in more or less distress. Second hand lots of *beta naphthol*, technical, could be had in good volume at 30c. per lb., although sales have been made during the week as low as 28c. Producers are holding their prices up around 40@45c. per lb., although in some quarters contracts have been offered at 35c. The market is very much disturbed and buyers are entering bids at figures well below the market price.

Prices on *dimethylaniline* are generally unsteady, although somewhat firmer than last week. Offers are heard at 55c. per lb. in the resale market, while some holders are asking as high as 65c. Little business is being transacted and consumers seem unwilling to come into the market in spite of the comparatively low price. Second-hand lots of *diphenylamine* are offered in several directions at prices well below the cost to manufacture. Offers are made at 60c. per lb., but it is quite well understood that this figure could be shaded in the face of firm business. Producers are naming prices around 70@75c. per lb., according to quantity. Manufacturers' figures on *paranitraniline* are given around \$1@1.05 per lb. Reports are still current, however, that odd lots are being held down to 90c. per lb. in several quarters. In the absence of firm business it has been impossible to determine what is the actual market value.

A wide difference exists between producers' prices and the resale market on *paratoluidine*. Offers have been heard as low as \$1.25 per lb., while one producer is still quoting as high as \$1.60. The general quotation ranged from \$1.30@1.40 per lb. The consuming demand for *beta naphthylamine* continued of a moderate routine nature. Producers in some quarters say they are better able to supply regular quantities, and quote the sublime variety at \$2.25@2.40 per lb. Spot stocks of *phenol* are comparatively low and prices are holding fairly well around 10@11c. per lb. The inquiry has been very dull and actual sales were few. In view of the present scarcity of spot material any considerable amount of business would probably force prices up further. There seems to be little inclination, however, for the consuming trade to enter the market to any extent.

The Chicago Market

CHICAGO, Feb. 4, 1921.

Steady progress in the return to a solid price basis was marked by new contract figures on *soda ash* and *caustic soda*. *Soda ash*, previously quoted at \$1.82½@1.90 per 100 lb. for 48 per cent f.o.b. works, is now priced \$1.72½@1.75. This quotation is for carload quantities. *Caustic*, 60 per cent base, in car f.o.b. works is now \$3.50@3.60 per 100 lb., which is about 15c. under previous offerings. A good business is being maintained and present price seems firm. *Bleaching powder*, quoted on contracts at 3½c. per lb., is reported as selling as low as 2½c. from second hands, spot demand being weak. Little interest is seen in *sal soda*, prices ranging from \$2@2.50 per 100 lb. out of local stock.

Barium chloride, in ample supply at \$85@90 per ton, seems to be getting topheavy from a recent influx of imported stock, and lower prices are looked for. *Bichromate of soda*, more plentiful in supply and weak in demand, is quoted at 9½c. per lb. from spot stock. *Soda cyanide* remains in short supply and the price is firm at 35c. per lb. *Soda prussiate* is weak, quotations ranging from 18@20c. per lb. Slackness in *glycerine* trade continues, with current quotation on c.p. grade being 20c. per lb., with but few transactions recorded.

Trading in *alcohol* is quiet, stocks being larger than seems justified by demand. The *ethyl* grade, 190 proof, is \$5.10@5.35 per gal.; *methyl* grade, 95 per cent, \$1.28@1.32 per gal.; *denatured*, complete, 75@80c. per gal. *Formaldehyde* remains down around 20@21c. per lb., with consumption slow.

VEGETABLE OILS

Declines have been noted in the entire line of vegetable oils during the past few weeks. Interest is lacking in crude *cottonseed oil*, offered for prompt shipment at 6c. per lb. f.o.b. valley. Texas offerings are 5½c. per lb. Large lots of Manila grade *coconut oil* changed hands last week at 8½c. per lb. in buyers' tanks f.o.b. Coast. This is nearly 1c. off former pricings. Ceylon grade is offered on the Coast at 9½c. per lb. *Corn oil*, diminished in supply and still in weak demand, is offered for February delivery in sellers' tanks at 6½c. f.o.b. Chicago. *Soya bean oil*, also in poor demand, is nominally 10½@11c. per lb. for edible grade, in Chicago stock. Inactivity in consuming industries is causing this market to continue weak on all items.

COAL-TAR PRODUCTS

The market for crudes is in a little better shape except in the case of *naphthalene*, which is still plentiful on the spot. Flakes are quoted at 9@10c. per lb. and balls at 10@11c., but it is reported that bone fide orders would produce sharp shading. *Benzene*, water white grade, is 33@33½c. per gal., and reports are heard of limited transactions at a lower figure. *Solvent naphtha* is weak in demand, water white grade being quoted at 28@30c. per gal. and crude at 16@19c.

Among the intermediates, *aniline oil* and *aniline salt* are representative. In the face of numerous inquiries the price is off, the oil being offered at 29@30c. per lb. by producers and down as low as 22c. by second hands. The salt is a little firmer, 29@32c. being the quoted range, with some business done at the lower figure. *Benzyl chloride* is subject to lively inquiry and the current quotation is around 28c. on the 95 per cent and 23c. on the crude.

The St. Louis Market

ST. LOUIS, Feb. 4, 1921.

The feeling of cheerfulness reported two weeks ago has spread until heavy chemical producers are looking forward to a resumption of a fair amount of activity during the month of February. This optimistic mood of producers is being backed up to some extent by buyers. One of the largest producers reports that orders are coming better at present than at any time during the last forty days and that shipments scheduled for February will be considerably higher than those for January. It is admitted, however, that even with the present increase in sales the market would be characterized as somewhat slow during normal times.

The 98 deg. *sulphuric acid* is being shipped in fair amounts on a quotation of \$24 per ton f.o.b. works. The market for the 66 deg. *sulphuric acid* has held up well during the past two weeks, the demand being fairly strong, and the price remaining unchanged at \$20@21 per ton and 1½c. per lb. in carboys. The demand for the 60 deg. *sulphuric acid* is quiet. It is being quoted at \$16 per ton and 1½c. per lb. in carboys. Inquiries for *oleum* continue good, with sales bettering somewhat. Producers are asking \$28.50 per ton.

Muriatic acid is showing flashes of activity and production has increased somewhat. Current quotations are 1½@2c. per lb. in carboys and \$25 per ton in bulk.

The demand for *sodium bisulphate* has slowed down to a very conservative level once more, though shipments on contract are holding up well. It is being quoted at \$7 to \$8 per ton.

Nitric acid is in better demand with prices at the same level as they were two weeks ago. Quotations are \$7 per 100 lb. for the 36 deg. test and \$10 per 100 lb. for the 42 deg. Standard mixed acid is unchanged in price from its quotation of two weeks ago, 1½c. per lb. of sulphuric content and 11½c. per lb. of nitric content.

The Iron and Steel Market

PITTSBURGH, Pa., Feb. 4, 1921.

The stagnation in the iron and steel market is even more pronounced than at any previous time in this depression. That, however, is what should have been expected, since there has been no such change in fundamental economic or financial conditions as would produce an improvement.

Readjustment in commodity prices and wage rates is by no means completed, if indeed it is more than well begun. As to financial conditions, if the operation of the Federal Reserve banking system prevented the development of a panic or financial crisis, then the fundamental conditions that usually cause such a phenomenon must have been present and their other results must be expected. The steel industry has noticed recently a great slowing down in payments in some quarters, and as it normally does a cash business, this is a suggestive symptom.

The rate of pig iron production by merchant furnaces and independent steel works furnaces has continued to decrease. Taking the iron and steel industry as a whole and considering the high operating rate of the Steel Corporation on the one hand and the low operating rate of the independent steel works and the merchant blast furnaces on the other, the rate of production in both pig iron and steel ingots is now approximately 60 per cent of actual productive capacity.

STEEL PRICES

While there are many rumors in circulation of cut prices being made, that is, as noted in last report, really a psychological phenomenon always observed in the steel industry in a time of depression. In previous periods most of the rumors proved unfounded, and that is the case now. With the exception of plates, steel prices in general are being very well held indeed. As to plates, the market should be quoted at 2.50c. rather than at the Industrial Board price of 2.65c. There is no question that plates have been and can be bought at 2.50c., although not only the Steel Corporation but several independents are rigidly adhering to the 2.65c. figure. Otherwise the market remains quotable at Industrial Board prices: Bars, 2.35c.; shapes, 2.45c.; blue annealed sheets, 3.55c.; black sheets, 4.35c.; galvanized sheets, 5.70c.; plain wire, 3.25c.; wire nails, \$3.25; standard steel pipe, 57½ per cent basing discount; hoops, 3.05c.; tin plate, \$7 per base box, 100 lb. The tin plate quotation is on "production plates." Mills having odd lots in stock would probably sell such material at the usual concessions, and there are stocks held by middle interests, chiefly intended originally for export, that can be picked up at \$6 or less by those who are content to take misfit sizes.

Nuts and bolts, reduced last week by fully 20 per cent, following other reductions last year, have been quite steady, although not in good demand. They may be regarded as one of the manufactures of steel that have been fully adjusted down to the mill prices now ruling for their raw material. Rivets are 4c. and railroad spikes 3.65c., prices that suggest need of further revision. This week the base price of chain was reduced from 7.25c. to 6.75c., while the differentials for smaller sizes were reduced, whereby some sizes are reduced altogether by 1c. and others by 1.25c. The war control price was 7.50c., the lowest price since then, during the second half of 1919, having been 5.75c. The quoted price refers to 1-in. proof coil chain.

PIG IRON

There have been offerings of foundry iron by producers on the basis of \$29, valley basis, or \$1 under what was previously quotable as the market, but buyers show no interest in this price and no disposition to suggest a price in which they would be interested. Bessemer and basic remain quotable at \$32 and \$30 respectively, but these prices are altogether nominal, subject to revision by furnaces in case any disposition is shown to buy even a moderate sized tonnage. At the meeting of the American Pig Iron Association stocks in merchant furnace yards were reported as slightly under 400,000 tons, and undelivered tonnage on books 1,500,000 tons, equal to about seven weeks of production at a fairly full rate or four months at present rate.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	\$0.13 - \$0.13½	\$0.55 - \$0.60
Acetone.....lb.	1.34 - 1.4	1.34 - 1.4
Acid, acetic, 28 per cent.....100 lbs.	3.00 - 3.25	3.50 - 3.75
Acetic, 56 per cent.....100 lbs.	6.00 - 6.25	6.50 - 6.75
Acetic, glacial, 99½ per cent, carboys.....100 lbs.	10.50 - 11.00	11.25 - 11.50
Boric, crystals.....lb.	14½ - 15	15½ - 16
Boric, powder.....lb.	15½ - 16½	17 - 18
Citric.....lb.	46 - 48	46 - 48
Hydrochloric.....100 lb.	1.60 - 1.75	1.85 - 2.25
Hydrofluoric, 52 per cent.....lb.	15 - 16	16½ - 18
Lactic, 44 per cent tech.....lb.	10 - 11	11½ - 12
Lactic, 22 per cent tech.....lb.	04½ - 05½	06 - 07
Molybdic, C. P.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.	07 - 07½	08 - 08½
Nitric, 40 deg.....lb.	08½ - 09	09½ - 10
Nitric, 42 deg.....lb.	18 - 18½	18½ - 19
Oxalic, crystals.....lb.	15 - 15½	16 - 16½
Phosphoric, Ortho, 50 per cent solution.....lb.	30 - 32	35 - 40
Picric.....lb.	2.30 - 2.40	2.30 - 2.40
Pyrogallol, resublimed.....lb.	14.00 - 15.00	14.00 - 15.00
Sulphuric, 60 deg., tank cars.....ton	18.00 - 19.00	22.50 - 23.00
Sulphuric, 60 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., tank cars.....ton	23.00 - 24.00	23.00 - 24.00
Sulphuric, 66 deg., drums.....ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, 66 deg., carboys.....ton	32.00 - 35.00	40.00 - 45.00
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 - 24.00	23.00 - 24.00
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 - 35.00	40.00 - 45.00
Tannic, U. S. P.....lb.	1.15 - 1.25	1.15 - 1.25
Tannic (tech.).....lb.	45 - 47	48 - 50
Tartaric, crystals.....lb.	33 - 35	33 - 35
Tungstic, per lb. of WO.....lb.	1.20 - 1.40	1.20 - 1.40
Alcohol, Ethyl.....gal.	5.10 - 5.50	5.10 - 5.50
Alcohol, Methyl (see methanol).....gal.	65 - 67	65 - 67
Alcohol, denatured, 188 proof.....gal.	68 - 70	68 - 70
Alcohol, denatured, 190 proof.....gal.	04½ - 04½	05 - 05½
Alum, ammonia lump.....lb.	05½ - 06	06½ - 07
Alum, potash lump.....lb.	13 - 13½	14 - 14½
Alum, chrome lump.....lb.	02½ - 03	02½ - 03
Aluminum sulphate, commercial.....lb.	03 - 03½	03½ - 04
Aluminum sulphate, iron free.....lb.	07 - 07½	07½ - 08
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	30 - 32	33 - 35
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	11½ - 11½	12 - 12½
Ammonium carbonate, powder.....lb.	08½ - 08½	08½ - 09½
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	09 - 09½	09½ - 10
Ammonium chloride, granular (gray sal-ammoniac).....lb.	09 - 09½	10 - 10½
Ammonium nitrate.....lb.	3.30 - 3.40	3.50 - 3.75
Ammonium sulphate.....100 lb.	4.25 - 4.50	4.25 - 4.50
Amylacetate.....gal.	3.50 - 3.75	3.50 - 3.75
Amylacetate tech.....gal.	10 - 10½	10½ - 11
Arsenic oxide, (white arsenic).....lb.	14 - 14½	15 - 15½
Arsenic, sulphide, powdered (red arsenic).....lb.	65.00 - 70.00	75.00 - 80.00
Barium chloride.....lb.	24 - 25	26 - 27
Barium dioxide (peroxide).....lb.	10 - 10½	10½ - 11
Barium nitrate.....lb.	04½ - 05	05½ - 06
Barium sulphate (precip.) (blanc fixe).....lb.	04½ - 05	05½ - 06
Bleaching powder (see calc hypochlorite).....lb.	04½ - 05	05½ - 06
Blue vitriol (see copper sulphate).....lb.	04½ - 05	05½ - 06
Borax (see sodium borate).....lb.	04½ - 05	05½ - 06
Brimstone (see sulphur, roll).....lb.	50 - 52	54 - 56
Bromine.....lb.	2.00 - 2.05	2.00 - 2.05
Calcium acetate.....100 lbs.	04 - 04½	04½ - 05
Calcium carbide.....lb.	27.00 - 29.00	30.00 - 32.00
Calcium chloride, fused, lump.....ton	01½ - 02	02½ - 03
Calcium chloride, granulated.....lb.	02½ - 03	03½ - 04
Calcium hypochlorite (bleaching powder).....lb.	1.25 - 1.30	1.25 - 1.30
Calcium peroxide.....lb.	16 - 18	16 - 18
Calcium phosphate, monobasic.....lb.	80 - 85	80 - 85
Camphor.....lb.	08 - 08½	09 - 09½
Carbon bisulphide.....lb.	12 - 12½	13 - 13½
Carbon tetrachloride, drums.....lb.	75 - 1.00	75 - 1.00
Carbonyl chloride (phosgene).....lb.	09 - 09½	10 - 10½
Caustic potash (see potassium hydroxide).....lb.	43 - 50	43 - 50
Caustic soda (see sodium hydroxide).....lb.	3.10 - 3.20	3.10 - 3.20
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	22 - 22½	24 - 25
Chloroform.....lb.	06½ - 06½	06½ - 07½
Cobalt oxide.....lb.	06½ - 06½	06½ - 07½
Copperas (see iron sulphate).....lb.	06½ - 06½	06½ - 07½
Copper carbonate, green precipitate.....lb.	06½ - 06½	06½ - 07½
Copper cyanide.....lb.	06½ - 06½	06½ - 07½
Copper sulphate, crystals.....lb.	06½ - 06½	06½ - 07½
Cream of tartar (see potassium bitartrate).....lb.	06½ - 06½	06½ - 07½
Epsom salt (see magnesium sulphate).....lb.	06½ - 06½	06½ - 07½
Ethyl Acetate Com. 85%.....gal.	1.05 - 1.10	1.05 - 1.10
Ethyl Acetate pure (acetic ether 98% to 100%).....gal.	1.18 - 1.18½	1.18 - 1.19
Formaldehyde, 40 per cent.....lb.	3.50 - 3.60	3.50 - 3.60
Fusel oil, ref.....gal.	2.75 - 3.00	2.75 - 3.00
Fusel oil, crude.....gal.	2.75 - 3.00	2.75 - 3.00
Glauber's salt (see sodium sulphate).....lb.	20 - 21	20 - 21
Glycerine, C. P. drums extra.....lb.	3.85 - 4.00	3.85 - 4.00
Iodine, resublimed.....lb.	10 - 20	10 - 20
Iron oxide, red.....lb.	1.25 - 1.50	1.75 - 2.00
Iron sulphate (copperas).....100 lb.	14½ - 16	14½ - 16
Lead acetate, normal.....lb.	11 - 12	12½ - 13
Lead arsenate (paste).....lb.	11 - 12	12½ - 13
Lead nitrate.....lb.	15 - 20	15 - 20
Litharge.....lb.	08½ - 09	09½ - 10
Lithium carbonate.....lb.	10½ - 11	11½ - 12
Magnesium carbonate, technical.....lb.	2.50 - 3.00	2.50 - 3.00
Magnesium sulphate, U. S. P.....190 lb.	1.50 - 1.75	1.50 - 1.75
Magnesium sulphate, commercial.....190 lb.	1.30 - 1.40	1.30 - 1.40
Methanol, 95%.....gal.	1.50 - 1.60	1.50 - 1.60
Methanol, pure.....gal.	1.2 - 1.2½	1.2 - 1.2½
Nickel salt, double.....lb.	13 - 13½	13 - 13½
Nickel salt, single.....lb.	13 - 13½	13 - 13½
Phosgene (see carbonyl chloride).....lb.	45 - 46	47 - 50
Phosphorus, red.....lb.	45 - 46	47 - 50
Phosphorus, yellow.....lb.	14½ - 14½	15 - 15½
Potassium bichromate.....lb.	14½ - 14½	15 - 15½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar).....	lb.	\$.33 — .35	\$0.33 — \$0.35
Potassium bromide, granular.....	lb.	.20 — .40	.20 — .40
Potassium carbonate, U. S. P.....	lb.	.35 — .40	.45 — .50
Potassium carbonate, crude.....	lb.	.11 — .11½	.11 — .12
Potassium chlorate, crystals.....	lb.	.08 — .10	.11 — .18
Potassium cyanide.....	lb.	.65 — .70	.65 — .70
Potassium hydroxide (caustic potash).....	lb.	.14 — .14½	.15 — .16
Potassium muriate.....	ton	75.00 — 80.00	
Potassium iodide.....	lb.		3.00 — 3.20
Potassium nitrate.....	lb.	.09½ — .10	.10 — .12½
Potassium permanganate.....	lb.	.48 — .50	.52 — .60
Potassium prussiate, red.....	lb.	.50 — .52	.53 — .55
Potassium prussiate, yellow.....	lb.	.26 — .26½	.27 — .27½
Potassium sulphate (powdered).....	per uni		— 2.25
Rochelle salts (see sodium potas tartrate).....			
Salammoniac (see ammonium chloride).....			
Sal soda (see sodium carbonate).....			
Salt cake.....	ton		33.00 — 35.00
Silver cyanide.....	oz.		1.25 —
Silver nitrate.....	oz.		.43 — .44
Soda ash, light.....	100 lb.	2.10 — 2.15	2.20 — 2.30
Soda ash, dense.....	100 lb.	2.20 — 2.25	2.30 — 2.50
Sodium acetate.....	lb.	.05½ — .05½	.06 — .06½
Sodium bicarbonate.....	100 lb.	2.50 — 2.75	3.00 — 3.25
Sodium bichromate.....	lb.	.08½ — .08½	.08½ — .09
Sodium bisulphate (nitre cake).....	ton	7.00 — 7.50	8.00 — 11.00
Sodium bisulphite powdered, U.S.P.....	lb.	.06½ — .06½	.06½ — .07½
Sodium borate (borax).....	lb.	.07 — .07½	.07½ — .08
Sodium carbonate (sal soda).....	100 lb.	2.00 — 2.25	2.50 — 2.75
Sodium chl rate.....	lb.	.10 — .10½	.10½ — .11
Sodium cyanide, 96-98 per cent.....	lb.	.20 — .21	.22 — .28
Sodium fluoride.....	lb.	.13 — .14	.14½ — .15
Sodium hydroxide (caustic soda).....	100 lb.	3.85 — 3.90	3.95 — 4.25
Sodium hyposulphite.....	lb.		.03½ — .04
Sodium nitrate.....	100 lb.	2.85 —	3.00 —
Sodium nitrite.....	lb.	.06 — .06½	.06½ — .07
Sodium peroxide, powdered.....	lb.	.30 — .31	.32 — .34
Sodium phosphate, dibasic.....	lb.	.03½ — .04½	.04½ — .05
Sodium potassium tartrate (Rochelle salts).....	lb.		.31 — .32
Sodium prussiate, yellow.....	lb.	.16½ — .17	.17½ — .17½
Sodium silicate, solution (40 deg.).....	lb.	.01½ — .01½	.02 — .02½
Sodium silicate, solution (60 deg.).....	lb.	.03 — .03½	.03½ — .04
Sodium sulphate, crystals (Glauber's salt).....	100 lbs.	1.75 — 2.00	2.25 — 2.50
Sodium sulphide, crystal, 60-62 per cent (conc.).....	lb.	.05 — .05½	.05½ — .06
Sodium sulphite, crystals.....	lb.	.04 — .04½	.04½ — .05
Strontium nitrate, powdered.....	lb.	.17½ — .18	.18½ — .18½
Sulphur chl ride, red.....	lb.	.07 — .07½	.07½ — .08
Sulphur, crude.....	ton	16.00 — 18.00	
Sulphur dioxide, liquid, cylinders.....	lb.	.08 — .08½	.08½ — .09
Sulphur (sublimed), flour.....	100 lb.		2.25 — 3.10
Sulphur, roll (brimstone).....	100 lb.		2.00 — 2.75
Tin bichloride, 50 per cent.....	lb.	.18 — .19	
Tin oxide.....	lb.		.48 — .50
Zinc carbonate, precipitate.....	lb.	.16 — .18	.19 — .20
Zinc chloride, gran.....	lb.	.11½ — .12	.12½ — .13
Zinc cyanide.....	lb.	.45 — .49	.50 — .60
Zinc dust.....	lb.	.12 — .13	.13½ — .14
Zinc oxide, XX.....	lb.	.08½ — .09	.09½ — .11
Zinc sulphate.....	lb.	.03½ — .03½	.04 — .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude.....	lb.	\$1.10 — \$1.15
Alpha-naphthol, refined.....	lb.	1.45 — 1.50
Alpha-naphthylamine.....	lb.	.38 — .40
Aniline oil, drums extra.....	lb.	.21 — .27
Aniline salts.....	lb.	.27 — .30
Anthracene, 80% in drums (100 lb.).....	lb.	.75 — 1.00
Benzaldehyde (f.f.c.).....	lb.	2.00 — 2.10
Benzidine, base.....	lb.	1.00 — 1.10
Benzidine sulphate.....	lb.	.80 — .90
Benzoic acid, U.S.P.....	lb.	.70 — .75
Benzoate of soda, U.S.P.....	lb.	.70 — .80
Benzene, pure, water-white, in drums (100 gal.).....	gal.	.30 — .35
Benzene, 90% in drums (100 gal.).....	gal.	.28 — .32
Benzyl chloride, 95-97%, refined.....	lb.	.30 — .35
Benzyl chloride, tech.....	lb.	.25 — .30
Beta-naphthol benzoate.....	lb.	3.50 — 4.00
Beta-naphthol, sublimed.....	lb.	.75 — .80
Beta-naphthol, tech.....	lb.	.30 — .35
Beta-naphthylamine, sublimed.....	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.).....	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.).....	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums.....	gal.	.95 — 1.00
Cresylic acid, 75-97%, dark, in drums.....	gal.	.90 — .95
Cresylic acid, 50%, first quality, drums.....	gal.	.65 — .75
Dichlorobenzene.....	lb.	.06 — .09
Diethylaniline.....	lb.	1.25 — 1.30
Dimethylaniline.....	lb.	.55 — .65
Dinitrobenzene.....	lb.	.30 — .32
Dinitrochlorobenzene.....	lb.	.25 — .30
Dinitronaphthalene.....	lb.	.33 — .35
Dinitrophenol.....	lb.	.40 — .45
Dinitrotoluene.....	lb.	.25 — .30
Dip oil, 25%, tar acids, car lots, in drums.....	gal.	.37 — .40
Diphenylamine.....	lb.	.60 — .70
H-acid.....	lb.	1.30 — 1.50
Meta-phenylenediamine.....	lb.	1.25 — 1.30
Monochlorobenzene.....	lb.	.14 — .16
Monoethylaniline.....	lb.	2.00 — 2.10
Naphthalene crushed, in bbls. (250 lb.).....	lb.	.08 — .08½
Naphthalene, flake.....	lb.	.08 — .08½
Naphthalene, balls.....	lb.	.09 — .09½
Naphthionic acid, crude.....	lb.	.70 — .75
Nitrobenzene.....	lb.	.12 — .15
Nitro-naphthalene.....	lb.	.30 — .35
Nitro-toluene.....	lb.	.18 — .25
Ortho-amidophenol.....	lb.	3.20 — 3.75
Ortho-dichlorobenzene.....	lb.	.15 — .20
Ortho-nitro-phenol.....	lb.	.75 — .80
Ortho-nitro-toluene.....	lb.	.22 — .24
Ortho-toluidine.....	lb.	.25 — .30
Para-amidophenol, base.....	lb.	1.90 — 2.0
Para-amidophenol, HCl.....	lb.	2.10 — 2.20

Para-dichlorobenzene.....	lb.	.15 — .25
Paranitroaniline.....	lb.	.90 — .95
Para-nitrotoluene.....	lb.	.90 — 1.05
Para-phenylenediamine.....	lb.	1.80 — 2.20
Para-toluidine.....	lb.	1.30 — 1.60
Phthalic anhydride.....	lb.	.55 — .60
Phenol, U. S. P., drums (dest.), (240 lb.).....	lb.	.10 — .12
Pyridine.....	gal.	2.00 — 3.50
Resorcinol, technical.....	lb.	1.85 — 2.00
Resorcinol, pure.....	lb.	2.75 — 3.00
Salicylic acid, tech., in bbls. (110 lb.).....	lb.	.23 — .25
Salicylic acid, U. S. P.....	lb.	.27 — .30
Salol.....	lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal.....	gal.	.28 — .32
Solvent naphtha, crude, heavy, in drums, 100 gal.....	gal.	.16 — .18
Sulphanilic acid, crude.....	lb.	.30 — .35
Tolidine.....	lb.	1.40 — 1.60
Toluidine, mixed.....	lb.	.45 — .50
Toluene, in tank cars.....	gal.	.30 — .32
Toluene, in drums.....	gal.	.33 — .35
Xylidines, drums, 100 gal.....	lb.	.45 — .50
Xylene, pure, in drums.....	gal.	.42 — .45
Xylene, pure, in tank cars.....	gal.	.45 — .45
Xylene, commercial, in drums, 100 gal.....	gal.	.33 — .35
Xylene, commercial, in tank cars.....	gal.	.30 — .35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark.....	lb.	\$0.24 — \$0.26
Beeswax, refined, light.....	lb.	.27 — .28
Beeswax, white pure.....	lb.	.40 — .45
Carnauba, No. 1.....	lb.	.75 — .80
Carnauba, No. 2, North Country.....	lb.	.35 — .40
Carnauba, No. 3, North Country.....	lb.	.18 — .19
Japan.....	lb.	.19 — .20
Montan, crude.....	lb.	.07 — .08
Paraffine waxes, crude match wax (white) 105-110 m.p.....	lb.	.04½ — .05½
Paraffine waxes, crude, scale 124-126 m.p.....	lb.	.04½ — .04½
Paraffine waxes, refined, 118-120 m.p.....	lb.	.06 — .06
Paraffine waxes, refined, 125 m.p.....	lb.	.06½ — .06½
Paraffine waxes, refined, 128-130 m.p.....	lb.	.07½ — .07½
Paraffine waxes, refined, 133-135 m.p.....	lb.	.08 — .08½
Paraffine waxes, refined, 135-137 m.p.....	lb.	.10 — .10
Stearic acid, single pressed.....	lb.	.12½ — .12½
Stearic acid, double pressed.....	lb.	.13½ — .13½
Stearic acid, triple pressed.....	lb.	.14 — .14

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940.....	gal.	\$1.70
Pine oil, pure, dest. dist.....	gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035.....	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.....	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990.....	gal.	.75
Pine tar, ref., thin, sp.gr. 1.080-1.960.....	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970.....	gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990.....	gal.	.37
Pinewood creosote, ref.....	gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl.....	280 lb.	\$8.50 —
Rosin E-I.....	280 lb.	8.50 —
Rosin K-N.....	280 lb.	8.50 —
Rosin W. G.-W. W.....	280 lb.	8.75 —
Wood rosin, bbl.....	280 lb.	9.00 —
Spirits of turpentine.....	gal.	.65 —
Wood turpentine steam dist.....	gal.	.64 —
Wood turpentine, dest. dist.....	gal.	.63 —
Pine tar pitch, bbl.....	200 lb.	8.50 —
Tar, kiln burned, bbl. (500 lb.).....	bbl.	15.00 —
Retort tar, bbl.....	500 lb.	15.00 — 15.50
Rosin oil, first run.....	gal.	.52 —
Rosin oil, second run.....	gal.	.54 —
Rosin oil, third run.....	gal.	.62 —

Solvents

73-76 deg., steel bbls. (85 lb.).....	gal.	\$0.41
70-72 deg., steel bbls. (85 lb.).....	gal.	.39
68-70 deg., steel bbls. (85 lb.).....	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.).....	gal.	.30

Crude Rubber

Para-Upriver fine.....	lb.	\$0.18½ — \$0.19
Upriver coarse.....	lb.	.14 — .14½
Upriver caucho ball.....	lb.	.14½ — .14½
Plantation—First latex crepe.....	lb.	.18½ —
Ribbed smoked sheets.....	lb.	.17½ —
Brown crepe, thin, clean.....	lb.	.18 —
Amber crepe No. 1.....	lb.	.20 —

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.....	lb.	\$0.09 — \$0.10
Castor oil, AA, in bbls.....	lb.	.11 — .11½
China wood oil, in bbls. (f.o.b. Pac. coast).....	lb.	.08½ — .08½
Cocanut oil, Ceylon grade, in bbls.....	lb.	.12 — .12½
Cocanut oil, Cochin grade, in bbls.....	lb.	.12½ — .13
Corn oil, crude, in bbls.....	lb.	.08½ — .09
Cottonseed oil, crude (f. o. b. mill).....	lb.	.06 — .06½
Cottonseed oil, summer yellow.....	lb.	.08½ — .09
Cottonseed oil, winter yellow.....	lb.	.09 — .09½
Linseed oil, raw, car lots (domestic).....	gal.	.70 — .71
Linseed oil, raw, tank cars (domestic).....	gal.	.63 — .63
Linseed oil, boiled, car lots (domestic).....	gal.	.72 — .73

Olive oil, commercial.....	gal	\$2.25	—	\$2.40
Palm, Lagos.....	lb.	.07½	—	.07½
Palm, Niger.....	lb.	.07	—	.07½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.06½	—	.07
Peanut oil, refined, in bbls.....	lb.	.13	—	.13½
Rapeseed oil, refined in bbls.....	gal.	1.10	—	1.15
Rapeseed oil, blown, in bbls.....	gal.	1.20	—	1.25
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.08	—	.08½
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.05½	—	

FISH

Light pressed menhaden.....	gal.	\$0.48	—	\$0.50
Yellow bleached menhaden.....	gal.	.50	—	.52
White bleached menhaden.....	gal.	.52	—	.54
Blown menhaden.....	gal.	.88	—	

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	17.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	
Blanc fixe, dry.....	lb.	.05	—	.05½
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.18
Chalk, domestic, extra light.....	lb.	.05	—	.06
Chalk, domestic, light.....	lb.	.04½	—	.05½
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04½	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	25.00	—	35.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mi es.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Fla.....	net ton	25.00	—	
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	
Fullers earth, imported, powdered.....	net ton	35.00	—	40.00
Graphite, crucible, 90% carbon, Ashland, Ala.....	lb.	.07	—	.09
Graphite, crucible, 85% carbon, Ashland, Ala.....	lb.	.11	—	.40
Graphite, higher lubricating grades.....	lb.	.04	—	.50
Pumice stone, imported, lump.....	lb.	.06	—	
Pumice stone, domestic lump.....	lb.	.04	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton		—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton		—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton		—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.60	—	
Shellac, orange superfine.....	lb.	.70	—	
Shellac, A. C. garnet.....	lb.	.58	—	
Shellac, T. N.....	lb.	.55	—	
Soapstone.....	ton	15.00	—	25.00
Sodium chloride.....	long ton		—	17.50
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	40.00	—	50.00
Talc, California talcum powder grade.....	ton	20.00	—	45.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	
Chrome brick, f.o.b. Eastern shipping points.....	net ton	80-100	
Chrome cement, 40-45% Cr ₂ O ₃	net ton	45-50	
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton		55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	
Magnesite brick, 9-in. straight.....	net ton	100	
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105	
Magnesite brick, soaps and splits.....	net ton	120	
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65-70	
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56-61	
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	50-60	

Ferro-Alloys

All f.o.b. Works

Ferrocobalt-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	16	—	17
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	16	—	17
Ferromanganese, 76-80% Mn, domestic.....	gross ton	100.00	—	
Ferromanganese, 76-80% Mn, English.....	gross ton	100.00	—	
Spiegeleisen, 18-22% Mn.....	gross ton		—	40.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.00	—	2.50
Ferrosilicon, 10-15%.....	gross ton	55.00	—	60.00
Ferrosilicon, 50%.....	gross ton	78.00	—	80.00
Ferrosilicon, 75%.....	gross ton	140.00	—	145.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.55	—	.60
Ferrouranium, 35-50% of U, per lb. of U content.....	lb.	7.00	—	
Ferrovanadium, 30-40% per lb. of contained V.....	lb.	5.00	—	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content, less than 2% Fe ₂ O ₃ , up to 20% silica, not more than H 4% moisture.....	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.60	—	.65
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.55	—	.60
Coke, foundry, f.o.b. ovens.....	net ton	6.50	—	7.00
Coke, furnace, f.o.b. ovens.....	net ton	5.00	—	5.50
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	21.00	—	22.00
Fluorspar, lump, f.o.b. Tonuco, New Mexico.....	net ton	15.00	—	
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	—	25.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.38	—	.40
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.65
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.12	—	
Pyrites, Spanish, furnace-size, c.i.f. Atlantic seaport.....	unit	.16½	—	
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	—	3.25
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	2.75	—	3.00
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.75	—	3.00
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	
Zircon, washed, iron free.....	lb.	.03	—	

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	14.00
Aluminum, 98 to 99 per cent.....	28.30 @ 28.5
Antimony, wholesale lots, Chinese and Japanese.....	6.00
Nickel, ordinary (ingot).....	43.00
Nickel, electrolytic.....	45.00
Monel metal, spot and black.....	.35
Monel metal ingots.....	.38
Monel metal, sheet bars.....	.40
Tin, 5-ton lots.....	32.00
Lead, New York, spot.....	5.50
Lead, E. St. Louis, spot.....	5.00
Zinc, spot, New York.....	6.00
Zinc, spot, E. St. Louis.....	5.65

OTHER METALS

Silver (commercial).....	oz.	\$0.66½
Cadmium.....	lb.	1.40 @ 1.51
Bismuth (500 lb. lots).....	lb.	2.40
Cobalt.....	lb.	6.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.35
Platinum.....	oz.	75.00
Iridium.....	oz.	350.00 @ 400.00
Palladium.....	oz.	75.00
Mercury.....	75 lb.	50.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per Lb.

Copper sheets, hot rolled.....	21.00
Copper bottoms.....	33.00
Copper rods.....	28.00
High brass wire and sheets.....	18.75
High brass rods.....	16.75
Low brass wire and sheets.....	27.50
Low brass rods.....	18.50
Brazed brass tubing.....	35.25
Brazed bronze tubing.....	40.50
Seamless copper tubing.....	25.00
Seamless high brass tubing.....	24.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	11.50	18.50	10.00	10.50
Copper, heavy and wire.....	11.00	16.50	9.50	9.50
Copper, light and bottoms.....	9.00	14.50	9.00	8.50
Lead, heavy.....	4.00	7.25	4.00	4.00
Lead, tea.....	3.00	5.25	3.00	3.00
Brass, heavy.....	7.00	9.50	7.00	10.00
Brass, light.....	5.50	8.00	5.00	5.50
No. 1 yellow brass turnings.....	6.00	9.50	5.50	6.00
Zinc.....	4.00	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	*Current	One Month Ago	One Year Ago	Current	Year Ago	Current	Year Ago
Structural shapes.....	\$3.73	\$3.80	\$3.47	\$3.58	\$3.37	\$3.58	\$3.47
Soft steel bars.....	3.93	3.70	3.52	3.34	3.27	3.48	3.52
Soft steel bar shapes.....	3.93	3.70	3.52	3.48	3.27	3.48	3.52
Soft steel bands.....	4.33	4.65	4.22	6.25			
Plates, ½ to 1 in. thick.....	3.93	4.00	3.67	3.78	3.57	3.78	3.67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Colorado

LA VETA—City had plans prepared for construction of sewerage system, including Inhoff tank, gravel bed filtration and chlorine plants. J. O. Francisco, engr.

Florida

KISSIMMEE—Tucker Brick Co. plans to rebuild brick plant which was recently destroyed by fire. Estimated cost, \$15,000.

Illinois

LITCHFIELD—City plans water-works improvements and construction of filtration plant. Estimated cost, \$200,000. J. W. Allen, City Hall, city clk.

Indiana

INDIANAPOLIS—C. & A. Potts & Co., 816 West Washington Ave., plans to build 1-story, brick and steel foundry on Blake St. Estimated cost, \$45,000. Architect not selected.

Iowa

BUFFALO CENTER—Consolidated School Dist. is having plans prepared for the construction of a 2-story, 82x145-ft. rein.-con. and brick high school here. A chemical laboratory will be installed in same. Estimated cost, \$150,000. G. L. Lockhart, 294 Endicott Bldg., St. Paul, Minn., archt.

OTTUMWA—The Bd. Educ. will receive bids until Feb. 23 for construction of a 3-story rein.-con. and brick high school. A chemical laboratory will be installed in same. Estimated cost, \$700,000. Croft & Boerner, 1006 Marquette Ave., Minneapolis, archts. Noted July 21.

UTE—C. W. Hitchen, city clk., will receive bids until Feb. 15 for the construction of about 19,000 lin.ft. vitr. pipe sewer, settling tank and twin filter beds. Estimated cost, \$50,000. E. E. Carlson, Battle Creek, engr.

Illinois

SPRINGFIELD—City Water Dept. plans to build water softening and iron removal plant. Estimated cost, \$75,000. Burns & McDonnell, 400 Interstate Bldg., Kansas City, Mo., engr.

Michigan

DETROIT—Park Davis & Co., Atwater St. and McDougall Ave., will soon award the contract for construction of a 7-story, 200x248-ft. brick, steel and rein.-con. factory. Smith, Hinchman & Grylls, 710 Washington Arcade, archts. Noted Jan. 19.

GRAND RAPIDS—City will receive bids about Feb. 15 for construction of a filtration plant. Estimated cost, \$400,000. R. E. Harrison, 1260 Nicholas Bldg., Toledo, engr.

Minnesota

COOKSTON—Miller Tanning Co., 615 Woodland Ave., having plans prepared for the construction of a 2-story, 50x50-ft. concrete tannery here. Estimated cost, \$13,000. E. T. Gillies, 248 McKnight Bldg., Minneapolis, engr.

MANKATO—The Immanuel Hospital Association is having plans prepared for construction of a 3-story rein.-con. and brick addition to hospital on Washington and Ford Sts. A clinical and pathological laboratory and X-ray department will be installed in same. Estimated cost, \$150,000. Schippel & Schmidt, Kruse Bldg., archts. Noted Dec. 8.

Ohio

CLEVELAND—Bd. Educ. is having plans prepared for the construction of a 3-story, brick and steel high school on East 116th St. and Corlett Ave. A chemical laboratory will be installed in same. Estimated cost, \$2,000,000. W. R. McCormack, East 6th St. and Rockwell Ave., archt.

CLEVELAND—Bd. Educ. is having plans prepared for the construction of a 2-story, brick and steel high school in Collinwood Dist. A chemical laboratory will be installed in same. Estimated cost, \$2,000,000. W. R. McCormack, East 6th St. and Rockwell Ave., archt.

GENEVA—Bd. Pub. Affairs will receive bids until Feb. 15 for enlarging and improving water filtration plant here, including construction of new filter plant with 1,000,000-gal. capacity. P. Burgess, 141 East Broad St., Columbus, engr.

GIBSONBURG—Kelly Island Lime & Transport Co., c/o J. A. Kling, pres., Leader-News Bldg., Cleveland, has awarded the contract for the construction of a 1-story, 50x130-ft. hydrating lime plant here, to Forst City Steel & Iron Works, 1500 West 110th St., Cleveland. Estimated cost, \$50,000.

NEWARK—Leonard Oil Gas Co. plans to build an oil refinery here. Rust Engr. Co., 1901 Fifth Ave., Pittsburgh, Pa., engr.

Oklahoma

MOUNTAIN VIEW—City is having preliminary plans prepared for construction of sewerage system and disposal plant. V. V. Long & Co., 1300 Colcord Bldg., Oklahoma City, engr.

Pennsylvania

READING—Bd. Educ. 8th and Washington Sts., plans to build 3-story, 300x300-ft. concrete high school. A chemical laboratory will be installed in same. Architect not selected.

South Dakota

ABERDEEN—Bd. Educ. receives bids about April 2 for construction of a 3-story, rein.-con. and brick high school. A chemical laboratory will be installed in same. Estimated cost, \$300,000. W. W. Beach Co., Sioux City, Iowa, archts.

BELLEFOURCHE—Bd. Educ. will soon receive bids on 42x60-ft. rein.-con. and brick first unit of a 2-story high school. A chemical laboratory will be installed in same. Estimated cost, \$100,000. W. W. Beach Co., Sioux City, archts.

Tennessee

ALTON PARK—The Du Bois Rubber Co., 315 Volunteer Bldg., let contract for the construction of a 2-story, 40x50-ft. rubber plant here, to Chickamauga Quarry & Constr. Co., Chickamauga. Estimated cost, \$100,000.

Texas

DALLAS—City plans the construction of a water purification plant, 15,000,000-gal. capacity. Estimated cost, \$500,000. G. D. Fairtrace, city engr.

GRAHAM—City plans to construct reservoir dam on Salt Creek, extend water mains, enlarge pumping plant and filtration bed and extend and enlarge sewage disposal plant. Estimated cost, \$100,000. H. E. Elrod Eng. Co., Interurban Bldg., Dallas, consult. engr.

TERRELL—City has awarded the contract for the construction of a pump house and filtration system, including oil engines and 2 pumps, to Mergle Machinery Co., Tulsa, Okla. Estimated cost, \$47,850.

WACO—Herring Ave. Methodist Church is having plans prepared for the construction of a 3-story, 75x100-ft. brick and concrete hospital on Herring Ave. A chemical laboratory will be installed in same. About \$100,000. R. H. Hunt Co., Southwest Life Bldg., Dallas, archts.

Wisconsin

KAUKAUNA—Molock Co. is in the market for brass foundry equipment, including ovens.

RACINE—Wisconsin Gas & Electric Co., Public Service Bldg., Milwaukee, has awarded the contract for the construction of a 2-story, 40x60-ft. brick and concrete gas plant addition to Bingard & Christianson, 2220 Kinzie Ave.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold annual meeting Feb. 21 to 24 at Columbus, Ohio, with headquarters at the Deschl Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City, April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN ENGINEERING COUNCIL will meet at Syracuse, N. Y., Feb. 14 and 15.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursion will be made to Ann Arbor, Saginaw, Michigan and Bay City.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS will hold its spring meeting Feb. 14 to 17 in New York City.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Product Analysts) will hold its twelfth annual meeting in Chicago May 16 and 17.

AMERICAN PAPER & PULP ASSOCIATION will hold its annual meeting at the Waldorf Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting at the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

NATIONAL PETROLEUM CONGRESS will meet at the Hotel Baltimore, Kansas City, Mo., March 22 to 25.

NEW JERSEY CHEMICAL SOCIETY holds meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

DR. EDGAR F. SMITH will address the joint gathering of the New York Section of the American Electrochemical Society and the American Chemical Society, and the American sections of the Society of Chemical Industry and the Société de Chimie Industrielle at the Chemists' Club on the evening of Feb. 11. His subject is "Research."

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: Feb. 11, American Electrochemical Society, joint meeting with Society of Chemical Industry, American Chemical Society and Société de Chimie Industrielle; March 11, American Chemical Society; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

Manufacturers' Catalogs

PITTSBURGH IRON & STEEL FOUNDRIES CO., Pittsburgh, Pa., is distributing an attractive booklet on "Adamite in the World's Work," which illustrates and describes the performance of Adamite under severe operating conditions.

THE NORTON CO., Worcester, Mass., calls attention to a catalog on "Balancing Equipment for Grinding Wheels." Illustrations and descriptive matter are given, together with prices.

WALLACE & TIERNAN CO., INC., New York City, announces Technical Publication 23 on "Modern Bleaching Methods," which are based on the use of liquid chlorine with control equipment.

THE HARDINGE CO., New York City, calls attention to Catalog 8, on the Hardinge conical mill, and Grinding Data No. 4 and No. 5.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
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Industrial Editors
J. S. NEGRU
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Number 7

Ignorance in High Places

IT CAN be stated almost with certainty that legislation to protect our dye industry will not be enacted at this session of Congress. Responsibility for the delay, however, can with no uncertainty be laid to the opposition of Senators THOMAS of Colorado and MOSES of New Hampshire. The former in particular is known to have a constitutional antipathy for tariff protection, while the latter is said to oppose the Longworth bill in the interest of certain textile manufacturers. Whatever may be their reasons, their power to obstruct legislation is so thoroughly recognized in the Senate that the committee having the matter in charge does not feel warranted in bringing it up.

Seldom do we realize all the forces at work in our legislative halls, nor can we always delve deeply enough into these forces to discover the animus behind them. Sometimes it is partisan politics, sometimes personal interest, sometimes prejudice, and sometimes plain ignorance of the subject. The last is not only incomprehensible but quite unjustifiable in a day when knowledge and information are thoroughly organized and readily available. Nevertheless we find a curious instance in Senator THOMAS' opposition to protection of the American dye industry. In response to our efforts to convert him to the necessity of legislation on this matter he assured us first of his thorough knowledge of the subject and then asked if we were not aware of the fact that "the small volume of German dyes now in course of production is dependent very largely upon intermediates supplied from the United States." This fallacy being thoroughly fixed in the Senator's mind, he sees no reason why, if we "are so frightened over the prospect of drastic German competition or Germany's speedy rehabilitation as a war power," we cannot "easily limit her production . . . by cutting off this supply." The Senator expresses the hope that he may "live until that policy is adopted." In the meantime, however, he stands stanchly against protection of the dye industry because it is a sinister piece of legislation, the ultimate purpose of which is to create a huge combination of chemical activities in the United States. With full faith that the desired protection will be consummated by the next Congress, the Senator bravely avers that "it will never be so long as I have strength to prevent it." The Senator retires on March 4. In the meantime it is to be hoped that if the next Congress declares peace by legislation, it will simultaneously extend the powers of the War Trade Board Section of the State Department so that dye importation can still be controlled by license until appropriate legislation is passed.

Participation of Technical Men in Public Affairs

WRITING at the close of his term of office on the subject "This Country of Ours," President BENJAMIN HARRISON gave a bit of advice too often ignored by professional men. He said:

We have not realized in government, any more than in mechanics, inherent and perpetual motion. It is not enough to construct and start. Watchfulness, administration and love are needed to keep the best planned government on its projected lines. Men, rather more than machines, need watching.

There has been no time in the history of this country when more intimate attention to Government affairs was justified than at present. The chemist and the engineer, among others, have their responsibility clearly before them in these circumstances. Just now there are before Congress many important matters of legislation in which these technical professional groups are intensely interested. However, it is not enough to be simply interested in them; positive constructive action is required.

The recent experience of the chemical and engineering professions should justify all of us in venturing again into these legislative matters. Undoubtedly the effort made in the case of Patent Office legislation was the effective means for securing the favorable action on Patent Office salaries. The conferees from the House of Representatives and the Senate met with two salary scales before them. One was a distinct improvement over the present provision for the technical staff of the Patent Office, but even at that rather inadequate. The second provision cut the present limited staff in numbers and provided negligibly small increases for any grades in the staff. Under ordinary circumstances the result of conference on these two salary scales would have been a compromise; and, with the plea for economy sounding in the ears of all members of Congress, it is probable that the lower scale would have been adopted in most particulars. However, the technical men of the country, representing science and industry, demanded attention and as a result the members of both houses were convinced and have reported favorably upon the higher salary scale throughout.

In matters of dye legislation, chemical glassware importation (duty-free or otherwise), reorganization of the technical services of the Government, emergency tariff legislation, tariff revision, nitrogen legislation and other matters of this sort we find political factors which are beyond the experience of most technical men. With respect to these political factors we shall doubtless have to permit the professional politician to orate and finally to decide. There are, however, in each of these, and in numberless others, matters of technical

fact or of distinctly technical concern. With respect to these our professional engineers and chemists should be heard, and if they will but exercise "watchfulness, administration and love" they can and will be listened to attentively. The result will be a most satisfying participation in national affairs not only for the gratification of personal or professional desires but also for the general public welfare.

Chemical Warfare Service

An Investment for Economy

CHEMICAL warfare is the most effective, the most economical and the most thoroughly humanitarian arm of modern military service. It may seem anomalous to credit maximum effectiveness and humanitarianism to the same weapon, but it is a wholly justifiable anomaly.

Without effective defensive equipment for use in gassed areas, other arms of the military service are helpless. Within the range of even the "Big Bertha" troops cannot operate with impunity unless provided with defensive equipment adequate to cope with the most lethal gas which the enemy may choose to use. To send troops into the field without such equipment is worse than foolhardy. Yet that is substantially what the United States is proposing to do when it says to the Chemical Warfare Service that it may not expend each year a sufficient sum to develop, manufacture and replace from time to time with the most modern forms a supply of gas masks sufficient to equip perhaps three-quarters of a million troops within a period of thirty days. To send troops into the field with even the mask which was issued during the last months of the late war would be to place them in a defenseless position before any nation well equipped with the more modern types of gas shell. Yet that is precisely the condition which today is being authorized.

The Chemical Warfare Service has asked for a two-year period a sum approximately equal to $2\frac{1}{2}$ per cent of the total estimated Army appropriation. The War Department itself cut these requests nearly in half, and Congress seems inclined to even greater "economy." It is worth while, however, to determine whether this is real saving or simply a penny-wise policy.

It is well recognized that in future military operations against a well-equipped enemy a very large percentage of hospital cases are certain to be gas casualties. Every such casualty on the field of battle represents a tremendous cost in money, a material reduction in effective fighting strength and a large increase in the medical and hospital personnel and facilities. It is a well-known saying among military men that every wounded man requires two well men to care for him. And this is no exaggeration. Every ineffective mask is, therefore, potentially responsible for three persons rendered *hors de combat*.

The effectiveness of gas in modern warfare need not be emphasized. It is worth while, however, to recall again the fact that there is a much higher percentage recovery from gassing than from any other type of casualty. Thus one can well defend the claim that it is the most humanitarian of all means of attack upon combatants.

The chemical industries should appreciate the important points which can be made in support of chemical warfare. This type of warfare is really available only to a civilized nation of high industrial intelli-

gence. The industries of any nation developing chemical warfare to a full state of effectiveness will find simultaneous advantage to industry through the incidental organic chemical research. Indeed this alone probably would justify the expenditure. But more than this, industry can rest assured that if the nation is thoroughly prepared in this respect no other country has an opportunity effectively to attack us with hostile motive. Industry is thus both directly benefited and indirectly protected, and may well ask why the Chemical Warfare Service should not be provided with at least 2 per cent of the estimated Army expenditure, which is the very modest request the Service is making.

The Right Way To Do It

THE Committee on the Chemistry of Colloids of the Division of Chemistry of the National Research Council has issued a list of about 200 research problems prepared by Prof. WILDER D. BANCROFT, of which forty-five were published in the January number of the *Journal of Industrial and Engineering Chemistry* of the American Chemical Society, and forty-eight more in the February number of the same magazine. The list was issued last November, and it is hoped that the serial publication will be completed in April or May.

The work was undertaken to stimulate research, and the method has proved to have great merit. Of course it would be hard to find the equal of Prof. BANCROFT in the exposition of problems, but it goes without saying that these may serve as a pattern for others. No sooner had the first forty-five been published than letters began to pour in to the chairman of the committee, Prof. HARRY N. HOLMES, at Oberlin College, Oberlin, Ohio. For instance, an industrial chemist wanted to "team" with a university man better versed in theory than he, in regard to a problem in the chemistry of paints. Some men are asking for specific problems that they fancy. A prominent manufacturing company asks, in regard to one of the problems, to be put in touch at once with any good chemist who has selected it for his own research. It says it has some helpful information that it will put at his disposal. Here is the very thing that academic men accuse industrial concerns of not doing. They ask them to hand out results of their research, and lo and behold, it is done!

"Why," asked a chemist of Dr. HOLMES, "don't men in other fields of chemistry do the same thing: put out lists of stimulating research problems?" Well, why don't they? We've always been in favor of such a procedure, and in an editorial on "Metallurgical Mysteries" in a late number we intimated a number of such problems in the metallurgical field.

We congratulate the National Research Council on the sanity of the method of the Committee on Colloids and on the subtle intelligence with which the committee transacts its business. The open publication of problems reaches the man who wants to do the job, who has a leaning for it. It touches the person in whom the fires of enthusiasm are already burning. Instead of being assigned to a chemist, it is chosen by him; chosen because of his faith in his own ability to do this very thing. That is sound psychology.

Suppose instead of this direct, sincere work, the committee were to sit in high conclave and determine who is best fitted for each problem and then to allot them accordingly? Even if the committee sat on the top

floor of the Bankers' Trust Building, surrounded with Gothic tapestries, and rested in chairs specially imported from the Musée de Cluny, and smoked two-dollar cigars, it would still lack the pentecostal light to lead it unto wisdom. As likely as not its members would forget the one man in all the world who is best fitted to undertake it, who is, very possibly, making urine analyses for the country doctor to help out his salary as professor of chemistry at some Deepwater Baptist College in a town they've hardly heard of. But that one man does know, and as soon as he reads the call he answers it.

To our mind the Committee on Colloids is on the right track. Or, to mix our metaphors, we might also express the opinion that it is leading the band.

The Function of Educational Institutions in Research

SEVERAL weeks ago we attempted a delineation of two types of research, scientific and industrial, and suggested what seemed to us a logical allotment of those types to agencies best suited to conduct them. Briefly, the conclusion was reached that scientific research is best fostered in the laboratories of universities and government bureaus, while industrial research had best be left to commercial laboratories and consultants. The line is not drawn hard and fast, because it is recognized that industry may see fit to conduct scientific research of the highest order and that occasionally university and college laboratories may properly be devoted to the solution of industrial problems. The general distinction, however, we believe to be sound and in the best interests of all concerned.

An organization like the Mellon Institute is outside the scope of our criticism because it stands practically by itself and it is doubtful if commercial laboratories would fill the same need in the same way. Probably the success of the Institute has suggested the adoption of industrial fellowships at other schools, but it is not likely the same success will be attained elsewhere. The Mellon Institute had its inception in the mind of a far-seeing leader, and its realization was dependent upon financial support of such magnitude as is unlikely to be readily obtained.

The relation of universities and industrial research may be further discussed in view of the recent tendency on the part of some of our institutions of learning to establish industrial fellowships and engage in research and consultation. This attempt to combine two entirely different types of work in the same institution, and often under the same direction, must inevitably lead to an *impasse*. The primary function of the university is the education of its students. Presumably this education consists in the inculcation of broad elements of culture and the exposition of fundamental principles. The purpose and methods are quite distinct from those of industrial research having as its ultimate goal the discovery or improvement of a process or product. We doubt if the two can be prosecuted successfully side by side. One is likely to be subordinated to the other, and suffer in consequence. If the attempted service to industry is to be successful the institution must develop into a consulting organization to the detriment of its teaching function, while if the latter be exercised in the highest degree any attempt at industrial research is likely to prove abortive. If instruction suffers the result will be poorly equipped graduates whose field of en-

deavor has been narrowed by the almost certain prospect of competition with their own alma mater.

The whole question of competition between universities and their alumni looms up in this connection. It is argued that when universities enter into competition against established consultants they can usually underbid the latter by the offer of free laboratory service and the assistance of industrial fellows whose salaries are modest, but probably commensurate with their abilities. The result is unfair competition which affects not only the private consultant, who may be an alumnus of the institution, but also the industrial fellow who may be working on a problem beyond his capability, the instructor who divides his time between theoretical instruction and supervision of industrial research, the student who possibly suffers from this division of effort, and finally the company or organization supporting the research, due to possible dissatisfaction with the results of poorly planned or ill-advised investigation. The last is greatly to be deplored because it is likely to deter the other companies from undertaking industrial research and thus retard the progress of industry. In general it seems that the whole matter of industrial fellowships in universities would profit from a searching examination as to purpose, influence on instruction and value of commercial results. We believe it will be found that the search for the truth and the search for the dollar are different occupations and that their paths are not the same.

But if we do not regard industrial research as a legitimate activity for universities we are none the less confirmed in our opinion that there is a vast number of scientific research problems which they should undertake and which ultimately would inure to the benefit of industry. These relate to the fundamental data, properties, constants, etc., which are so badly needed by those who apply science in our technological industries. They are of the type discussed in our last Chemical Exposition number by Prof. RICHARDS, and subsequently by DONALD M. LIDDELL. It is just the sort of research which should make less arduous and difficult the work of the National Research Council in gathering data for American tables of chemical and physical constants. In fact there is enough scientific research to be done to keep a far greater number of men busy than are now engaged in it, and the place for it is in the atmosphere and surroundings of the university laboratory.

Another type of research which is quite within the scope of the university is of a semi-public character which is not likely to be undertaken by individuals or companies but from which they and the general public will profit. A typical example is the work undertaken by Dr. WITHROW at the University of Ohio in the study of the nuisance resulting from fumes from chemical manufacturing plants. Such an investigation will serve the state, the immediate community and the industry. Problems of this kind relating to public health or welfare undoubtedly exist in many communities and can be undertaken by universities, particularly if supported by the state. In general we feel that in deciding whether or not a certain line of research is legitimately within the field of the university a safe criterion will be the existence or non-existence of other suitable agencies, corporate or individual. With this in mind universities will find little excuse for excursions into industrial research, just as they will find little competition but much approval for their efforts in scientific research.

Readers' Views and Comments

Sulphur Dioxide May Have Therapeutic Value

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your Dec. 15 number is an article "Chlorine May Have Therapeutic Value." Sulphur dioxide gas may have a similar property. During the influenza epidemic of 1918, the working force of the British Acetones Co. at Toronto, Ont., was reduced nearly 30 per cent by cases of influenza, but in the sulphuric acid department not one of the eight men employed there suffered from it.

S. A. IONIDES.

Denver, Col.

Duty-Free Apparatus for Colleges

To the Editor of Chemical & Metallurgical Engineering

SIR:—I note in your issue of Jan. 12 that Prof. J. W. Richards, in opposing the repeal of the duty-free importation privilege now possessed by our educational institutions, says: "Let's have a broader vision and have a further look ahead."

After reading Prof. Richards' arguments I was really surprised at his own very limited range of view in this respect. A look a little further into the future than Prof. Richards seems to have taken would disclose the fact that in the long run a properly protected industry in this country has, almost without exception, resulted in the development here of cheaper and better material than that previously imported from abroad. With this in mind, it seems clear that eventually if the manufacture of chemical supplies is properly protected here our technical students will have not only a better and cheaper supply but one near at hand.

This will result in much greater convenience in obtaining supplies and prevent what has occurred during the last six years—a complete cut-off of all supplies of this kind. Technical students then will never again be "hampered" in their training as they have been for the past six years and still are today. A duty on such supplies may cause annoyance for a short time, but ultimately they will undoubtedly be made better and cheaper here and the purchasing power of the educational funds will not be decreased but made greater in the long run. All of this will be conducive to increased efficiency in technical education.

It may be that for some time certain kinds of apparatus will not be made here, but eventually they will be and the amount of tariff paid by our educational institutions for these few items will certainly not constitute a heavy drain on their resources. They would also get a partial offset by cheaper freight rates. A tariff does not shut out foreign articles and hence would not prevent those who want to use foreign apparatus from doing so if they wish. An appeal to the patriotism and good judgment of the friends and alumni of any institution of higher learning that finds itself hampered by the increased cost of material due to a protective tariff on goods of American manufacture, levied for the purpose of developing American independence in such material, would certainly bring a response which would more than compensate for any temporary increased cost or embarrassment to the college.

I am sure when Prof. Richards gets a truly "broader vision and further look ahead" he and others of his view will not fail to see the advantages of developing our own supply close at hand and insuring against all future holdups of such materials by any foreign country.

Department of Chemistry,
Case School of Applied Science,
Cleveland, Ohio.

ALBERT W. SMITH.

Water Purification

To the Editor of Chemical & Metallurgical Engineering

SIR:—"A Comparison of Various Methods of Water Purification," by William Macklin Taylor, in your issue of Jan. 19, is of much interest and contains many suggestions which should be valuable when considering water softening.

As Mr. Taylor very properly states in concluding his article, ". . . it is apparent that each type of water purification has a fairly well-defined field in which it is unquestionably best." Speaking frankly from a precipitation water-softener standpoint, it seems to me that he claimed too much breadth of field for the admittedly discredited boiler compound method of softening.

The "soapy taste" which Mr. Taylor states is characteristic of lime-soda softened water is something which is foreign to the experience of the citizens of Columbus, Ohio; McKeesport, Pa.; Owensboro, Ky., and many other municipalities where softened water is used for domestic purposes. The complete satisfaction afforded by these and other lime-soda purified supplies scarcely checks with Mr. Taylor's sweeping statement in regard to the unfitness of lime-soda softened water for domestic use.

Small boiler installations where less than 500 gal. per hour of water is evaporated are not readily covered by the continuous type of lime-soda softener. For this service an intermittent or batch type of softener is particularly well adapted.

There is no doubt that certain substances can advantageously be added to water in boilers for the purpose of diminishing foaming and that certain others may be used to counteract electrolytic corrosion. This kind of treatment, however, has nothing to do with water softening. Where actual water softening is concerned—and the removal of calcium and magnesium salts from the water is required—the elimination of these objectionable substances by precipitation methods is universally conceded to be the best.

Practically every boiler plant engineer and certainly all steam railroad water service engineers have tried the boiler compound method. Of course they have used the most effective chemicals known as well as the "worthless components." As a last resort in preparing water for boiler feeding they turn to precipitation methods, as is witnessed by the increasing numbers of these plants being installed. The net result is that some railroads are already completely equipped and additional softeners are being installed elsewhere as rapidly as funds become available.

L. M. BOOTH.

Elizabeth, N. J.



The Cordage Fiber Industry of the Philippine Islands

Description of the Production of Manila Rope Fiber From the Abaca Plant—Opportunity for Industrial Advances — Agricultural and Botanical Notes—Yield, Methods of Manufacture and Products Obtained From Fiber

BY DR. ALVIN J. COX*

ABACÁ (Manila hemp), the most important and valuable fiber and export product of the Philippine Islands, is the foremost commercial cordage fiber in the world. High-grade machine-laid ropes made from it usually have a tensile strength of more than 15,000 lb. per sq.in. Statistics given for abacá for 1919 by the Director of Customs for the Philippine Islands show that it comprised about 40 per cent of the total value of the exports and amounted to 121,247,668 kg. (267,305,034 lb.), valued at \$26,851,825. The last report issued by the same bureau covering the first six months of 1920 gives 86,891,232 kg. (195,175,085 lb.) valued at \$21,972,175. It was still in the lead in value as an individual export product, though the recent increase in the production of coconuts, tobacco and sugar cane which are exported as copra and coconut oil, cigars and in other forms, centrifugal and raw sugar, respectively, have reduced the percentage. The purchaser is now protected in the abacá materials which he buys due to government supervision and grading.

GROWTH OF EXPORTS

Abacá was first exported to the United States from the Philippine Islands early in the last century and from that time on the use of the fiber has been very popular and has rapidly extended. The Philippine Bureau of Agriculture Bulletin 12, pages 9 and 10, says that the first authentic account of the use of abacá or banana fiber in the Philippines is that given by an Englishman, Dampier, who lived in the Island of Mindinao in 1686; that in 1820 a sample of abacá was brought to Salem, Mass., by John White, a Lieutenant in the Navy, and that from 1824 to 1827 the fiber began

to be used quite extensively in Salem and in Boston. The figures in the accompanying table indicate the increase in production and exportation since these became of importance:

EXPORTS OF ABACÁ FROM THE PHILIPPINE ISLANDS

Year	Kg.	Lb.	Value in Dollars U. S. Currency
1850	7,700,000	17,000,000	.....
1860	27,000,000	37,500,000	.....
1870	28,500,000	62,830,000	.....
1880	46,000,000	101,500,000	.....
1890	62,700,000	138,230,000	.....
1900	81,600,000	179,900,000	12,240,000
1910	170,788,629	348,219,990	17,404,922
1920	86,891,232*	195,175,085*	21,972,175*

* For the first six months.

SPECIES OF PLANTS

The name abacá is applied not only to the fiber but to the plant from which it is obtained. Abaca *Musa textilis* *née* closely resembles the common banana *Musa sapientum* in appearance and habits of growth, but may be easily distinguished from it by its narrower, more tapering, and darker colored leaves. Plantain *Musa paradisiaca* is also a closely related species. The common banana produces a fiber similar in appearance to that from abacá but lacking in tensile strength. The fruit of the abacá somewhat resembles that of the banana but is smaller, full of black seeds, inedible and of no economic value. Abacá fiber frequently is called Manila hemp and is generally known to the trade by that name. However, it is not hemp and this designation is misleading. Hemp is the fiber produced by the plant *Cannabis sativa*. The two are quite different. Abacá is a hard, light, strong, resilient, durable structural fiber as described below, whereas true hemp is a tough, fibrous layer between the wood and the bark known as bast fiber which is characteristic of certain

*Director, Bureau of Science, Government of the Philippine Islands, Manila, 1912-19.

families of plants. In the Philippines there are many bast fibers that have an extensive local use as a substitute for abacá and in some parts of the islands—for example, the Ilocano provinces—the making of rope from bast fibers has a considerable commercial importance. When much exposed to moisture some bast fiber ropes are superior in durability to abacá rope and in a few cases have a breaking length—i.e., the breaking load divided by its weight per unit length—closely approaching that of high-grade machine-laid abacá rope.

THE ABACÁ PLANT

The true stem of the abacá plant has a diameter of about 2 in. and is that part which bears the fruit. The flower bud remains at the root until the plant has attained about its full size and then pushes rapidly upward. The stalk or trunk is formed by this true stem and the thickened petioles of the leaves which form overlapping layers around it, and the plant grows to be from 15 to 35 ft. high and a foot or even more in diameter.

The abacá plant has a perennial root, and may be grown for many years without replanting. As the stems mature the root sends up numerous suckers which make the subsequent stalks, so that after a time the plants no longer remain in accurate rows. The time required for development varies with different varieties and in different localities. Generally cutting may be begun in about two years after the original planting, and after three years a plantation should be in full bearing. It is customary to cut a plantation about every four to eight months and from two to four stalks per plant can be harvested at a time. All stalks do not

mature at the same time. The stalk is ready for cutting between the time of appearance of the flower and the development of the fruit. If cut before or after this period an inferior quality of fiber will be obtained. When the plant is in flower the large violet-colored flower bracts fall to the ground and make it easy when passing through a field to select the plants that are ready to be cut.

The stalk is cut on a slant 2 or 3 in. above the ground with a sharp bolo or large knife. A horizontal cut is to be avoided, for then water will collect on the stump and cause it to rot and thus injure the root and the remaining shoots.

PREPARATION OF ABACÁ FIBER

The fiber comes from the petioles and the quality varies with the different layers. That from the outer layers is usually coarse and dark colored. After the leaves have been trimmed from a stalk the petioles are separated one from the other and split into strips, the fiber being obtained from the outer portion of these strips. The next step is to insert a small sharp piece of bamboo or bone into a strip of petiole and, after starting the separation of the fibrous portion, pull it off in ribbons as long as the strip. The remainder of the strip is discarded. When a quantity of these ribbons has been collected it is pulled under a knife to remove the fleshy material from the individual fibers. The knife is held horizontally, serves as a scraper, and when it is desired to insert or remove a ribbon of fiber it is lifted by a crude spring controlled by a foot treadle. Every ribbon is passed under the knife twice, the second time to strip the end that the operator grasped during the first pull. As the abacá stalk contains a large percentage of water and is very heavy and the stripping equipment is light and easily transported, the latter is usually moved from place to place and the fiber extracted near the spot where the stalk is felled. The cutting and stripping should be done on the same day, else the petioles deteriorate and yield a dark-colored and inferior fiber. After the fiber is stripped it is hung on a pole, generally bamboo, in the sun to dry. The more quickly it is dried the whiter and more lustrous the fiber.

Numerous attempts have been made to extract abacá fiber with machines and a number have been used with a measure of success, but the major portion of the abacá fiber produced in the Philippine Islands is hand-stripped. The cleaning of the fiber, which is controlled by the condition of the knife blade, the pressure with which it is pressed against the block and the drying are very important, for upon them depend the important qualities of both strength and color. A method of stripping must not break, tangle, discolor, waste or in any way injure the fiber.

When thoroughly dry the fiber is tied into bundles and brought together into central warehouses, where it is carefully sorted into the different commercial grades and baled for export. In the final baling a certain amount of oil is generally used on the fiber.

The best marine cordage, oil-drilling rope, binder twine, trawl line, etc., are made of abacá. Although the chief use of abacá is as a cordage fiber, the conclusion should not be drawn that it is not suitable for other purposes. Abacá is used either in its natural color or dyed in the manufacture of matting, hats, bags, baskets, trays, slippers, belts, lamp shades, cloth, lace, etc. Abacá cloth is a gauzy fabric known as sinaway and is



FIG. 1. VIEW SHOWING GROWN ABACÁ PLANTS IN BLOOM SURROUNDED BY YOUNG SUCKERS

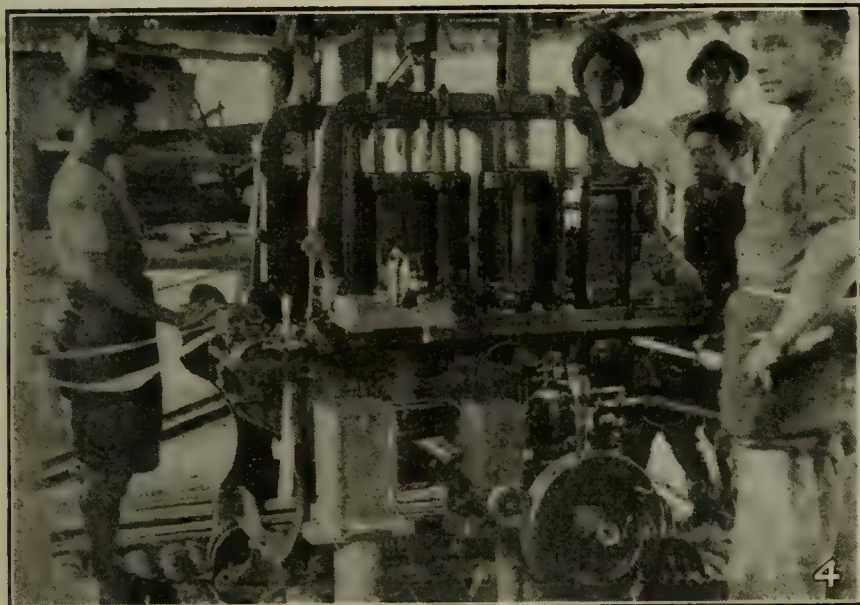


FIG. 2. SEPARATING THE LAYERS OF PETIOLES
FIG. 4. BEHRENDT ABACÁ STRIPPING MACHINE
IN OPERATION
FIG. 6. DELIVERING HEMP TO WAREHOUSE

FIG. 3. STRIPPING FIBER FROM STALKS
FIG. 5. DRYING AND CURING THE ABACÁ FIBER
FIG. 7. PRODUCTS MADE OF ABACÁ, INCLUDING
ROPE, HEMP, ETC.

much used by Filipino women for camisas (waists). Sometimes cotton or silk is woven with the abacá to make exceptionally beautiful fabrics.

COMMERCIAL CENTERS

The exportation of knotted abacá is an important industry in Cavite, Batangas, the Bicol and certain other provinces. There are also factories in Manila for manufacturing the tied abacá fiber into braid of various widths. The braid as well as knotted abacá is exported to Europe and Japan for the manufacture of ladies' hats, which are made by sewing strands of braid together. Abacá hats are also manufactured in the Philippine Islands.

There are many different varieties of abacá, frequently a dozen or more in a single locality. The principal differences between them are in color and shape of stem, color and size of leaves, greater or less tendency to produce suckers, resistance to drought, and in development, strength, delicateness and quantity of fiber. It is desirable to secure an abacá plant which is hardy, grows rapidly and withstands drought, which has a long, thick and not too tapering stalk, and which produces fiber in abundant quantity, of good quality and easily extracted.¹

The abacá plant is peculiar in that it cannot be grown

¹From Philippine Bureau of Agriculture Bulletin 12, p. 11.

elsewhere than in the Philippine Islands. Experimental plantings have been made in Borneo, India, the West Indies and other parts of the world. In some instances the plants grew fairly well, but the fiber was inferior. Abacá requires a uniform warmth without excessive heat for its best development. A cold climate will retard not only its growth but the development of the fiber as well. Heavy winds have to be avoided, for they seriously injure the heavy, broad leaves. Only in the Philippine Islands has the fiber ever been successfully produced as an article of commerce. This fact undoubtedly has been of great benefit to the Philippine planter. However, the lack of competition has resulted in the continuance of antiquated methods of cultivation and fiber extraction. There are still many differences in agricultural practices in the various provinces. With keener competition the best methods used by any province would be extended to every other district possessing the same soil characteristics.

DEMAND EXCEEDS SUPPLY

Even in ordinary times the abacá supply is insufficient and is constantly exceeded by the demand. Since the outbreak of the World War there has been an unusual shortage of abacá fiber and naturally the use of other fibers has been extended. There also has been an inclination on the part of some to use cheaper fibers wherever possible in manufactured products and to market them as abacá. Frequently Philippine maguey and other structural fibers are cheaper than abacá and are used as diluents in abacá rope and similar materials. It is impossible accurately to differentiate microscopically between maguey and abacá, and the small abacá fibers are smaller than large maguey fibers. Color tests to distinguish between abacá and other fibers have been developed by the Bureau of Science. A satisfactory method of staining has been devised which gives distinctive colors, such as golden yellow for abacá and pink for maguey.

Abacá is not grown generally throughout all the Philippine Archipelago, though it is distributed throughout the greater part, and its commercial cultivation is restricted to certain favorable districts where there are deep, mellow, fertile, well-drained soils, freedom from winds, a high humidity and an abundant rainfall uniformly distributed throughout the year, where it attains its highest development. Such natural agencies as temperature, amount of light and sunshine, winds and the evaporation of the soil moisture, exposure, altitude, humidity, the amount and distribution of the rainfall and other climatic and physical conditions exert an influence either favorable or unfavorable and are of as great importance in the production and quality of abacá as the inherent characteristics of the soil itself.

CONDITIONS REQUIRED FOR GROWTH

The structure of all banana plants and their habits of growth are such that a large and constant supply of moisture is required. The humidity which regulates plant transpiration is only second in importance to rainfall. In districts having a long and definitely defined dry season the cultivation of abacá cannot be carried on successfully unless a ground water table at an even depth or a practically constant available water supply in the soil can be maintained by irrigation.

In a paper entitled "Philippine Soils and Some of the Factors Which Influence Them," I pointed out that not

only is a rainfall well distributed throughout the year a condition absolutely essential to the success of certain crops such as abacá, coconuts, tobacco and rubber, but this distribution also controls the prevalence of certain species of plants of the native vegetation. A map upon which was charted the provinces with 5 per cent or more of total cultivated area in abacá, coconuts and tobacco differentiated the Philippine Archipelago into the western region having a prolonged dry season and the eastern and southern having a rainfall well distributed throughout the year about as accurately as one in which these two different types were plotted immediately from meteorological records. Some variation is noted in the eastern part of the islands due to the topography of the regions, but there is sufficient rainfall during even the driest months so as not seriously to interfere with abacá or other stable crop dependent on continuous rainfall.

1,000 ACRES UNDER PRODUCTION

Abacá may be cultivated up to 3,000 or 4,000 ft. above sea level, but above this height the temperature is not favorable to its best development. The most favorable locations are along the eastern and southern coasts. The most important provinces, sub-provinces and islands in order of the importance of their production are as follows: Leyte, Albay, Sorsogon, Ambos Camarines, Samar, Davao, Misamis, Surigao, Oriental Negros, Cavite, Zamboanaga, Cebu, Laguna, Tayabas, Mindoro, Capiz, Agusan, Bohol, Romblon, Occidental Negros, Panay, Batangas, Antique, Lanao, Palawan and Cotabato. It is grown to some extent in other provinces of Luzon and on many of the smaller islands. The amount of land under cultivation for the growing of abacá has been estimated at about 1,000,000 acres. It is quite difficult to get an accurate estimate, because the plant often is grown on small and widely scattered areas in remote places.

LITTLE CULTIVATING REQUIRED

In the best plantations there are usually about four hundred to five hundred plants to the acre, but the exact number varies with the character of the soil and the variety of abacá grown. Frequently camotes (native sweet potatoes) are set out at the same time or other crops are planted which grow rapidly. This system is advantageous in that the growth of weeds is prevented and the loose soil is not washed away where the land is sloping. Where the soil and other conditions are favorable, abacá may very profitably be grown on the same ground with coconuts until the latter come into bearing. Under the present system little cultivating is done except to keep the land clear of grass and weeds. As the abacá matures it shades the ground and the grass and weeds are much less.

TYPICAL ANALYSIS OF SOIL

The use of commercial fertilizers has thus far not been extensively practiced. The abacá lands as a class are very fertile and probably will not have to be fertilized for a long time to come. An analysis of soil from one plantation in the Cotabato Valley taken for purposes of illustration is as follows:

Constituent	Per Cent
Moisture (H ₂ O).....	7.39
Loss on ignition.....	13.20
Nitrogen (N).....	0.276
Phosphoric anhydride (P ₂ O ₅).....	0.201
Lime (CaO).....	0.31
Potash (K ₂ O).....	0.27

^aPhilippine Journal of Science, Section A (1911), vol. 6, No. 4.

The enemies of abacá, such as insect pests and plant diseases, are very few and the total damage which the plants suffer from such causes is very little and in the aggregate entirely negligible.

YIELD OF FIBER

The yield of fiber varies greatly depending upon the variety grown, the soil, climatic conditions, efficiency of the method of extracting the fiber, etc., but usually from ½ to 1 lb. of fiber per stalk may be obtained. Under ordinary conditions the annual yield will average about one-half ton of dry fiber per acre. The figures given at the outset of this paper for the first six months of 1920 show the export product to have an average value in Manila of 11½c. per lb. Therefore at the present time the annual gross return from an acre of land planted to abacá may be estimated at \$115.

The probable cost of establishing an abacá plantation, including rental, clearing, cultivating, etc., and bringing to maturity, will be about \$60 per acre, and the annual cost of subsequent care may be placed at one-tenth of this amount. Stripping is sometimes done on a share basis, but in any event the cost of harvesting, stripping and marketing the product should not exceed \$50 per acre. Therefore the first full crop should eliminate the debit balance and in subsequent years the net return should be at least \$50 per acre per annum.

The utilization of waste products will still further increase the revenue. It is believed that by the present methods of extracting the abacá fiber at least 25 per cent of it is wasted. For several years the Bureau of Science has been investigating the suitability of various materials for the making of paper pulp. Paper pulp manufactured from abacá waste was strong and of superior quality. It should be possible to utilize all of the abacá waste commercially for the manufacture of paper and such utilization should be a great benefit not only to the planters but also to the paper manufacturers.

The cultivation of abacá in the Philippines unquestionably is a most profitable branch of tropical agriculture and the opportunities for its extension are very promising. Prices seem to be fairly assured for some time to come and the planter who selects good land and modern methods of cultivation, fiber extraction and management should produce superior fiber at a minimum cost and have a handsome income assured.

Present Condition of Graphite Production in Madagascar

The French Ministry of the Colonies has just furnished the office of the Commercial Attaché at Paris information on the present production of graphite in Madagascar.

It is stated business conditions were so unfavorable during 1920 that no new producing districts were opened, no new company for the exploitation of graphite formed, and operations at a number of the old deposits ceased. This is explained by the fact that adverse conditions have recently necessitated selling graphite at a loss. Resumption of operations at the old beds is dependent only upon more favorable conditions, and new deposits will doubtless be discovered as soon as there is some incentive to greater production.

Previous decline in business is shown by the following figures covering exportation in metric tons (metric ton = 2,204 lb.) of graphite from Madagascar: 1917, 27,838; 1918, 15,015; 1919, 4,056.

Nitrogen and Case-Hardening

BY HENRY FAY

THAT nitrogen plays a more important rôle in steel than is generally supposed is evidenced by the increasing number of articles appearing in the journals on this subject; that it plays an important rôle in case-hardening operations is shown in the work of Brophy and Leiter which appeared in the Sept. 22, 1920, number of this journal and from some work which has been in progress in this laboratory during the past several years. This work is not in a state of completion and it is the purpose of this note merely to mention a few of the more important results already obtained.

The writer has long had a suspicion that the case-hardening produced by cyanide was partly a nitrogenizing process, and this was confirmed qualitatively about four years ago. The methods of analysis for nitrogen were so crude that it was thought desirable first to investigate the methods that had already been used for this determination. Dr. Frederick Hurum has investigated the various methods and he has demonstrated that the method of Grabe and Petré, with modifications as to apparatus, is the most trustworthy. Very accurate results can be obtained by this method. Whether or not the method is capable of determining all of the nitrogen is still an open question which is now under investigation, but it is quite certain that it is capable of giving all of the nitride nitrogen.

As an example of the nitrogenizing process which takes place when a steel is heated in cyanide, I shall quote the following results from Dr. Hurum's thesis. A round bar of low-carbon steel was heated in a cyanide bath for ten minutes at 830 deg. C. and allowed to cool in the air. Successive layers $\frac{1}{800}$ inch in thickness were turned from this bar and analyzed for carbon and nitrogen, with the following results:

Thickness of concentric layers in succession from outside toward interior, in.....	1	2	3	4
	$\frac{1}{800}$	$\frac{1}{800}$	$\frac{1}{800}$	$\frac{1}{800}$
Carbon, per cent.....	0.16	0.30	0.06	0.15
Nitrogen, per cent.....	0.57	0.201	0.155	0.027

It will be seen that the outside layer contains 0.57 per cent of nitrogen, which is indeed surprising when it is considered that this sample was treated for only ten minutes. The nitrogen progressively diminishes toward the center of the bar, but apparently penetrates at a slightly greater rate than carbon.

C. B. Sawyer in another thesis has made an experiment along the same line designed to compare the observed increase in weight of thin sheet iron when heated in cyanide with the increase of weight as calculated from the results of an analysis for carbon and nitrogen. The original analysis of the sheet iron showed 0.05 per cent carbon and 0.005 per cent nitrogen. Four pieces of this sheet iron, about 5 g. each, were cleaned, dried and weighed, then heated in sodium cyanide at 830 deg. C. for two hours, quenched in water, then washed, dried and weighed. The average increase in weight was 2.42 per cent. The analysis of a mixed sample from the four pieces shows 1.63 per cent carbon and 0.726 per cent nitrogen. The percentage increase in weight accounted for by the carbon-nitrogen analysis amounts to 97.6 per cent. This result seems to show conclusively that the reaction is essentially a carbonizing and nitrogenizing process.

Other processes for case-hardening than the cyanide method are also capable of introducing nitrogen into steel. A low-carbon nickel steel was case-hardened by Dr. Hurum in one of the best commercial bone-charcoal mixtures and from this bar successive layers were turned off and analyzed for carbon and nitrogen with the following results:

Thickness of successive layers, in.	1 $\frac{1}{100}$	2 $\frac{1}{100}$	3 $\frac{1}{100}$	4 $\frac{1}{100}$	5 $\frac{1}{100}$
Carbon, per cent.	0.61	0.48	0.22	0.19	0.14
Nitrogen, per cent.	0.031	0.025	0.019	0.0106	0.0037

The source of the nitrogen in this case is undoubtedly the ammonia from the raw bone, but the nitrogen in the air may also be involved to some extent.

Another striking illustration of the nitrogenizing process is shown in some specimens treated by Dr. Shimer's cyanamide process. The results obtained are the following results:

Number	Time in Cyanamide Bath, Hours	Temperature, Deg. C.	Carbon, Per Cent	Nitrogen, Per Cent
0	Original		0.050	0.0049
1	2	650	0.440	0.505
2	2	750	1.082	0.579
3	2	800	0.835	0.187
4	1½	900	1.293	0.123

Several important facts are brought out by this experiment:

1. Diffusion of carbon takes place below A_{c1} —viz., at 650 deg.
2. Nitrogen combines with iron and also diffuses below A_{c1} .
3. The nitrogen content decreases with the rise of temperature, indicating that equilibrium is reached at some lower temperature.

In the experiment carried on at 800 deg. C. the carbon content and possibly also the nitrogen content is low due to the cyanamide bath becoming exhausted. Cyanamide has been replenished in the experiment at 900 deg. C. and the results at that temperature are accurate.

That the absorption of nitrogen in case-hardening operations is a general process seems to be fairly well established. Further evidence bearing on this point is shown by the fact that practically all successful case-hardening mediums are either highly nitrogenous, containing bone, leather, cyanides, ferrocyanides, etc., or are so designed as to be capable of absorbing atmospheric nitrogen. Such mediums as the latter always contain an alkali of some nature. Of course the methods involving the use of carbon monoxide or a hydrocarbon are exceptions to this statement.

In an article, "On the Conduct of Finely Divided Iron Toward Nitrogen," Remsen has shown that "when iron . . . and certain nitrogenous organic substances are heated together with metallic sodium in an atmosphere of nitrogen a cyanide is readily formed." Bucher has used this reaction, substituting sodium carbonate for metallic sodium, as the basis of his process for manufacturing sodium cyanide. This reaction is undoubtedly a general one whenever iron, an alkali and air, or nitrogen, are heated together. There is a formation of cyanide, and the cyanide in turn reacts with iron, forming carbide and nitride, which diffuse into the steel, the depth

of penetration being dependent upon temperature and time. It is a well-known fact that iron in contact with pure wood charcoal is capable of being case-hardened only weakly, but if an alkali is added to this mixture the process is much accelerated, due undoubtedly to the formation of cyanide.

Ammonia reacts very readily with iron, forming nitride. Dr. Hurum has shown that the nitride is capable of being held in solid solution and that it acts in this respect similarly to carbon, forming an austenite. By microscopic means he has been able to show that a round bar when treated with ammonia under pressure will show on its outer surface an austenitic structure after quenching. At a short depth the structure is martensitic and further in is found free the familiar iron nitride. After turning off the outer layer the chips have been found to be non-magnetic and to have a much lowered A_{r1} temperature. The nitrogen concentration of the austenitic layer has not been definitely determined, but work is now in progress to this end. The formation of this nitride-austenite offers a probable explanation of the ease and rapidity with which steels are case-hardened in cyanide.

In view of the fact that steel combines so readily and with so much nitrogen, case-hardening can no longer be considered as merely a carbonizing process but must also be considered as a nitrogenizing process. The question of course will be raised as to whether the introduction of nitrogen is harmful. To this it may be answered that the evidence all points to its being beneficial, adding to strength and hardness, up to certain limits. As in the case of carbon, so with nitrogen, when increased beyond certain amounts new effects are produced. When it is definitely learned just how much nitrogen may be held in solid solution new light will be thrown on this subject.

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Prevention of Tarnishing of Polished Metals Under Heat-Treatment

In a process recently invented in Germany, for protecting polished metals which have to undergo annealing, from the tarnishing which occurs under ordinary treatment, a solution of boric oxide is used. The solution is only applied as a very thin film over the articles to be annealed, but it is claimed that it completely excludes atmospheric oxygen. The film melts at a temperature varying between 550 and 650 deg. C., according to its composition, and acts as a protection so long as it remains solid. Steel, for example, remains bright when heated to the melting point of the composition, and no coloration takes place when the steel is tempered. It is stated to be still more effective in the molten or semi-molten condition, as it then forms a perfectly gas-tight cover round the article, even when heated to the highest temperature used in practice. The coating is perfectly fireproof, does not evaporate and dissolves any oxidized matter on the surface of the heated metal. The coating can be applied either as a powder, sprinkled or dusted over the surface of the objects to be annealed, or as a liquid. It is soluble in water and methylated spirit, and the work to be annealed is simply dipped in the solution and allowed to dry. The coating peels off on cooling, or it may be dissolved in warm water.—*The Engineer*, Nov. 26, 1920.

Notes on Monel Metal

A Brief Statement of the Physical Properties of This Natural Alloy, and the Commercial Uses to Which It Has Been Adapted—Its Resistance to Corrosion and Its Strength at High Temperatures Are Perhaps the Most Useful Properties

By PAUL D. MERICA

Superintendent of Research, International Nickel Co.

THIS alloy was introduced by the International Nickel Co. about 1905 and named after its then president, Ambrose Monell. It is a natural alloy produced directly from Canadian bessemer matte by roasting and reducing with charcoal and has the following average composition: nickel, 67 per cent; copper, 28 per cent; other metals (iron, manganese, silicon), 5 per cent.

Several grades of this metal are produced for different purposes of which the following typical analyses are given:

	C	Mn	Fe	Si	S
Rolled Monel metal sheet..	0.11	0.15	1.76	0.18	0.026
Rolled Monel metal rods...	0.26	1.78	2.00	0.20	0.035
Monel metal wire.....	0.12	1.66	2.10	0.13	0.025
Monel metal castings.....	0.18	0.25	1.90	1.06	0.03

It will be noted that the wire is made with low-carbon content in order that it may be readily cold-drawn, whereas hot-rolled rods are produced with somewhat more carbon in order to increase the ease of hot-rolling.

The practice in producing castings and malleable ingots of this alloy follows very closely that in the

from 1,040 to 1,100 deg. C., using the same precautions as in the case of nickel against oxidation and absorption of sulphur during heating. Rods are produced by hot-rolling or forging; from these, bright, cold-drawn rods are also produced by close-annealing and cold-drawing. Wire is drawn from hot-rolled, close-annealed wire rod about $\frac{1}{4}$ to $\frac{3}{8}$ in. in diameter. Annealing of hot-rolled Monel metal preparatory to cold-rolling or drawing is carried out at about 900 deg. C., preferably in charcoal boxes to prevent scaling. Light scaling, however, may be removed by pickling with sulphuric acid and ferric sulphate as in the case of nickel, but it is a slow and rather unsatisfactory process.

Monel metal is on the market in the usual commercial forms, sheet, bars, wire and various special manufactured forms such as wire cloth, screens, nails, chain, bolts, nuts, golf club heads, and in the form also of castings.²

METALLOGRAPHY

The elements entering into the composition of Monel metal form a continuous series of solid solutions with each other, consequently the structure of the annealed



FIGS. 1 TO 3

Fig. 1. Rolled Monel metal rod. $\times 100$

Fig. 2. Typical structure of cold-drawn Monel metal rod. $\times 150$

Fig. 3. Dendritic structure of cast Monel metal. $\times 100$

production of malleable nickel and nickel castings which has already been described.¹ After bringing to pitch in the furnace—i.e., adjusting the carbon and oxide content—it is deoxidized with manganese, or ferromanganese, and magnesium, the latter being used in the same proportions as for nickel, and poured into ingot molds or sand castings. Unless so deoxidized it is, generally speaking, not malleable and cannot be rolled or forged.

The ingots so produced may be rolled or forged at

or rolled metal is quite simple and similar to that of nickel, consisting of grains of solid solution with small particles of the oxides (?) of magnesium and manganese. This is illustrated in Fig. 1; the typical structure of cold-drawn rods is illustrated in Fig. 2. The structure of cast Monel metal is, however, quite different from that of cast nickel and is that characteristic of solid solutions—i.e., the cored or dendritic structure illustrated in Fig. 3. The darker portions are richer in copper than the light areas, due to the selec-

¹Published by permission of the Director, Bureau of Standards.
²CHEM. & MET. ENG., vol. 24, p. 18.

²Booklets by the Monel Metal Products Co. and the International Nickel Co. describe the properties and uses of this alloy.

tive method of solidification. This heterogeneity of concentration is relieved by annealing and by the processes incident to hot forging or rolling.

Monel metal may be etched with satisfactory results by the use of the 50 per cent nitric acid solution containing 25 per cent of glacial acetic acid. It is also attacked by ferric chloride solutions, and such solutions are also suitable for metallographic etching; a solution containing 1 g. FeCl₃ to 2 c.c. concentrated HCl diluted to 2 or 3 volumes with water is recommended.

Monel metal exhibits the same phenomenon as does nickel of intercrystalline brittleness produced by exposure at rolling temperature to the action of oxidizing or sulphurizing gases.³

USES AND APPLICATIONS

The principal properties of this metal which render it of commercial value are perhaps the following: Resistance to corrosion, the bright nickel finish which it takes and retains, its strength and hardness particularly at high temperatures, and its resistance to erosion by water and steam.

Monel metal resists excellently the action of ammonia, solutions of ammonium hydroxide, fused and dissolved caustic alkalis and carbonates, fatty and many other organic acids, sea water, solutions of neutral salts such as alum, sulphates, chlorides, etc., gasoline and mineral oils generally, phenol and cresols, photographic chemicals, urine, dry mercury, dyeing solutions, alcoholic and other beverages. It resists fairly well the action of sulphuric, weak phosphoric, hydrocyanic acids, hydrofluoric, acetic and citric acid, ferrous sulphate and dry chlorine. It is not resistant to the action of hydrochloric and nitric acids, molten lead and zinc, potassium cyanide fused or in solution, sulphurous acid, ferric chloride and chromic acid.

Monel metal sheet showed the following losses in weight upon exposure to the action of boiling acetic acid for eight hours:

	Mg.
Loss in wt. per sq.in. per hour in 10% acid.....	0.07
Loss in wt. per sq.in. per hour in 26% acid.....	0.08
Loss in wt. per sq.in. per hour in 56% acid.....	0.11
Loss in wt. per sq.in. per hour in 90% acid.....	0.12

It lost 0.078 mg. per sq.in. per day during eight months' exposure to cold glacial acetic acid.

Because of its relative incorrodibility it has been used to some extent for roofing materials. The roof of the Pennsylvania Terminal in New York City is covered with Monel metal sheet, selected because of its superiority over other roofing materials demonstrated during a ten-year test. It is also used for window screens for the same reasons.

Both rods and castings are used to a large extent in the manufacture of pumps, pump liners, rods, valves,

etc., for handling sea water, mine waters and acid and alkaline corrosive solutions generally. One of the principal applications of the metal is in the construction of tanks and crates for pickling steel; rods are used for this purpose and have apparently proved superior to any other material. In this connection the results of corrosion tests of Monel metal rod in pickling acid are of interest. Rods exposed for ninety days to the action of continually renewed 6 deg. Bé. (6 to 7 per cent) sulphuric acid at 74 deg. C. lost weight at the average rate of 0.0045 g. per sq.in. per day, corresponding to the removal of a layer 0.00003 in. thick per day; the removal of a 0.1-in. layer would therefore require about ten years. In fact Monel metal pickle-pins and pickle-rods have been removed from service after eight years and were found to show practically no evidence of corrosion. Their average life is perhaps three years. On account of its resistance to corrosion the metal is also used in the construction of mining machinery, mine screens, dyeing machinery and equipment and in the chemical and oil industries for miscellaneous parts exposed to severely corrosive conditions.

Monel metal takes and retains a finish almost identical with that of pure nickel and is for this reason much used for small fittings, trimmings and stampings, for golf-club heads and for table cutlery. This property in conjunction with its resistance to corrosion by substances used in preparation of foods and in washing have made it valuable for the construction of certain cooking utensils and for washing tanks, cream separator machinery, etc.

The resistance of the alloy to steam erosion and its strength at high temperatures, which seems to be higher than that of the steels or bronzes, have caused its extensive application in the production of steam pressure valves and steam turbine blading. For these purposes it is well suited by further reason of the fact that its thermal expansivity is approximately equal to that of steel, with which it is usually associated in such construction.

Marine propellers have been cast of Monel metal. In connection with its quite widespread use in naval construction it may be recalled that the steam yacht Sea-Call was covered with Monel sheathing, in this particular case unsuccessfully, for the reason that the galvanic action between it and the exposed steel parts of the hull caused accelerated corrosion of the latter.

Monel metal is remarkably resistant to oxidation even at high temperatures (750 deg. C.) and is used for electrical resistance and spark-plug wire and other parts exposed to high temperatures. Monel metal is made up into screens of various types, into filter cloth for corrosive liquids, and into screw machine products of all kinds.

The physical properties of this alloy are described by the International Nickel Co.² Its melting point is about

TABLE I. TENSILE PROPERTIES OF MONEL METAL.

Material	Average Tensile Properties			Average Range of Tensile Properties			Reduction of Area, per Cent
	Yield Point, Lb./Sq.In.	Tensile Strength, Lb./Sq.In.	Elongation in 2 In., per Cent	Yield Point, Lb./Sq.In.	Tensile Strength, Lb./Sq.In.	Elongation in 2 In., per Cent	
Hot-rolled rods:							
Up to 1-in. in diameter.....	63,100	94,600	40				
1 1/8 to 1 1/2.....	62,000	93,000	39				
1 1/2 to 2.....	50,100	87,700	42	50 to 75,000	85 to 110,000	28 to 55	45 to 65
2 1/2 to 3.....	43,800	85,300	44				
Over 3.....	47,300	84,800	43				
Castings.....	37,100	72,300	34	32.5 to 44,000	65 to 85,000	25 to 45	
Annealed sheet.....					60 to 75,000	30 to 40	
Cold-drawn rods.....					87 to 96,000	30 to 40	50 to 65
Wire { Annealed.....					60 to 75,000		
Hard drawn.....					110 to 150,000		

³CHEM. & MET. ENG., vol. 24, p. 198.

1,360 deg. C., its density in the rolled condition, 8.97 (0.323 lb. per cu.in.). The mean coefficient of thermal expansion between 20 and 100 deg. C. is 0.000015.

Its electrical resistivity in the form of wire is 42.5 microhm per cm. (256 ohm-mil per foot), temperature coefficient of resistivity 0.0019 per degree C. The thermal conductivity of Monel metal is one-fifteenth that of copper, or about 0.25 $\frac{\text{watt-second}}{\text{cm.-second-deg. C.}}$. The optical reflec-

tivity of Monel metal is not markedly different from that of nickel; values are given in a previous article.⁴

Monel metal is slightly magnetic and its permeability varies markedly with composition and mechanical and heat-treatment. An annealed rod containing 66.1 per cent nickel, 28.8 per cent copper, 2.68 per cent iron, 1.91 per cent manganese, 0.22 per cent carbon and 0.29 per cent silicon gave the following values of magnetic induction:

Magnetizing Force-Gausses	Magnetic Induction-Gausses
1	413
2	699
4	989
10	1,203
20	1,244
50	1,282
75	1,300
100	1,317
150	1,346

With varying treatment, values of the magnetic induction for a magnetizing force of 50 gaussses may be obtained varying from 500 to 2,000.

The modulus of elasticity (Young's modulus) is 22 to 23,000,000 lb. per sq.in.

Hardness varies with the form and condition of the metal, as may be seen from the following table:

	Scleroscope Hardness, Universal Hammer	Brinell Hardness 10-mm. Ball 500 Kg. 3,000 Kg.
Hot-rolled rods.....	20 to 30	100 to 130 145 to 170
Cold-drawn rods.....		150 to 170 180 to 200
Cast Monel metal.....	20 to 25	90 to 100
Monel metal sheet.....		
Annealed Monel metal.....	15 to 20	80 to 100

The tensile properties of Monel metal also vary largely with the composition, conditions and size of the rod; values are given in Table I. The proportional limit of hot-rolled rods averages from 30,000 to 45,000 lb. per sq.in., that for castings from 15,000 to 25,000 lb. per sq.in.⁵

⁴CHEM. & MET. ENG., vol. 24, p. 75.
⁵Specifications are issued by the U. S. Navy Department for this alloy in its different forms and from which further information may be obtained of its tensile properties.

TABLE II. TENSILE PROPERTIES OF MONEL METAL AND 30 PER CENT NICKEL STEEL AT HIGHER TEMPERATURES

—Rolled Monel Metal—					—Rolled 30% Nickel Steel—			
Temperature in Deg. C.	Tensile Strength, Lb./Sq. In.	Elastic Limit, Lb./Sq. In.	Elongation, per Cent in 2 In.	Reduction in Area	Tensile Strength, Lb./Sq. In.	Elastic Limit, Lb./Sq. In.	Elongation, per Cent in 2 In.	Reduction in Area
21	104,900	78,350	31.3	61.7	94,498	39,850	51.2	59.8
149	97,400	58,500	29.7	57.8	97,000	37,100	64.1	65.0
233	97,800	58,690	29.7	51.0	84,950	32,250	62.5	65.0
275	96,400	58,400	32.8	59.5	83,000	26,200	59.4	66.8
317	89,600	57,950	32.8	59.5	69,575	25,650	56.3	72.6
399	67,600	42,550	28.1	58.1	45,650	21,100	43.0	59.0
510								
555	47,200	26,800	28.1	60.7	36,350	15,500	37.5	55.7

TABLE III. TORSIONAL PROPERTIES OF MONEL METAL AT HIGHER TEMPERATURES

Material	Temp-erature in Deg. C.	Tor-sional Strength	Elastic Limit	Twist	
$\frac{1}{2}$ -in. rolled Monel metal.....	21	94,610	45,510	12 turns	150°
	196	83,030	33,940	5 turns	0°
	317	72,290	31,300	5 turns	205°
	426	40,610	10,910	6 turns	240°
$1\frac{1}{8}$ -in. rolled Monel metal.....	19	91,990	37,780	11 turns	150°
	196	78,030	36,140	4 turns	320°
	...	54,210	19,800	4 turns	340°
	317	59,591	26,123	4 turns	90°
	426	38,600	10,680	7 turns	50°

The torsional properties of Monel metal hot-rolled rods have the following range of values:

Shearing stress at outermost fiber at proportional limit, 20,000 to 40,000 lb. per sq.in.; yield point, 50,000 to 80,000 lb. per sq.in.; maximum, 75,000 to 95,000 lb. per sq.in.

Direct shearing tests on hot-rolled Monel metal rods carried out in the engineering laboratory of Lehigh University gave the following average results:

Diameter of Test-Bar, In.	Single Shear Max. Stress, Lb./Sq.In.	Double Shear Max. Stress, Lb./Sq.In.
1	55 to 61,000	115 to 127,000
$\frac{3}{4}$	45 to 50,000	90 to 103,000

Compression tests of rods and castings give the following results:

	Rods, Lb./Sq.In.	Castings, Lb./Sq.In.
Proportional limit.....	25,000 to 50,000	15,000 to 25,000
Yield point.....	60,000 to 70,000	20,000 to 30,000

Very few tests have been made of the resistance of Monel metal to the action of alternating stresses, but the indications of a few tests are that the hot-rolled rods about 1 in. in diameter will withstand approximately 10,000,000 complete reversals of stress—i.e., from tension to compression—at 25,000 lb. per sq.in., maximum fiber stress, these tests having been made on a White-Souther machine.

The effect of temperature on the tensile and torsional properties of Monel metal has been studied by Bregowsky and Spring,⁶ whose results are given in Tables II and III.

Arnott⁷ gives the following values which are the average of eighteen tests:

Temp., Deg. C.	Tensile Strength, Lb./Sq.In.	Yield Point, Lb./Sq.In.	Elongation in 2 In., Per Cent	Reduction of Area, Per Cent
20	92,700	47,700	51	69
320	86,200	38,100	48	62
410	75,700	35,600	49.5	63
500	64,300	34,100	45	56
630	36,300	23,300	33	...
700	23,100	17,700	27	36
905	6,300	3,600	27	28

It is evident that Monel metal retains its strength to a remarkable extent at higher temperatures as compared with brasses, bronzes and steel.

Webster⁸ has studied the effect of cold-rolling on the tensile properties of Monel metal and has given the following values:

Material	Tensile Strength, Lb./Sq.In.	Elongation in 4 In.	Reduction of Area
Normalized Monel.....	79,000	26	35
Same after 20% reduction...	102,000	4	22
Same after 40% reduction...	118,000	3	18
Same after 60% reduction...	132,000	2	17

⁶Proc., Int'l Asso. Testing Materials, 1912, Sec. 1, Paper VII.
⁷J. Ind. Metal., vol. 23, p. 545 (1920).
⁸Proc., Int'l Asso. Testing Materials, vol. 7, p. 6 (1912).

A preceding discussion on the effect of impurities on the properties of nickel^o apply with almost equal force to Monel metal. Carbon, as in the case of nickel, hardens the metal and renders it easier to roll and forge hot, but more difficult to roll cold. The separation of graphite begins at a somewhat lower content of carbon than in the case of nickel, in the neighborhood of 0.35 per cent.

Although a long, tough chip is produced in the machining of this metal, it may readily be machined when proper conditions are observed. Tools are required of high-grade, high-speed steel and should be ground with large rake or lip and kept sharp. It may be machined either dry or with lubricant and a good average speed for general work is from 50 to 60 ft. per minute with a $\frac{1}{8}$ -in. cut and $\frac{1}{32}$ -in. feed.

Monel metal may be soldered and brazed in the same manner as iron or steel. It may be acetylene-welded. The welded joint will, however, not be as strong as the original metal and will have little ductility. Ordinary Monel metal wire rod may be used as the welding rod. Acetylene welding of this metal as well as of nickel should be executed with a nearly neutral flame, as the metal is highly sensitive at these temperatures to the presence of oxygen. Welded Monel metal and nickel tubes are being manufactured by the oxy-acetylene process.

British Lubrication-Research Report

The British Department of Scientific and Industrial Research has just made public the final report of the lubricants and lubrication inquiry committee appointed by the advisory council in 1917 "to prepare a memorandum on the field for research, containing an analysis of the problems involved, together with a suggested scheme of research which would be likely to lead to valuable results." The work accomplished may be thus stated in brief:

(a) The compilation of a bibliography of the chemical, physical and engineering aspects of lubricants and lubrication.

(b) The compilation of abstracts of important papers contained in the bibliography, especially in relation to chemical aspects of the subject.

(c) Research work on certain fundamental problems on which knowledge was lacking.

(d) Tests and reports on certain matters brought to the committee's notice by the department.

(e) The preparation of bulletins on cutting lubricants and on solid lubricants.

The work instituted by the committee at the National Physical Laboratory and elsewhere covered.

Tests with Lanchester worm gear.

Effects of pressure on viscosity.

Determination of the physical constants of oily and non-oily liquids.

Further apparatus for testing the effect of pressure on viscosity in an actual bearing.

Deeley's oil-testing apparatus.

Cup-and-ball viscosity tester.

Test of lubricating oils for aircraft purposes.

Experiments on cavitation on oil films.

Experiments on the addition of gelatine to oil emulsions to prevent separation.

Tests on a sample of compounding medium for lubricating oils.

Trials of "Oildag" in aëro engines.

Determination of the frictional coefficient of a shaft bearing, using oil with and without "Oildag."

Proprietary article called "Tonicol."

As to the future the committee recommends that research be carried on under these headings:

1. To isolate and determine the nature of the hydrocarbons in mineral lubricating oils which especially promote the properties of viscosity and "oiliness."

2. To determining the classes of hydrocarbons desirable in lubricants required to work under high pressure and high temperatures, particularly as regards their relative stability under the conditions obtaining in internal combustion engines, steam engines and air compressors.

3. To study the causes and means of preventing the formation of carbonaceous deposits from lubricating oils under the conditions named in (2), with special reference to the nature of the hydrocarbons, sulphur compounds, and resinous constituents of such oils.

4. To study the causes of emulsification in circulating oiling and in splash systems, with special reference to (a) the influence of the sulphur compounds in mineral oils, and (b) the characteristics of oils with non-emulsifying properties.

5. To study the causes of oxidation in circulation oiling systems, also the causes of formation of oxidation products in bearings and on bright metal surfaces.

6. To determine the direction in which the processes of manufacture can be modified so as to lead to the production of lubricating oils of improved types.

SYNTHETIC LUBRICANTS TO MEET SPECIAL REQUIREMENTS

7. To discover new methods of analysis which will enable the chemist, when examining a lubricating oil in the laboratory, besides determining its viscosity, specific gravity, flash point, etc., to determine the constituents of the oil and with the help of the knowledge gained under (1) to (5) to measure its ability to reduce friction and to meet the conditions of speed, load, temperature, and atmosphere in which it is required to work. Much of this information can be ascertained today only by the costly method of trial.

8. To elaborate further methods of producing lubricants synthetically in order to meet special requirements. Dicrosylcarbonate, for example, has been used as a lubricant. Reduced naphthenes, glycerides of naphthenic acids, and cinnamenes have been prepared and shown to have lubricating value. It might be found possible to produce lubricants whose rate of change of viscosity is less and whose freezing point is lower than is the case with existing lubricants.

9. To prepare in a pure state the esters met with in animal and vegetable lubricating oils and determine their relative lubricating values.

ADDITION OF FREE FATTY ACIDS TO MINERAL OILS

10. To investigate the claim that the free fatty acids present in commercial fixed oils are the active constituents which enable these oils to improve the lubricating value of mineral oils, and to investigate further whether the addition of such acids to mineral oils may, in certain circumstances, improve their lubricating value.

11. To investigate the colloidal nature of lubricating oils and its bearing upon lubricating problems.

12. To study the effect of ultra-violet light, sunlight and ozone upon lubricating oils.

13. To investigate the phenomena of dissimilar surfaces (oil and metal) in contact, especially in relation to the property of oiliness.

Conservation of Heat in Power and Heating Systems*

Discussion of 85 Per Cent Magnesia Insulation, Showing Low Depreciation Rate Under Wetting and Drying and High-Temperature Conditions—Chart for Determining the Economical Amount of Insulation—Amounts of Coal, Heat and Money Saved by Insulation

BY EDWARD R. WEIDLEIN†

THERE are two distinct methods of conducting scientific research for industry. Each of them has its advantages and, generally speaking, both are followed in investigational practice. The first is the more obvious. It consists in taking problems which are quite familiar and attacking them with the powerful weapon which science has placed in the hands of its trained workers. This method is capable of very wide application and has afforded most valuable results.

The second method is not nearly so obviously useful, but the history of scientific discovery reveals that it is extremely powerful. It consists in beginning not with a definite problem, but with the systematic application of the different branches of science to the study of a material of economic value, for the purpose of gaining as complete knowledge as possible of the nature and properties of the material. At first sight this procedure may appear to business men to be very indirect, but the experience of some of our most enterprising industrialists and associations of manufacturers shows that in the long run it is more profitable than the obvious and direct method.

If it is conceded that the indirect method of approach is often the better, it must be borne in mind that it is usually the slower. This has been the case in the Mellon Institute's elaborate study of the characteristics of "85 per cent magnesia" as a non-heat-conducting covering for power and heating systems.

The industrial applications of insulating materials may be divided into three main classes—viz.: (1) Boiler plants, steam pipes, and heated surfaces of all descriptions; (2) refrigeration plants and cold storage; and (3) furnace settings. This paper will be confined to a consideration of the conditions encountered in the first-mentioned class, for all the data which have been obtained so far relate to the conservation of heat losses from pipes and boilers.¹

FUEL ECONOMY IMPERATIVE

Heat insulation in all its varied aspects has a great future, since it is of recognized value in reducing working expenses, and specifically it is of very material aid

in effecting fuel economy. It is recognized generally that the losses from bare pipes and boilers are considerable, but the real magnitude of these losses is little appreciated. The fact that the loss from 1,000 sq.ft. of exposed surface at 100 lb. per sq.in. steam pressure represents over 300 tons of coal annually is a sufficient justification for the serious consideration of the subject.

The need for economy is becoming more imperative since the prospect for low-priced fuel in the immediate future does not seem to be very encouraging. Accordingly, there have been introduced improved methods of combustion, resulting in the operation of boilers at higher steam pressures and a general advance in boiler-room efficiency. However, the improved steam production is nullified to a large extent unless improvements are also made in the steam conveyances. Higher boiler pressures necessarily imply higher steam temperatures, and higher temperatures inevitably call for reconsideration of the whole question of insulation. The proper amount of non-heat-conducting material which should be applied to any heated surface will be that at which the cost of an increment of the covering will just balance the savings which will be accomplished by the increment.

GOOD INSULATING MATERIALS

A good heat-insulating material should have low heat conductivity; low specific heat, it being necessary that as little heat as possible should be absorbed by it; low specific gravity, in order to avoid the addition of undue weight and the introduction of undesirable strains in the piping systems; and sufficient mechanical strength to withstand vibration and accidental knocks. Moreover, it should be capable of withstanding the action of water and, preferably, also acids; it should be one which does not crack with alternate heating and cooling and with alternate wetting and drying; it should not disintegrate or decompose at the temperature to which it must be exposed; it must have no corrosive action on the surface to which it is applied; and it must be non-flammable.

Air is a poor conductor of heat. The transmission of heat through air is effected not in a considerable degree by conduction, as in the case of metals, but partly by radiation and largely by convection or by the currents set up by the difference in specific gravity of hot and cold air. This explains, therefore, why a good non-conductor of heat is generally found to be a porous material, or one which has entrapped pockets of air throughout its substance. For the highest insulating efficiency, it should have a uniformly honeycombed structure, and these pockets of air should be sufficiently small to prevent convection currents being set up in them.

The value of "85 per cent magnesia" as a non-heat-conducting material is increased greatly by the inter-

*Read before the American Institute of Chemical Engineers, New Orleans, Dec. 6, 1920.

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¹The data presented in this report represent part of the results obtained during the course of an investigation conducted for the Magnesia Association of America by the Mellon Institute of Industrial Research. The object of the investigation is to determine the true facts regarding the value of "85 per cent magnesia" as a heat-insulating material, and therefore the data are confined to this particular covering, and no effort has been made or will be made to furnish comparisons with other heat-insulating materials.

The researches carried out at the Institute under the supervision of the author have been conducted by the following industrial Fellows: G. F. Gray (1917), Glen D. Bagley (1918), M. S. Mason (1919), T. S. Taylor (1920) and R. H. Heilman (1917-1920), the present incumbent.

The author wishes to express here his appreciation of the accomplishments of these Fellows and his gratefulness to P. Nicholls, of the Franklin Manufacturing Co., Franklin, Pa., for his constantly helpful co-operation during the progress of the investigations.

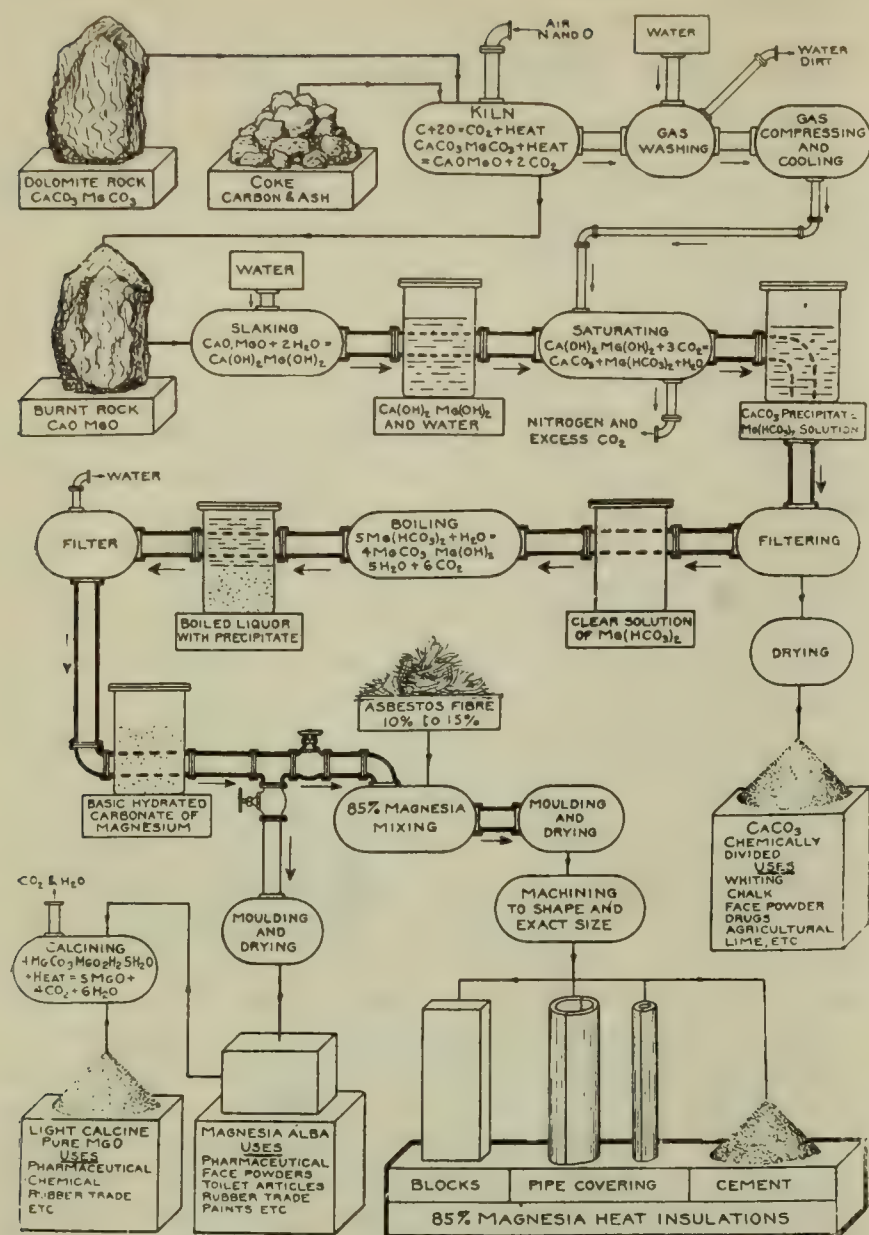
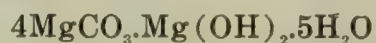


FIG. 1. FLOW SHEET SHOWING THE MANUFACTURE OF "85 PER CENT MAGNESIA"

lacing and felting together of the crystals to produce a block of magnesia containing 90 per cent of voids, which take the form of exceedingly small air pockets.

The name "85 per cent magnesia" denotes the fact that the coverings contain 85 per cent of basic magnesium carbonate, which is usually expressed by the following formula:



The remaining 15 per cent is asbestos, which is introduced as a binder to insure the requisite structural strength and durability. The flow sheet shown in Fig. 1 illustrates the method of manufacturing this product.

Pennsylvania dolomite rocks contain about 43 per cent of magnesium carbonate. The basic carbonate is separated in a pure form by a chemical process and is mixed with 10 to 15 per cent of asbestos fiber, after which the standard shapes and sizes are formed by a molding process. After the drying process, which requires five or six days, the rough-molded sections are planed to true dimensions. The heat insulation value is due largely to the mass of minute air cells formed by the interlocking walls of the crystals. This is also the reason for the extreme lightness of the product and for the ease with which it will absorb nearly three times its own weight of water. The Philip Carey Co., Cincinnati, Ohio; the Ehret Magnesia Manufacturing Co., Valley Forge, Pa.; the Franklin Manufacturing Co., Franklin, Pa., and the Keasbey & Mattison Co., Ambler, Pa., have supported this investigation through the Magnesia Association of America and they represent a total invested capital of \$16,500,000, which indicates the magnitude of this branch of chemical industry.

In a study of the conservation of heat losses, the first important fact to be considered is the actual value of the losses from bare surfaces. It is often considered that the loss from any bare surface is 3 B.t.u. per sq.ft. per hour per deg. F. temperature difference between the surface and the surrounding air. While this value is correct for some special cases, it is by no means generally so.

HEAT LOSSES FROM BARE AND COVERED PIPE

The full curves given in Fig. 2² show heat losses from bare pipes as predicted from Peclet's formula, and the dotted curve and points indicate the experimental results obtained by various investigators. The Peclet values agree closely with the experimental findings and can safely be used. They show that the constant may vary 50 per cent below 3 B.t.u. per sq.ft. per hour per deg. F. to values far above it. At 500 deg. temperature difference, which is often attained with superheated steam, the constant increases to double this value for the smallest size pipe. In some chemical plants steam is used at temperatures of 1,100 deg. F. The importance of using very thick insulation at these temperatures is easily judged from the rate at which the loss increases at 500 deg. F.

The next important point in a consideration of the conservation of heat is the value of the loss after the pipes are insulated. The electrical apparatus used in securing the experimental data is designed to test the material under conditions corresponding to actual practice. Tests have been made on five different makes of magnesia coverings in 1-in., 2-in. and 3-in. thicknesses. The results of the tests are given in Fig. 3. The contrast between the losses from a bare pipe and the losses through the various thicknesses of coverings is very striking. The efficiency increases with the temperature,

²See Bagley, *Trans., Am. Soc. Mech. Eng.*, vol. 40 (1918), pp. 667-94. Bagley presents detailed information regarding methods of tests and results.

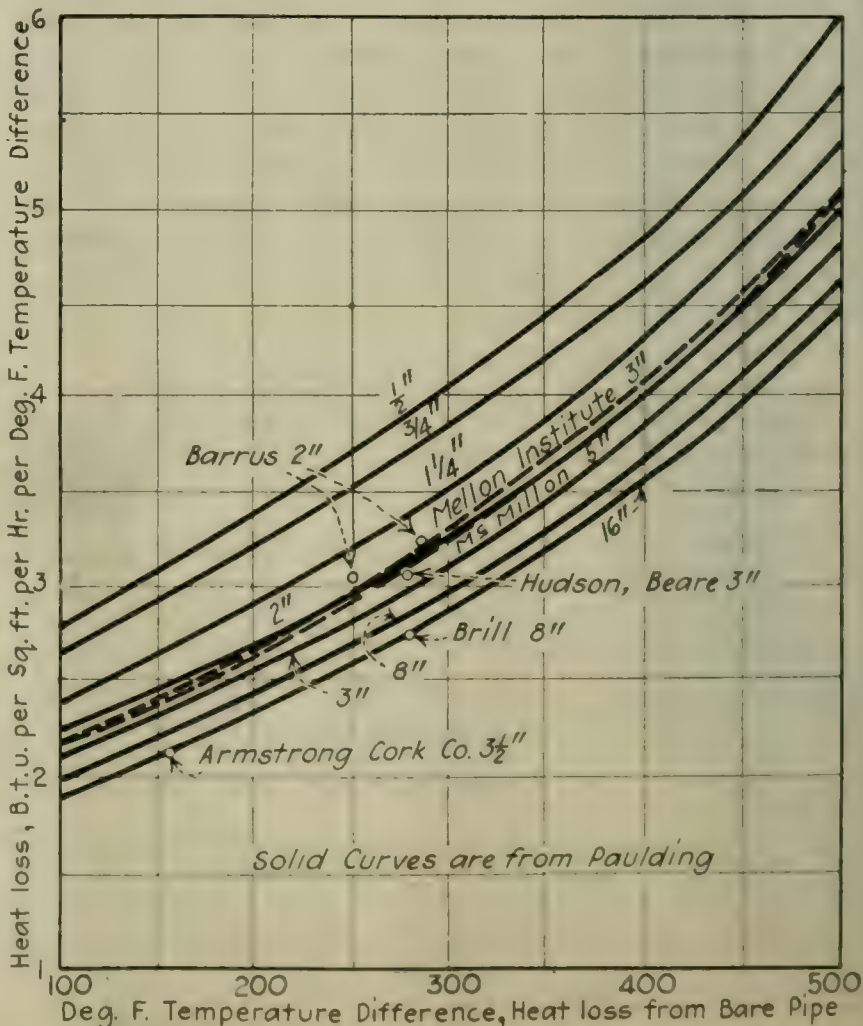


FIG. 2. HEAT LOSSES FROM BARE PIPE

for the loss from bare pipe increases much more rapidly in proportion than the loss from covered pipe.

DEPRECIATION RATE LOW

Pipe coverings may be subjected to wetting from leakage, floods, careless use of the hose, etc. Then, too, the necessity of removing and replacing the covering may arise. These questions, together with many others with regard to the permanency of the insulating qualities, rendered it necessary to conduct a careful investigation in this field, not only of new coverings but of coverings which had been in service for a number of years.

Tests were made to determine the effect of alternately wetting and drying coverings in relation to the change in heat conductivity, the change in mechanical structure and other physical chemical properties, and the possi-

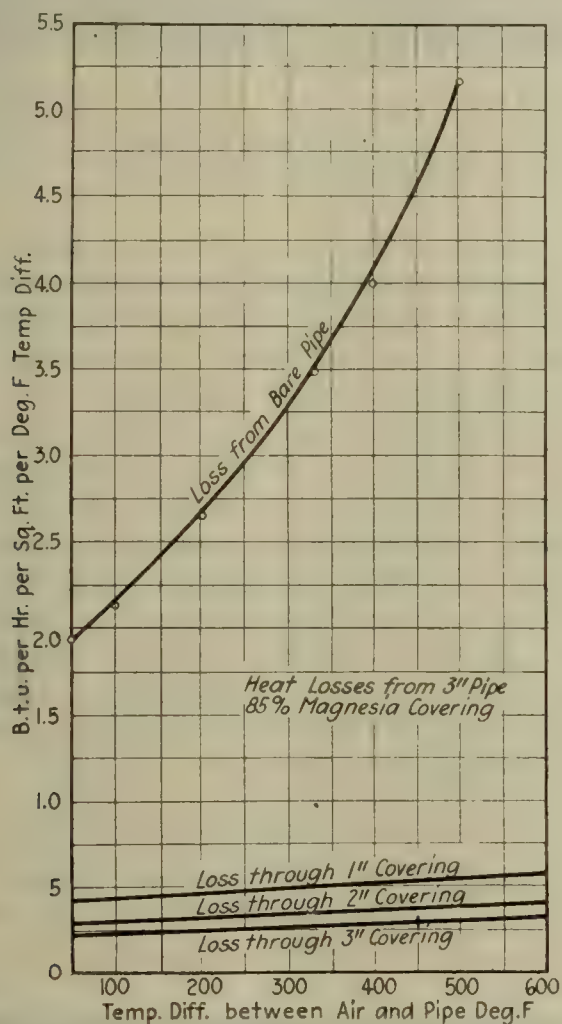


FIG. 3. HEAT LOSSES THROUGH "85 PER CENT MAGNESIA" COVERINGS ON 3-IN. PIPE

bility of removing and reapplying coverings which had been wetted.

The following routine test was made:

1. Inspect, photograph, weigh, measure and apply the sections of pipe covering.
2. Heat the covering forty-eight hours at a pipe temperature slightly above 212 deg. F.
3. Measure the heat conductivity of the covering up to 400 deg. F. (temperature difference from pipe to air).
4. Immerse the covering in water for thirty minutes, then dry the covering on the pipe at a temperature difference not exceeding 400 deg. F. Wet the covering four times, drying it after each wetting. Conduct the fourth drying at pipe temperatures of 212 and 250 deg. F.
5. Measure the heat conductivity up to 400 deg. F. temperature difference from pipe to air.
6. Observe and record the physical effects of the test upon each covering.

The magnesia coverings were successfully removed after each drying, then weighed, soaked, weighed again and reapplied four times. Fig. 4 is a photograph taken

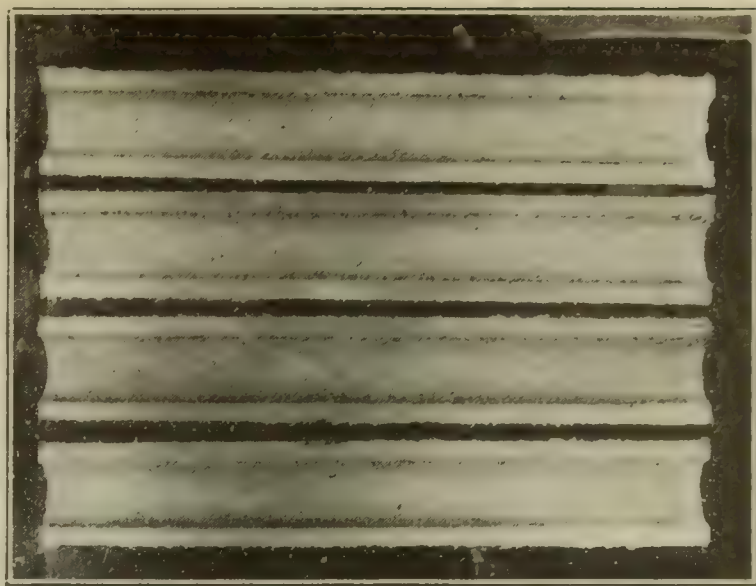


FIG. 4. CONDITION OF "85 PER CENT MAGNESIA" COVERING BEFORE (TOP) AND AFTER (BOTTOM) WETTING AND DRYING TESTS

of the covering before and after the wetting and drying tests. The heat conductivity is shown in Fig. 5 before and after wetting. The insulation value is increased, but in all cases the average shows the same conductivity before and after wetting and drying. The coverings were as strong after the test as before and could readily be reapplied, giving further evidence that they had not deteriorated; "85 per cent magnesia" has a crushing strength of about 100 lb. per cu.in., which is more than sufficient to withstand any of the ordinary strains or proper conditions under which it should be used.

Tests were made on several old magnesia coverings. Fig. 6 shows the conductivity of a 1-in. thick covering which had been in service for eight years at the Armour Glue Works in Chicago. The insulation value was slightly higher than the average of the new 1-in. coverings tested, showing that no deterioration in service had taken place. In the Niagara Power Station, in Buffalo, N. Y., "85 per cent magnesia" has been in service from sixteen to twenty years. A section and blocks were

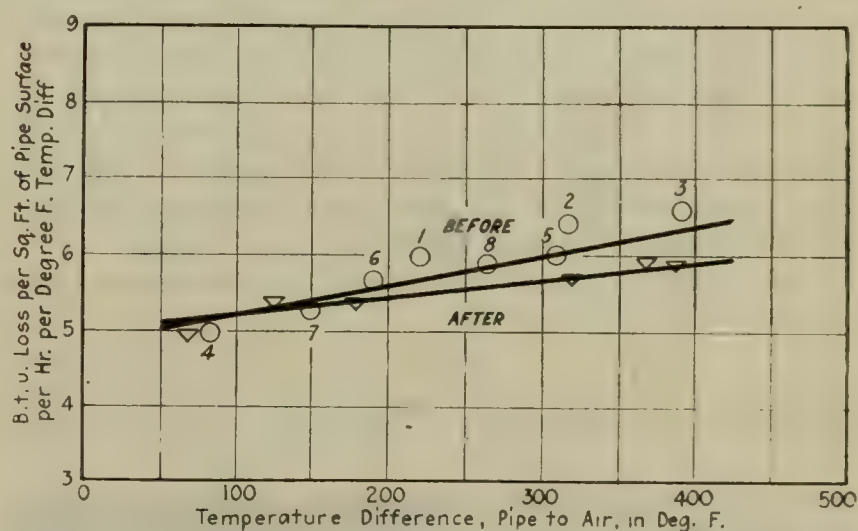


FIG. 5. COMPARISON OF "85 PER CENT MAGNESIA" COVERING BEFORE AND AFTER WETTING AND DRYING TESTS

tested and found to have increased in insulation value approximately 3 per cent. Several sections were obtained which had been saturated with oil. Tests on these showed much lower insulation values than new coverings. The damage was permanent and showed that care should be taken to protect coverings from oil while in service. Figs. 7 and 8 illustrate the conditions to which coverings are sometimes subjected and the value of having a good permanent covering.

Upon inspecting various installations of insulated

steam pipes, it has frequently been noted that the pipe has suffered considerable deterioration. This rusting of the steam pipe has in many cases been explained as being due to the action of the particular covering on the pipe, and not simply to oxidation on account of the pipe and coverings being frequently wetted.

The results of tests conducted in order to determine the probable influence of various factors on the rusting of insulated steam pipes indicate that the pipe coverings, in general, especially if alkaline in composition, do not of themselves promote rusting on steam pipes when they become wet. In fact, they really act as a protecting coating, since the oxygen does not get into intimate contact with the surface of the pipe. However, an electric current flowing through the covering may either promote rusting of the pipe or it may retard corrosion, depending upon the direction in which it is flowing. When the current flows from the pipe to the outside of the covering, this causes the oxygen separated by electrolysis to be liberated at the pipe, thus promoting the

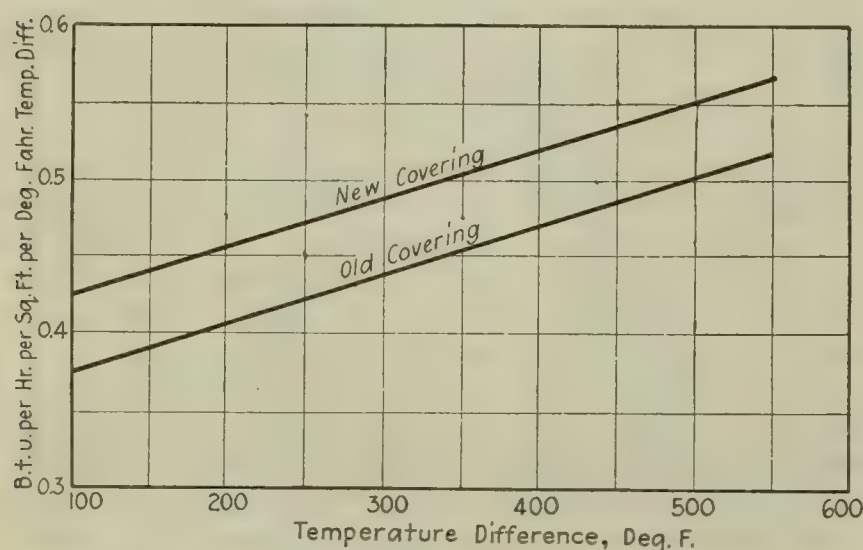


FIG. 6. COMPARISON BETWEEN OLD AND NEW COVERINGS

rusting of the pipe. The greater the current flowing the greater will be the rusting effect, so that if sufficient current were flowing a covered pipe might rust as much as the uncovered. When the current flows from the outside of the covering to the pipe, hydrogen formed by electrolysis is liberated on the pipe, which tends to retard any rusting of the pipe. The action of the electric current would be the same on an uncovered pipe, and the quantity of rust formed no doubt would be in the same proportion as was found in the cases of the exposed and covered pipes.

As the tendency in industry is to use higher temperatures, tests have just recently been completed at a temperature of 800 deg. F. The pipe was maintained

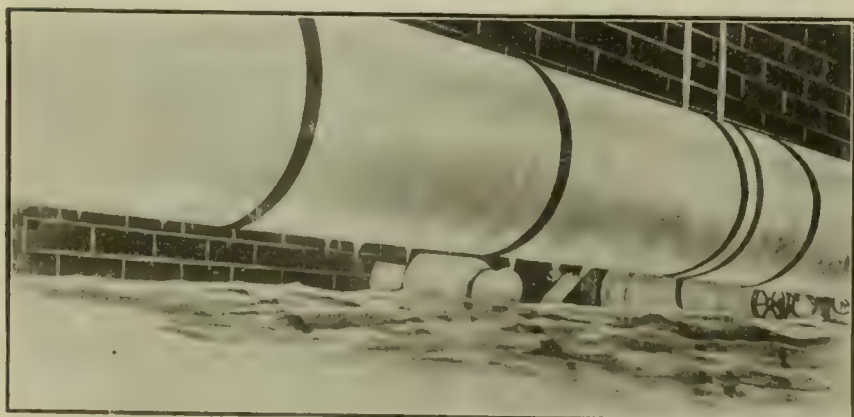


FIG. 7. THIS PIPE, COVERED WITH "85 PER CENT MAGNESIA," WAS SUBMERGED FOR THREE WEEKS BY FLOOD WATER WITHOUT DAMAGE



FIG. 8. EXPANSION JOINT IN 750-FT. 22-IN. PIPE LINE CARRYING STEAM AT 150 LB. "85 PER CENT MAGNESIA" COVERING ON THIS LINE SAVES 1,300 TONS OF COAL ANNUALLY

at a temperature of 800 deg. F. for a period of two months. The covering showed the average conductivity value, and after the test was not only successfully removed from the pipe but was in such a condition that it could have been successfully reapplied.

This agrees with the results obtained under actual working conditions in the plant of the Buffalo General Electric Co., Buffalo, N. Y. This company has in service 10-in., 6-in. and 3-in. steam lines which carry steam 75 per cent of the time at a temperature from 650 to 700 deg. F. with a peak temperature of 800 deg. F. The pipes have been covered with "85 per cent magnesia" for four years, and Fig. 9 shows a section of the covering removed from the 6-in. vertical steam line in perfect condition.

THE ECONOMICAL AMOUNT OF INSULATION

A careful study of the technical and theoretical sides of any problem is essential in order to determine the economic value of the process or product, and so with

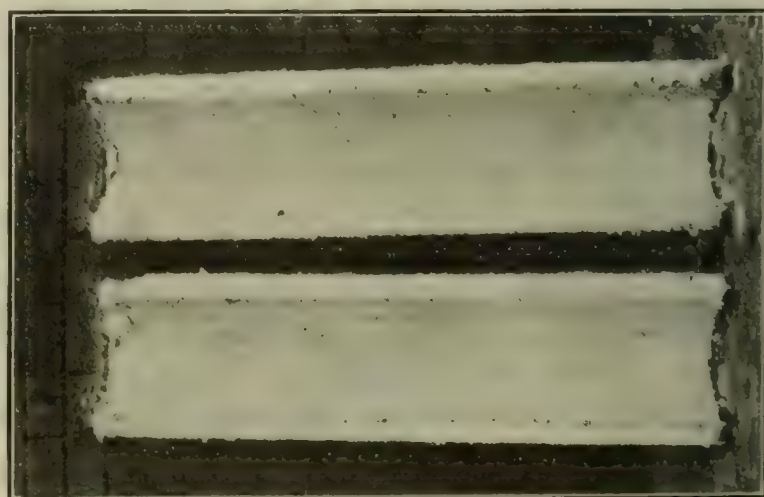


FIG. 9. SECTION IN USE FOUR YEARS AT TEMPERATURES FROM 650 TO 800 DEG. F.

"85 per cent magnesia" covering the result desired is the maximum net saving of money for any given condition. If the covering cost were nothing, the proper thickness would be limited only by the requirements of space available, for each increased thickness would result in some slight increased saving in heat. In a prac-

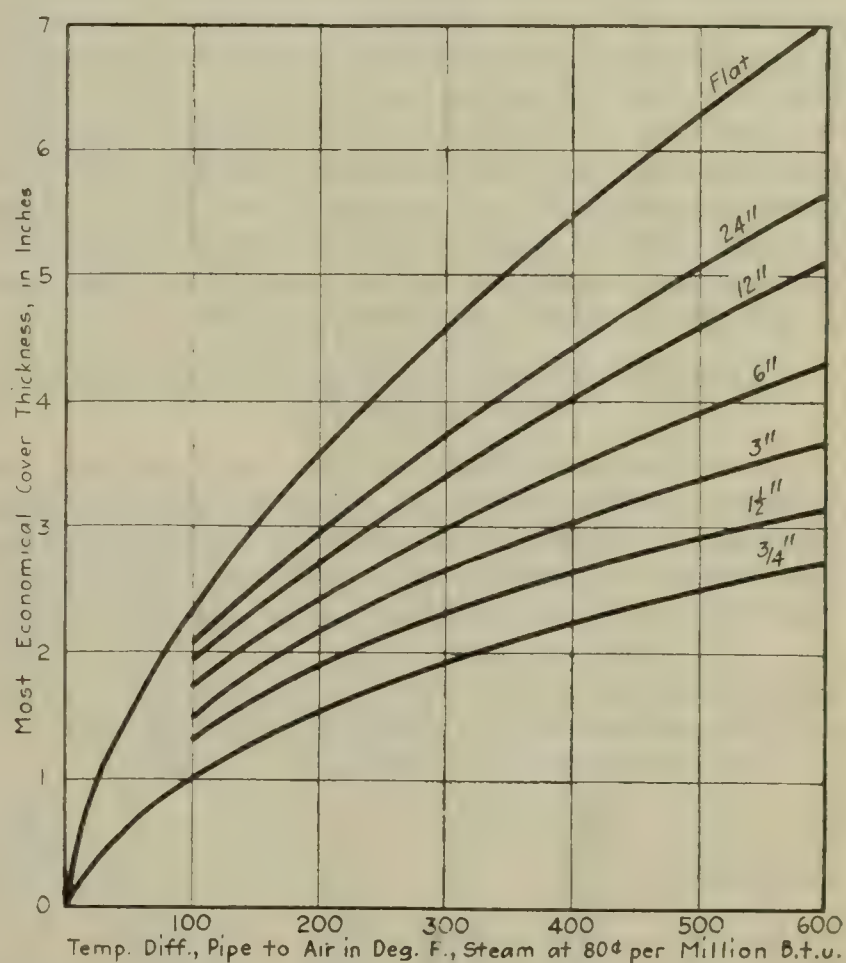
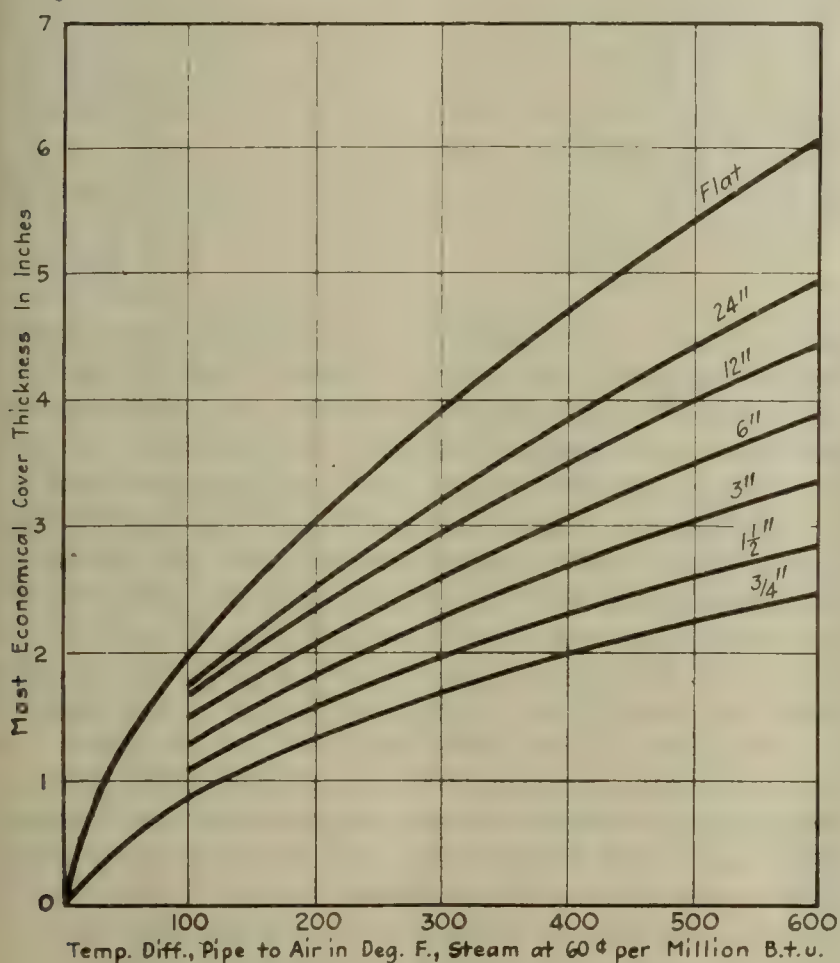
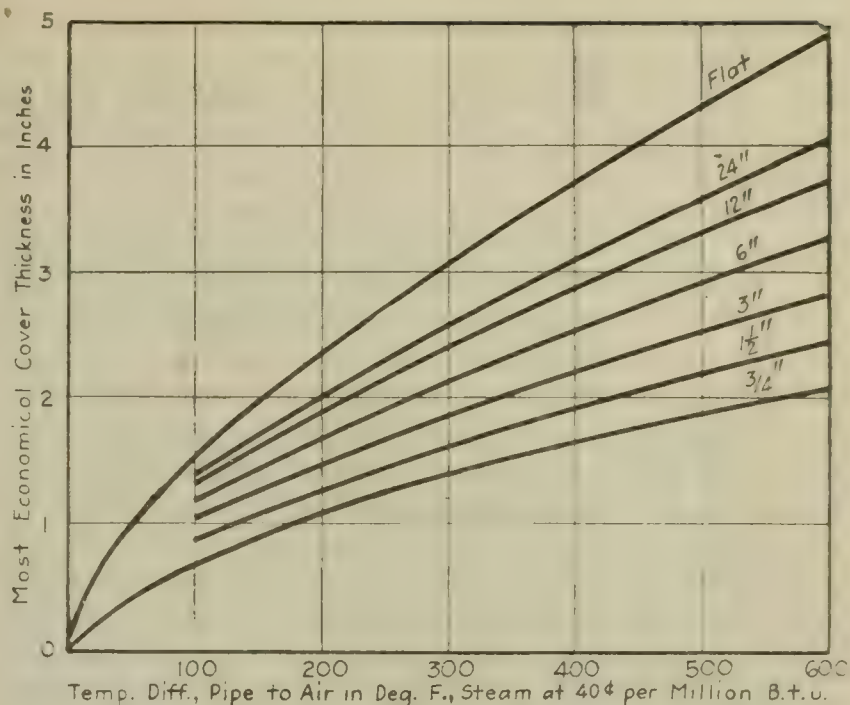
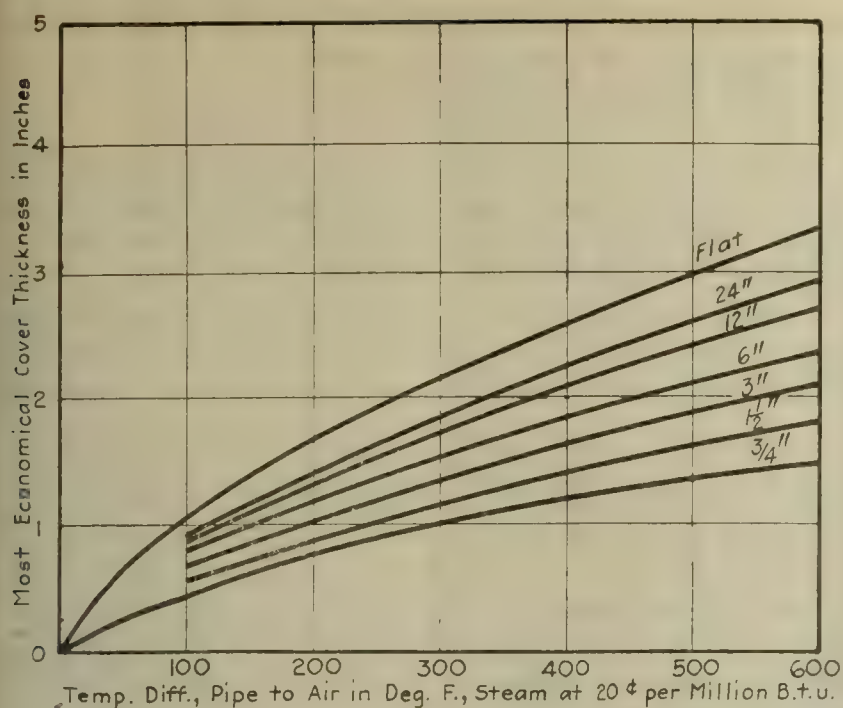


FIG. 10. THICKNESS OF COVERING FOR MAXIMUM NET SAVING WITH STEAM AT 20c., 40c., 60c. AND 80c. PER MILLION B.T.U.

tical case where the covering has a definite cost, a point is reached where the increased cost of the covering will be greater than the additional saving in heat effected. It is this point in which the user of coverings is most interested, for it defines the maximum net saving to be accomplished.

One important factor to take into consideration is the fact that prices of coverings vary with the thickness. For flat surfaces the price is directly proportional to the thickness, starting at 30c. per sq.ft. for coverings 1 in. thick. The difficulties encountered in the manufacture of molded coverings for pipes result in an increased cost per sq.ft. for a 1-in. thickness, and the cost increases much more rapidly with the thickness than in the case of flat surfaces. More material is also required in molded coverings per sq.ft. of pipe surface than in the same thickness in flat blocks on account of the curvature of the surface.

The cost per sq.ft. of surface covered can be determined for any thickness desired. From this cost the annual fixed charges due to the covering can be calculated. After considerable investigation, it has been determined that 20 per cent of the list price of the covering would be a fair allowance for the cost of application, and 13 per cent of the total cost as the annual charges (6 per cent interest, 5 per cent depreciation and 2 per cent insurance and miscellaneous). This fixed charge has been calculated for seven different sizes of pipes and five different thicknesses, based on the manufacturers' list costs of coverings.

The other cost to be charged to the operating expenses of the covering is the value of the heat losses through the different thicknesses of coverings. The previous work done on measuring the loss through a large number of samples of magnesia furnished the necessary data for calculating the loss in heat units.

After the heat loss was determined, it was necessary to convert the loss into dollars and cents. The assumptions used in making this conversion were that 1 lb. of coal as burned will evaporate 7 lb. of water from and at 212 deg. F., and that each pound of steam contains 1,000 B.t.u. above the feed-water temperature. The value of the heat losses was calculated for seven sizes of pipes, five temperature differences between pipe and air, and four different costs of heat, both on the basis of a known cost per million B.t.u. and on a cost per ton of coal and the average conditions of steam generation given here. By making these calculations both ways, the results are applicable to plants where the steam costs are accurately known as well as to those where accurate records are not kept.

By combining the fixed costs and the heat losses per sq.ft. per year, the total operating expenses were obtained. Once these are known, it is simply a matter of selecting that thickness which gives the minimum annual operating expense to obtain the proper covering to use. It is evident that the thickness which gives the minimum operating expense also gives the maximum net saving, as the loss from bare pipe is a constant under given conditions and the net saving is the difference between the operating expense and the loss from bare pipe. The curves in Fig. 10 are for use in plants where heat costs, steam temperatures, etc., are accurately known. They are applicable to all heated surfaces, since they are based on the temperature of the surface and the value of the heat in dollars per million B.t.u.

AMOUNTS OF COAL, HEAT AND MONEY SAVED BY INSTALLATION

The savings accomplished by the use of the economic thickness of pipe covering is comparatively very great. The use of "85 per cent magnesia" of suitable thickness will result in a saving which will repay the original cost of the installation in less than a year in practically

TABLE I. MONTHLY SAVING, IN DOLLARS AND CENTS, BY THE USE OF "85 PER CENT MAGNESIA" PIPE COVERING

Standard thickness, per 100 lineal feet of steam-pipe							
Size of Pipe	5 Lb. Steam Pressure	10 Lb. Steam Pressure	50 Lb. Steam Pressure	100 Lb. Steam Pressure	150 Lb. Steam Pressure	200 Lb. Steam Pressure	200 Lb. Steam Pressure, 100° Superheat
1	\$1.44	\$1.58	\$2.20	\$3.28	\$3.66	\$4.11	\$6.80
1 1/2	1.72	1.89	2.87	3.70	4.26	4.89	8.03
2	2.11	2.30	3.56	4.80	5.35	6.04	10.00
2 1/2	2.52	2.74	4.22	5.52	6.50	7.25	12.20
3	2.86	3.10	4.73	6.14	7.29	8.17	13.70
3 1/2	3.53	3.74	5.86	7.63	8.93	10.11	16.80
4	4.25	4.39	6.95	9.07	10.55	11.90	19.90
4 1/2	5.00	5.33	8.30	10.90	12.60	14.30	23.82
5	5.72	6.22	9.60	12.40	14.40	16.32	27.23
6	6.50	7.06	10.60	14.05	16.40	18.40	30.85
7	7.30	7.69	11.80	15.35	17.92	20.25	34.00
8	7.97	8.64	13.16	17.20	20.00	22.72	38.00
9	9.36	10.15	15.60	20.38	23.82	26.88	44.90
10	10.90	11.70	18.38	23.68	27.60	30.80	52.00
11	12.26	13.22	20.40	26.60	31.20	34.90	58.55
12	13.80	14.70	22.70	29.00	34.52	38.61	64.80
13	15.08	16.33	25.00	32.70	38.40	43.08	72.40
100 sq.ft. 1 1/2-in. thick, flat surface, 5.26	5.67	8.80	11.50	13.48	15.12	25.44	

every case, and under constant operation at high temperatures where great thicknesses are called for the saving will often pay for the installation in as short a time as two months.

Table I shows the actual cost saving per month with \$5 coal by the use of "85 per cent magnesia" pipe covering. Table II shows in greater detail the serious losses which are going on in many plants today—losses

which are wholly preventable but which amount in the aggregate to many tons of coal yearly.

BOILER TEST CHECK ON LOSSES

In order that the results of the laboratory test might be checked on a larger scale, several practical tests were made. The first and most important of these was a boiler test made at a mine in Bruceton, Pa. There were two boilers in the plant, of 80 and 60 hp., locomotive type. The total exposed surfaces on these boilers amounted to 675 sq.ft. The tests covered a period of

TABLE II. COAL SAVED BY "85 PER CENT MAGNESIA" COVERING 1-IN. THICK

Steam Pressure	Saturated 5 Lb.	Saturated 10 Lb.	Saturated 50 Lb.	Saturated 100 Lb.	Saturated 150 Lb.	Saturated 200 Lb.	200 Lb. Pressure with 100 Deg. Superheat
Steam temp., deg. F.	228	240	298	338	366	388	488
B.t.u. loss per hr., sq.ft. bare pipe	367	409	625	802	937	1,058	1,735
B.t.u. loss per hr., sq.ft. of pipe covered with "85 per cent magnesia" ..	69	76	105	126	142	153	210
B.t.u. saved per sq.ft. by covering pipe with "85 per cent magnesia" ..	298	333	510	676	795	905	1,525
Tons (2,240 lb.) coal saved per 10,000 sq.ft. per yr. of 8,760 hr. by pipe covered with "85 per cent magnesia"	1,190	1,330	2,080	2,700	3,180	3,620	5,650
Cars of coal saved year, as above, at 40 tons per car	30	36	52	68	80	90	140

twenty-four hours. Conditions of load, etc., were practically the same during both tests. During the first test, while the boilers were uncovered, 10,784 lb. of coal was burned to evaporate 58,000 lb. of water. In the second test, after the boilers had been covered with 2 in. of "85 per cent magnesia" blocks and plastic, 9,296 lb. of coal was burned to evaporate 59,500 lb. of water. The evaporation rate during the first test was 6.35 lb. of water from and at 212 deg. F. per lb. of coal as fired, and during the second 7.55 lb.; 1,500 lb. more water was evaporated with 1,488 lb. less of coal burned. If calculated for an equal evaporation of water, the saving in coal would be 1,700 lb. per day. The calculated saving based on the laboratory experiments was between 1,400 and 1,500 lb. per day. This saving amounts to 15 per cent of the coal burned due to covering the boiler alone, as the pipe lines were not included in the test.

NECESSITY FOR HEAT INSULATION LIKELY TO BE OVERLOOKED

The matter of insulating against heat losses has received general attention in service power plants, large factory power plants and office buildings; but unfortunately, since it invariably receives final consideration in the construction of power and heating systems, it sometimes is regarded as a luxury—added only for the sake of appearance or neglected to save investment costs. The present tendency is to practice economy, and everyone realizes the importance of conserving the natural fuel supply, and yet the few finishing touches in the way of applying a good non-heat-conducting cover to protect such losses often are overlooked. It is one chemical product that will continue to work independently of the human element of control, and for many years to come will continue to effect economies figured in the cold business way of dollars and cents.

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Bluing and Browning Steel Articles

A Brief Description of Several Commercial Methods of Producing an Oxidized Finish on Polished Steel Objects, Including Analyses of Several Browning Solutions in Use in Various Establishments

By SIDNEY CORNELL

STEEL articles that have been polished and properly cleaned can be given a simple finish by immersing them in molten niter. This finish was specified for small components in rifles required by this and the allied governments during the late war. A mixture of half and half sodium and potassium nitrate is melted in a cast-iron or steel melting pot of shape and depth to suit the work. The pot should be clean prior to putting in the saltpeter, as rust from any source affects the color of the work. The niter is melted, superheated to a temperature of about 900 deg. F. (500 deg. C.) and black oxide of manganese added in the ratio of about 1 part oxide to 50 parts of niter, by volume. The manganese gives the molten salt a greenish-black tinge, and causes all suspended matter to settle to the bottom of the pot.

As bluing by this process forms an iron oxide film on the piece, consumption of the manganese oxide would be expected. Replacement at the rate of 1 lb. black oxide every three hours to a 300-lb. batch of saltpeter keeps the bath in condition. While it is doubtful what is the exact function of the manganese dioxide, this much has been observed: that if omitted from the pot the melt does not produce good work. Baths found upon analysis to be charged with iron oxide gave bad results, whereas no excess iron oxide was found in solution in any bath containing an excess of manganese oxide.

OPERATION OF NITER BATHS

In a niter bath a peacock blue or temper blue can be consistently obtained in the following manner: The articles to be blued are first cleaned, then given a thin coating of oil, then immersed in the hot niter at 600 to 650 deg. F. (315 to 345 deg. C.). The pieces may be either suspended individually on wires, or screws, nuts and other small articles may be dipped, inclosed in a wire basket. The parts are held in the niter for a few minutes, and then raised to note the depth of coloring attained, replacing in the molten salt until they reach the desired color. The time required varies with the temperature and with the size of the pieces but is never over four or five minutes.

The reaction is nothing more than obtaining a uniformly colored oxide film, as is obtained when tempering steel to color. If left in the niter too long, say ten minutes, the film produced is no longer a temper blue or a gunmetal blue, but has become a dirty gray. Preliminary cleaning in gasoline or similar solvent produces bad results, resulting in a mottled dirty surface. The oil carried on the surface of the parts takes fire immediately upon immersion in the hot niter, and if any moisture is present on the articles bad spattering of hot salt will occur.

After the right blue is obtained, the articles are quenched in cold, clean water to strike the color, then

immersed in boiling water and finally in hot oil. Hot oil dip is very necessary in treating small screws or other tiny parts, as it removes from them all moisture, which if left on the blued article will form a spot of red oxide rust, a defect which has a tendency to form at the roots of threads or any re-entrant angle.

The lower bath temperature mentioned above yields the temper blue required by the French Government for finish of rifle parts, but the United States and the British Government require a darker gunmetal blue, to obtain which a temperature up to 1,000 deg. F. (540 deg. C.) is required.

Care should be taken not to dip articles after adding manganese oxide to a niter bath until the suspended oxide has sunk, as otherwise dirty spots will appear on a blued article. Cast iron, if highly polished, will take on a gunmetal blue corresponding to that given to polished steel, but it requires about twenty minutes' immersion at 1,000 deg. F. to accomplish this result.

OIL BLACKENING

Among other coloring methods for finished work may be mentioned oil blackening, which gives a dull finish; cyanide mottling, which gives a highly colored and mottled surface, and drawing to color in a sand bath, yielding a range of color from straw to purple.

To oil blacken, the polished steel part is packed in a carburizing box, using spent carburizing compound, and properly luted to exclude air. Box and contents are heated to 1,200 deg. F. (650 deg. C.), requiring about one and one-half hours. At 1,200 deg. F. the box may be drawn, the lid opened and the parts riddled free from carburizing compound and at once quenched in oil. A black oxide-skin is formed, dull in appearance but uniform in texture. It proved to be an ideal finish for front sights for rifles.

CYANIDE MOTTLING

Cyanide mottling is obtained in a manner similar to oil blackening, except that an active carburizing compound may be used. To the spent mixture there is added approximately 5 per cent by weight of powdered potassium cyanide. Polished parts are packed in this material in a carburizing box, properly luted to exclude air, and heated to 1,200 deg. F. (650 deg. C.) for approximately four hours. Then the box is drawn, the articles are riddled free from compound and immediately quenched in oil. As air will quickly spoil the color effect, it is often advisable to quench direct from the box without riddling. If such colors as are obtained are too gaudy, the cyanide may be omitted, using pulverized charcoal in its stead.

HEAT TINTING

A beautiful finish may be obtained by simply heating polished steel articles in a sand bath. Temperatures up

to approximately 650 deg. F., (340 deg. C.) should be used, but not higher, as high temperatures tend to produce gray colored work. The sand may be on a hot plate or, better, in a cylinder capable of being slowly rotated and heated by a gas flame underneath. From five to ten minutes will produce a fine rich blue when the sand is at approximately 650 deg. F.

PARKERIZING

Parkerizing¹ and other phosphatic coatings of iron and steel yield an excellent finish. In Coslettizing, the articles, polished and cleaned, are placed in a solution of ferrous phosphate, made from iron filings, phosphoric acid and water, and the solution boiled for approximately two hours. This treatment yields a coating to steel consisting of basic iron phosphate, which is strongly adhesive. Due to the low temperature used, the physical properties of tempered steel articles are not affected, even fine springs retaining their elasticity and magnets being unaffected. The method called Parkerizing differs from Coslett's original method by adding an oxidation agent and catalyzer to the solution, usually as MnO_2 to a 0.75 per cent solution of H_3PO_4 , containing ferrous phosphate. The coating produced is then a basic ferrosophosphate, the ideal coating being one containing 3 of ferrous to 1 of ferric phosphate. After coating, the articles are gray in color, and after drying are usually coated with a paraffined oil to give them a deep black color. Considerable variation of color is possible by this treatment. When the articles are first placed in the bath a large quantity of hydrogen gas is liberated, and as soon as this ceases the process is complete. It is possible to treat a ton of parts at a cost not above \$15 to \$20.

BROWNING

There are many processes for browning steel, each of which is thought the best by its originator or user. The matter, however, may be summarized by describing one process, in spite of numerous variations, chiefly in the composition of the browning mixture. Other variations occur in manipulation and in the atmospheric conditions, artificial or natural. The longer browning processes have relatively low temperatures and humidities, while the shorter processes have relatively high temperatures and humidities. The longer processes have poor conditions, while the shorter processes have good conditions for rusting.

The operation of browning is conducted as follows:

First, applying the browning solution evenly over the surface of the article with a brush, a sponge or by dipping.

Second, keeping the article for a certain time in a

room or cabinet where good conditions for rusting are maintained.

Third, boiling the article in water to reduce ferric oxide, Fe_2O_3 , to the magnetic oxide, Fe_3O_4 .

Fourth, carding the article to remove any loose particles of oxide on the surface.

The work, coated with the solution, should be placed in a warm room or cabinet, where a temperature of about 175 deg. F. can be maintained. Dry heat is satisfactory, as it is its function merely to bring the article up to a temperature such that when it is placed in the humid rusting cabinet, dew will not form on the surface, causing spots in the color.

The rusting cabinet or room should be maintained at 175 deg. F. (80 deg. C.) and at any humidity up to the saturation point.

A third cabinet or room may also be used, although it is not absolutely necessary, conditioned the same as the first. Its object is to "set" the rust.

All of these rooms should have proper thermometers and thermostatic controls, and the rusting room a recording hygrometer. Temperature and moisture should be automatically controlled. The layout of the apparatus should permit of a proper flow of work from one process to the other.

PROCEDURES IN BROWNING

The procedures in browning are as follows:

The articles are first thoroughly cleaned, which may be accomplished by boiling for fifteen minutes in a soda solution. Any grease appearing on the surface of such a solution indicates need of soda ash addition. Then dry the parts by placing them on a draining rack. When cooled to approximately 120 deg. F. (50 deg. C.), coat with the browning solution. Dry for approximately thirty minutes, apply a second coat of the solution and dry for thirty minutes more.

The articles are then placed in the first warming room mentioned above, and brought to temperature, which may vary from 140 deg. F. up to as high as 175 deg. F. (60 to 80 deg. C.). With articles such as bayonets, thirty minutes in the warm room is sufficient. The time will naturally vary according to the size of the piece. Transfer them from the warm room to the rusting room. This must be at the same temperature as that of the warming room. Humidity up to the saturation point is desired, but danger of condensation should be avoided, as pitted and spotted work will result if the dew point is reached. Articles are rusted in approximately one hour and thirty minutes for such shapes as bayonets, others taking longer or shorter periods depending on the size and surface.

The rusted metal, now a dirty greenish red, is removed from the humid room to the third cabinet, if

¹See CHEM. & MET. ENG., vol. 21, p. 787, Dec. 24, 1919.

TABLE I. COMPOSITION OF BROWNING SOLUTIONS

Solution:		A	B	C	D	E	F	G	H	I	J	K	L	M
Ferrous chloride	$FeCl_2$										0.9			
Ferric chloride	Fe_2Cl_6	3.9	2.8	8.9	2.1	2.8	7.0			5.3	2.8	3.3	22.2	
Mercuric chloride	$HgCl_2$	1.2			0.7			3.3	4.5					10.0
Cupric chloride	$CuCl_2$						0.5	1.7						5.0
Antimony chloride	$SbCl_3$												22.2	
Bismuth chloride	$BiCl_3$							1.7						5.0
Hydrochloric acid	HCl						7.5	9.9						30.0
Ferrous sulphate	$FeSO_4$		1.5											
Cupric sulphate	$CuSO_4$	0.6			0.7	1.5				1.8		2.5		
Nitric acid	HNO_3	1.8	8.5		6.4	8.5	4.3			2.2	0.5	3.7		
Spirits of niter		6.2										4.1		
Ammonium chloride	NH_4Cl								4.5					
Alcohol	C_2H_5OH	4.0	3.2	40.1	2.4	3.2	78.2			2.6	1.4	3.7		25.0
Gallic acid	$C_7H_6O_5$												11.1	
Iron filings	Fe						2.5							
Water	H_2O	82.3	84.0	51.0	87.7	84.0		83.4	91.0	88.1	94.4	82.7	44.5	25.0
Price per gallon		\$0.90	\$0.27	\$1.45	\$0.35	\$0.30	\$3.38	\$0.86						

used, and allowed to remain for thirty minutes. Then it is placed in boiling, clean water for fifteen minutes. The articles are allowed to drain dry, and then are carded on a wire brush or fiber wheel, which operation completes the first coating.

After the first coat, three more rustings are applied in substantially the same manner. Four coatings were required to make the finish required by the British Government, after which the browned surfaces are given a coating of thin white slushing oil.

SOLUTIONS FOR BROWNING

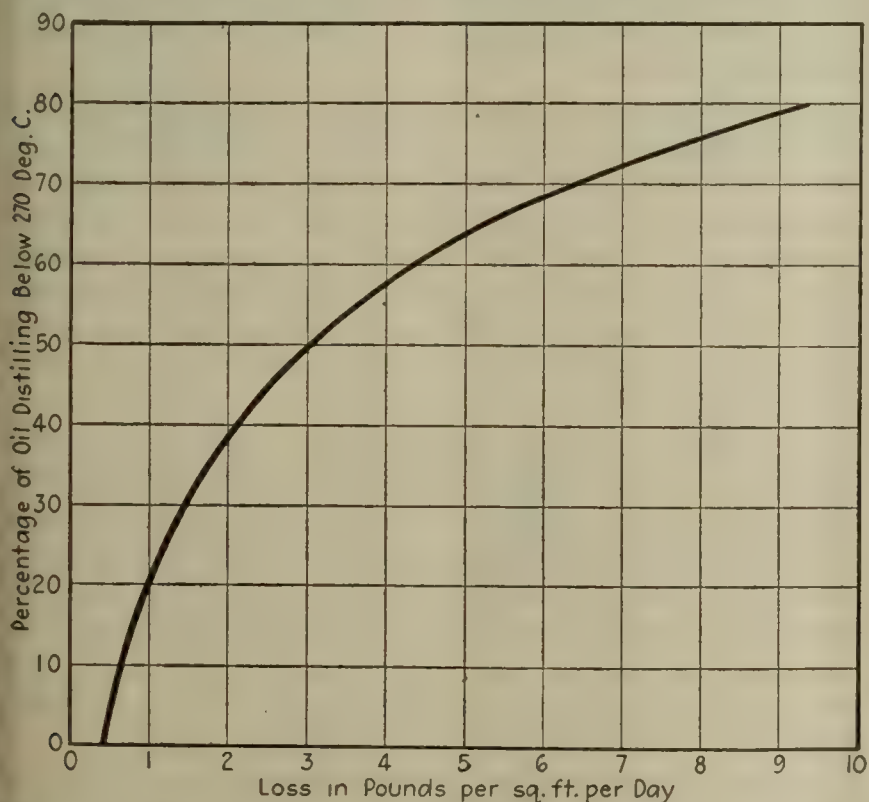
The number of solutions in use at various places total at least a score. Many formulas prescribe copperas or logwood for use in the water in which the articles are boiled after the rusting, but since omission of both of these ingredients led to the same finishes the conclusion was drawn that they were unnecessary. The complexity of browning solutions may be judged from the analyses in Table I and it might be stated that many of the ingredients appearing in them are as unnecessary as was the logwood or copperas in the wash water. Price and performance would be the guide as to the value of browning solutions, and they are arranged in their order of merit in the table.

Creosote Evaporation From Open Tanks*

The amount of creosote lost through evaporation in open-tank treatments is in proportion to the area of the exposed surface and the volatility of the oil. At the treating temperature of 195 deg. F., the loss of creosote in lb. per sq.ft. per day may be computed from the equation,

$$\log L = 0.0165 V - 0.347$$

in which L is the loss in lb. per sq.ft. of exposed surface and V the percentage of the creosote distilling below 270 deg. C. Or the loss may be found without computation from the curve of this equation given below.



The equation and curve are applicable only when the temperature of the treating bath is in the neighborhood of 195 deg. F. At higher and lower temperatures, constants other than 0.0165 and 0.347 should be used, and these constants have not yet been determined.

*From Technical Notes, Forest Products Laboratory.

Legal Notes

BY WELLINGTON GUSTIN

Court Holds Langmuir's Patent for Incandescent Lamp Valid

Interesting facts of invention regarding the Langmuir patent 1,180,159 for the tungsten lamp are given in the recent case of General Electric Co. vs. Nitro Tungsten Lamp Co. in the U. S. Circuit Court of Appeals. The General Electric Co. is the assignee and owner of the Langmuir patent. Langmuir declares in his patent that it is not "new in the art" to use an incandescent lamp filament of tungsten, but that, though "it has been suggested in the past to introduce into a lamp bulb a neutral atmosphere at a fairly high pressure, I am not aware that any such lamps have ever been used commercially or have been technically successful." This success he sets forth in claim 4 of the patent, as follows:

"The combination of a lamp bulb, a filling therein of dry nitrogen at a pressure materially in excess of that corresponding to 50 mm. of mercury and a filament of tungsten of large effective diameter; the filament being thereby adapted for operation at a temperature higher than that which it would have if operated in a vacuum at an efficiency of one watt per candle."

Langmuir's lamp is known as the nitrogen lamp, in contradistinction to the vacuum lamp of an art about forty years old, and it was admitted that if the patent was valid the defendant was an infringer. So the trial court held defendant to account and the Court of Appeals has affirmed this.

The defendant contended that the "path of invention in respect of electric lighting has now been trodden by the feet of so many men of talent, and research even into its bypaths has been so thorough, that the first defense offered is that 'the teachings of the prior art are such as to leave no room for the exercise of patentable invention on the part of Dr. Langmuir'."

In addition to the art or knowledge of the practical man of skill in such lighting the court points out other phenomena known to the scientist. In any scheme of incandescent lighting, the energy supplied to the filament is subject to three forms of expenditure: it radiates in light waves; it escapes in heat, and is dissipated by the movement or "sweeping action" of whatever gaseous material may be in contact with the incandescent substance. The patent sets out these forms of loss as radiation, conduction and convection. The object of the vacuum was to do away with convection by dispensing with the gaseous surroundings. Raising the heat of the incandescent light giver produced more light, but the higher the heat the more rapid the deterioration of the incandescent filament. The reasons for this deterioration were obscure, says the court. The "air washing" of Edison had become an obsolete phase. But it appears that Dr. Langmuir was the first to establish, so far at least as tungsten is concerned, that to heighten heat hastened a true evaporation of the heated substance. Also introduction of an inert gas, usually nitrogen, into the lamp bulb delayed evaporation of the filament, but brought back and accentuated convection losses, which the vacuum had minimized.

When the rare and refractory metals, thorium and others, began to be hopefully regarded as possible supplanters of carbon filaments, it was suggested that if the lamp bulk be filled with a mixture of nitrogen and carburetted hydrogen the lamp would also have an excellent lighting capacity. But this was never reduced to practice. The court thought both the commercial and theoretic art had been put on a wrong road by Mr. Edison in his patent in 1883, and that before Langmuir no scientist had disclosed to the world that in the nitrogen-filled bulb the loss by convection would be diminished, and a working compromise reached between that loss and the gain in filament life, by increasing the "effective size" of the filament itself. Langmuir was also first to establish a crucial fact, that with a tungsten filament nitrogen of ordinary or commercial dryness was worse than useless.

The court found that Langmuir did not invent any nitrogen-filled bulb with any tungsten filament in it, but a special article of special proportions and a carefully stated co-ordination of parts.

Court Construes Contract of Seller Not to Engage in Similar Business

Restraint of a seller of a business from working in a similar business for a term of years was the proposition presented in the case of *Cosmos Dyeing & Printing Works vs. Calderini and others*, before the Court of Chancery of New Jersey.

It appears that under date of June 10, 1919, Delfiory Calderini and wife, doing business under the name Fiory Dyeing & Printing Co., entered into a written contract with complainant wherein the two Calderinis agreed to sell all the good will of the business of the Fiory Dyeing & Printing Co., at Haledon, Passaic County, N. J., together with all the machinery, etc., and also the land upon which the plant stood; also the processes and formulas for piece dyeing and finishing, secret or otherwise, relating to the said business. The consideration was \$185,000. The defendants further agreed not to engage in the piece dyeing and finishing business in the State of New Jersey or in the State of New York for a period of five years from August, 1919.

In this suit the Cosmos company alleged that Calderini, in violation of his agreement, did engage in the silk dyeing and finishing business with the Atlas Finishing Co., with works at Homestead, N. J., becoming its general manager. Defendant claimed that he was simply an employee at the Atlas works, and that his investment of \$10,000 in such works was made for his son so that he might learn the trade and business. Facts developed that no salary had been paid Calderini prior to the hearing on this application for an injunction to restrain his working in violation of his agreement.

Upon argument for the application for an injunction it was agreed by the defendants that all money invested in the Atlas company by Calderini in behalf of his son would be withdrawn and that the only question remaining was as to whether he could go there and labor as a paid employee. The court taking proofs on the motion to modify the restraint on Calderini held the facts insufficient for granting a preliminary injunction restraining him from working for others as an employee, despite his covenant not to engage in such business in the states of New Jersey and New York for five years. It was said the Chancery Court should go as far as possible to restrain a fraudulent act by the seller of a

business in violation of his covenant not to engage therein, but the restraint must be reasonable, and the words of the covenant carefully construed.

Moreover, the rule in New Jersey was held to be that where the complainant's right is uncertain as a matter of law, a preliminary injunction will be denied. The true intent and meaning of contract by the seller of a business not to engage therein is a question of law, particularly in view of its being one which may be in restraint of trade. The court was not willing to say on this preliminary application that the covenant prevented Calderini from working for the Atlas company. It said a preliminary injunction would not issue unless the injury sought to be prevented is irreparable.

Seller Not Responsible for Crop Failure Where Fertilizer Was Sold by Analysis

The Supreme Judicial Court of Maine has ruled that where fertilizer was sold under an agreement that it should contain certain percentages of designated ingredients, evidence that the buyer's crop failed on the land was inadmissible in an action for the price of the fertilizer, though such evidence would be admissible if the sale was accompanied by a guaranty of suitability for the proposed crop. This ruling was made in an action brought by the Bowker Fertilizer Co. against B. H. Wallingford to recover the purchase price of fertilizer sold to and used by him. The fertilizer company had judgment and this was affirmed on the appeal.

It was admitted that samples of the fertilizer were taken at the factory from the same bins from which fertilizer was taken to be shipped to Wallingford, and were analyzed by the Maine Agricultural Experiment Station. The certificate of analysis showed 4-6-10, which was in accordance with the formula printed upon the bags and barrels received by Wallingford. The company had otherwise complied with state regulations. Wallingford defended failure to pay on the ground that the fertilizer was deficient in the elements necessary to aid him in the growing of a potato crop, and further damaging the crop.

In another case it was held that proof of defendant's own experience was too uncertain, speculative or conjectural to throw any real light upon the percentage of the ingredients of the fertilizer, and that such evidence is inadmissible when sold only on a guaranteed analysis basis. (*Armour Fertilizer Works vs. Logan*, 116 Maine, 33.) But it was held that such evidence is admissible when the sale was accompanied by guaranty of suitability or results.

Now there is a rule of law that when anything is bought for a specific purpose there is an implied warranty that it is reasonably fit for that purpose. It was admitted that the fertilizer company's selling agent had knowledge that the fertilizer sold was to be used for raising potatoes; therefore, the buyer contended, the fertilizer as sold to him should have been reasonably suited for the purpose for which he bought it. But this contention was overruled by the Supreme Court.

It was said the sale was for a fertilizer of a 4-6-10 brand and nothing more. When fertilizer is sold under guaranty of analysis stated on its tag, there is no implied warranty of its suitability for the growing of a particular crop, though the seller knew that the buyer intended to use it to fertilize land for such crop. This was said to be grounded in public policy, otherwise every crop failure might be made the basis of a suit.

Manufacture of Synthetic Ammonia at Oppau, Germany*—I

Principle of the Process—Manufacture of Producer Gas and Water Gas Used in the Process—
Purification of the Gas Mixture—Catalytic Oxidation of Carbon Monoxide—
Elimination of Carbon Dioxide and Carbon Monoxide

HABER'S researches enabled him to complete the work of Le Chatelier by determining the conditions under which the maximum combination of nitrogen and hydrogen in the presence of a catalyst to form ammonia could be obtained. However, before the process could enter into commercial competition, the following problems had to be solved: The economical production of large quantities of very pure hydrogen and nitrogen; extraction of the ammonia from the gaseous mixture; conversion of the ammonia into more readily marketable products; design and construction of suitable apparatus. A staff of chemists of the Badische Anilin- und Soda-Fabrik under the direction of Dr. Mittach worked on these problems for about ten years, and their results, combined with those obtained by others not directly connected with this company, led to the adoption of the commercial process now in use.

PRINCIPLE OF THE PROCESS

The principle of the process is as follows: Water gas, $\text{CO} + \text{H}_2$, is mixed with producer gas (lean gas), $\text{CO} + x\text{N}_2$, in convenient proportions; steam is added to this mixture and the whole is passed over a catalyzer at a temperature between 400 and 500 deg. C. The carbon monoxide and steam react and give hydrogen and carbon dioxide. The carbon dioxide is dissolved in the water at a pressure of 20 to 25 kg. and the remaining gaseous mixture is freed from harmful traces of carbon dioxide and carbon monoxide by passing it through solutions of caustic soda and ammoniacal copper formate.

The resulting gaseous mixture contains about 3 volumes of hydrogen per volume of nitrogen. The

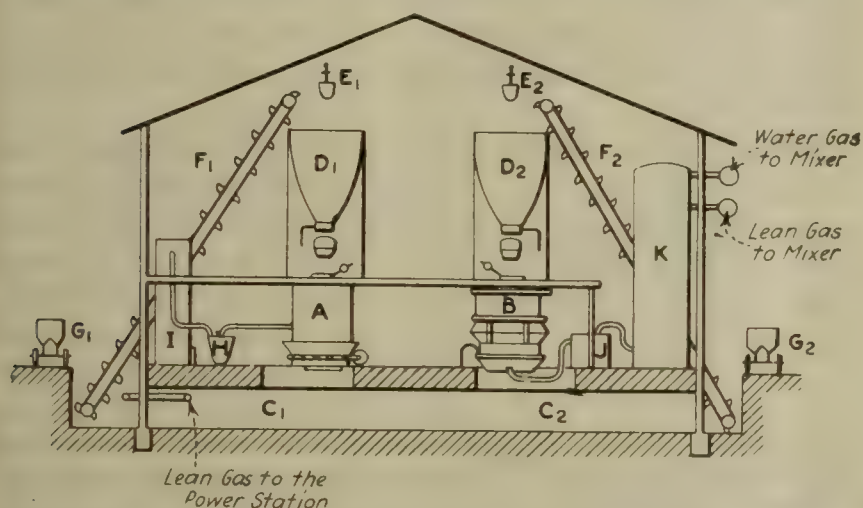


FIG. 1. SECTION OF PRODUCER-GAS BUILDING

nitrogen content is kept systematically a little below this theoretical value and additional nitrogen obtained by the distillation of liquefied air brings the mixture to the exact proportions for ammonia. This mixture is then subjected, under a pressure of 200 kg. and at a temperature of about 500 deg. C., to the action of a

second catalyzer, producing a little ammonia, which is immediately absorbed by water, and to the remaining gases which do not combine during this operation fresh amounts of gases are added and the whole is passed again through the catalyzer.

The ammonia obtained by the distillation of the solution may then be oxidized by catalysis or combined with nitric acid thus formed to give ammonium nitrate, or used for the production of ammonium chloride by the Solvay process, or for the production of ammonium sulphate by reaction with gypsum in the presence of carbon dioxide. Finally, at the Oppau plant, starting with ammonium nitrate, diverse fertilizers are manufactured, such as ammonium-potassium nitrate and a mixture of ammonium nitrate and potassium chloride sold under the name of "Mischsalz."

MANUFACTURE OF PRODUCER GAS AND WATER GAS USED IN THE PROCESS

The lean gas is furnished by a battery of gas producers, the fuel used being lignite briquets from the Cologne district.

In addition to the gas used in the production of the nitrogen-hydrogen mixture, this battery supplies gas for use under the boilers and for admixture with coal gas to form "Kraftgas," which is used in internal-combustion engines.

The water gas is furnished by a battery of coke-gas generators. The coke used is of good quality, free from sulphur, coming partly from the Ruhr district and partly from the coke ovens at the works.

The battery of lean gas producers A (Fig. 1) consists of 23 units of the Berlin Anhaltische Maschinen Aktien Gesellschaft ("B.A.M.A.G.") type and that of the water-gas generators B consists of eighteen units of the Pintsch type. Both batteries are situated in the same building, 140 x 32 m. In each battery the gas producers are located in two rows parallel to the long sides of the building and at floor level. The ashes and clinkers are emptied into underground tunnels C₁ and C₂. Storage bins D₁ and D₂, 3 m. wide and 4.5 m. high, are placed over each row of gas producers. These bins are fed by the overhead cars E₁ and E₂, carried by aerial cables, or by bucket elevators F₁ and F₂. There are four bucket elevators at each side of the building, which take the fuel from the storage tunnels running along the outside walls of the building in which the fuel brought into the plant by the cars G₁ and G₂ is stored. Under normal condition the overhead cars are used for lignite fuel and the bucket elevators for coke.

GAS PRODUCERS

The gas producers ("B.A.M.A.G.") are of sheet iron lined with refractory brick and are 2.80 m. in diameter and 3 m. high. They are divided into three groups. Each group has a common hydraulic main H and a series of washing and purifying apparatus consisting of three

*From *La Technique Moderne*, November, 1920, pp. 449-460.

washing towers 12 m. high and 1.5 m. in diameter and three rotating washers. Each of these washers is formed of two horizontal turbines 1 m. in diameter and 1.25 m. long direct connected to a 75-hp. electric motor. The two turbines are separated by a decantation vat in which the residue is collected. The gases leaving the second turbine pass through a cyclone tangential purifier with vertical axis by which the residue separates at the bottom, the gases leaving at the top through a 60-cm. diameter pipe. A bypass permits the escape of the gases to the atmosphere for a certain period when the gas producers are first started.

To facilitate supervision of the operation the gas producers are divided into groups of three units. These groups are connected to respective manipulating boards provided with six manometers indicating the pressures at the bottom

(about 310 mm.) and on top (about 130 mm.) and with means to operate hydraulically the regulating valves.

The fuel consumption is 125 kg. per hour per sq.m. of grate. The entire installation consumes 440 tons per twenty-four hours, giving 1,235,000 cu.m. of gas and 10 tons of tar—that is, about 2.8 cu.m. gas per kg. of briquets. The calorific value of the gas is 950 cal. per cu.m. and its average composition is 30 per cent CO, 67 per cent N₂ and 3 per cent CO₂. The life of the refractory lining is about two years.

WATER-GAS GENERATORS

The water-gas generators are also of sheet iron lined with refractory brick. Two units constitute a group. Each group has a common manipulating board, two scrubbers J, a double main pipe and a washing tower K. The manipulating board is provided with six manometers giving the pressures at different points and with means to operate hydraulically the regulating valves.

The gas producers are operated in cycles of four minutes, thus: Air is blown in at the bottom for one minute, the gases escaping through a chimney. Then superheated steam at 270 deg. C. and 12 kg. pressure is injected for half a minute at the bottom, then two and one-quarter minutes at the top, and finally for one-quarter minute at the bottom.

To stop the operation of the producers without extinguishing the fires it is sufficient to open portholes at the top, and the operation can be started again, even after a shutdown of twenty-four hours, by simply blowing in air for ten minutes.

The ashes and clinkers are crushed by rotating grates and dumped into underground galleries.

The fuel consumption is 100 kg. coke per hour per sq.m. of grate. The entire battery consumes 265 tons per twenty-four hours (14.75 tons per gas producer per twenty-four hours), giving 375,000 cu.m. of gas—that is, about 1.4 cu.m. gas per kg. of coke. The calorific value of the gas is 2,400 cal. per cu.m., and its average composition is 50 per cent H₂, 40 per cent CO, 4 to 6 per cent N₂, 6 to 4 per cent CO₂.

The air needed for the operation of the gas producers is carried in three conduits which are supplied respectively by one 2.5-m. diameter blower driven by a 600-hp. Brown-Boveri turbine, four 1.5-m. diameter blowers,

each driven by a 140-hp. electric motor, and one 1.5-m. diameter blower driven by a 100-hp. electric motor.

Under normal conditions the total power absorbed for supplying the air is 700 hp. Special apparatus are provided for indicating at each instant the quantity of gas in the gas holders, for the automatic recording of CO₂ content in the gases and for the calorific power of the gases (Junkers calorimeters).

PURIFICATION OF THE GAS MIXTURE

The gas mixture to be catalyzed consists of 2 parts water gas and 1 part lean gas. There are three 15,000-cu.m. gas holders, one for lean gas and two for water gas.

From the gas holders the gases pass through 1.5-m. diameter turbine type washers (four for water gas and two for lean gas), which are placed in the same building (Fig. 2). Each of these turbines is driven by a 37.5-kva. electric motor. From the turbines the water gas is led tangentially into apparatus called cyclones in which the water and the particles in suspension are separated at the bottom and the gas leaves at the top and enters the main pipes. Similarly the lean gas is sent into the respective cyclones and thence to main pipes. By a set of regulating valves the gases may be returned to the turbines for further treatment.

The circulation of the gases is controlled by four manometers, of which two are marked respectively "water-gas inlet" and "water-gas outlet" and the other two to indicate the velocities. It is probable that the quantity of water gas supplied is quite constant and that all the regulating necessary is for the needed quantity of lean gas.

The gases after passing three 10,000,000-cu.m. rotary meters (one for lean gas and two for water gas) are mixed and forced by three turbo-blowers to the catalysts for the reaction $\text{CO} + \text{H}_2\text{O}$.

CATALYTIC OXIDATION OF CARBON MONOXIDE

During the catalytic oxidation of carbon monoxide two points are of importance according to the patents of the Badische Anilin- und Soda-Fabrik—namely, the degree of porosity of the catalytic mass and the temperature regulation. The temperature has to be maintained at about 500 deg. C., because the reaction takes place only around this temperature and experience has shown that the catalytic power of the mass is destroyed at 600 to 650 deg. C.

A regulating device building is situated near the

turbine building and is electrically connected to the catalyzer building. It is from this regulating device building that the supply of the gases to the catalyzer building is controlled. The devices consist of valves, recording indicators giving at each instant the velocity of the gases through the meters, recording indicators graduated in cu.m. giving probably the volumes of the gases in the holders and Winkler burettes for gas analyses.

The different buildings through which carbon monoxide gas circulates are provided with CO indicators to give warning by sight and sound of the presence of this poisonous gas in the atmosphere of the buildings.

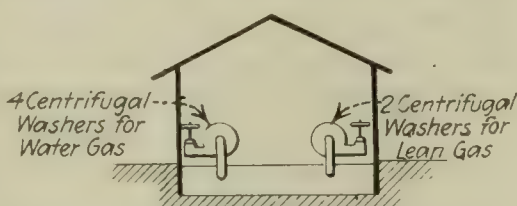


FIG. 2. SECTION OF TURBINE WASHERS BUILDING

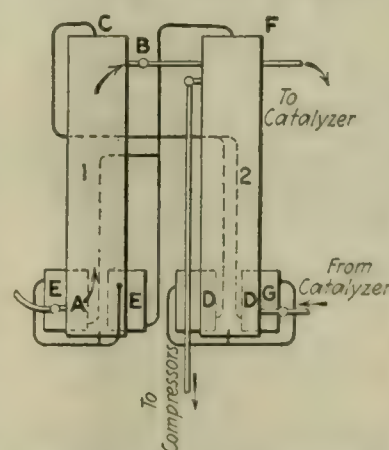


FIG. 3. ARRANGEMENT OF TOWERS

At the outlet from the turbo-ventilators the gaseous mixture receives the exhaust steam from the turbines (expanded from 12 to 4 kg.) in the proportion of about 76 g. steam per cu.m. of gas mixture (0.857 kg.), and the whole enters two 17-m. towers (Fig. 3), where it

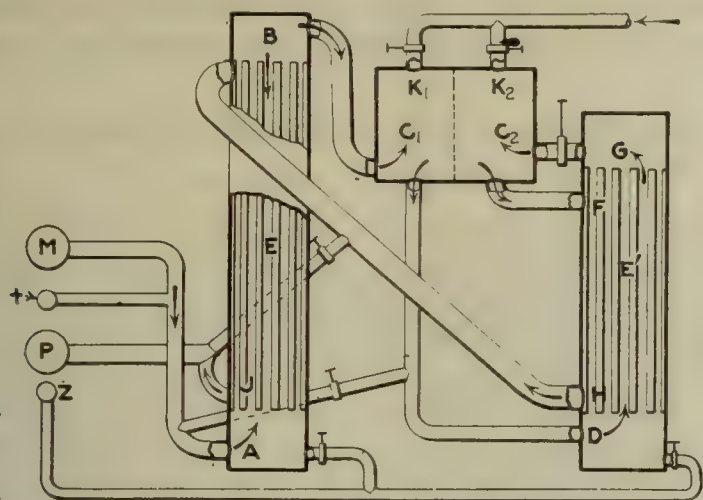


FIG. 4. SCHEMATIC ARRANGEMENT FOR THE CATALYSIS OF CARBON MONOXIDE

is heated and saturated with water vapor by jets of very hot water (about 95 deg. C.) This water comes from the washing of the catalyzed gases. The gases arriving at A in the first tower leave at B and are sent to the catalyzer. The warm water coming from the reservoirs D enters at C the reheating tower 1 and is collected in the reservoir E, whence it is brought to F and enters the tower 2 to cool the catalyzed gas which enters through G. The heated water is collected in D and the cycle can begin again.

After leaving the tower through M (Fig. 4) the gas receives an additional quantity of steam, and enters at A the heat exchanger E (1.5 m. in diameter and 7.5 m. high) and through B the first catalyzing chamber C_1 ; thence through D into the second heat exchanger E' (5 m. high), which is superposed on the first heat exchanger as shown in Fig. 5, thence through G into the

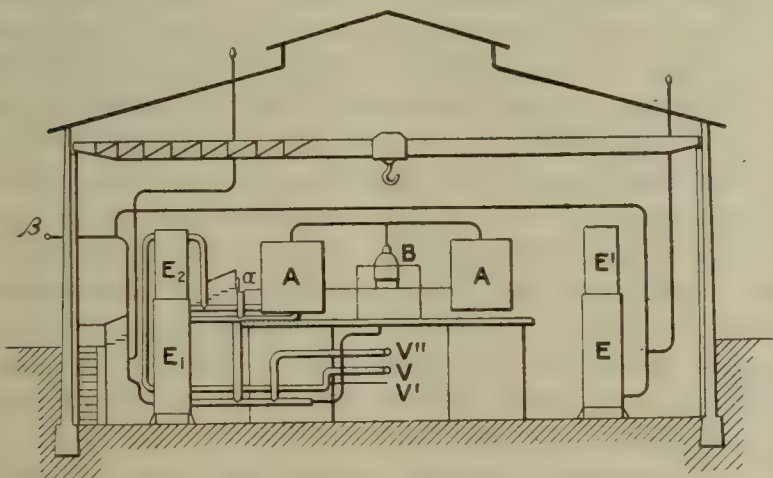


FIG. 5. SCHEMATIC ARRANGEMENT IN THE CARBON MONOXIDE CATALYZING BUILDING

second catalyzing chamber. From here the catalyzed gas passes the heat exchangers in an opposite direction following the path $FHIJ$ and enters the washing tower 2 of Fig. 3 through P. Hot gases from a Perrot furnace enter the catalyzing chambers through K_1 and K_2 and serve to bring the temperature of the catalyzers and heat exchangers to that required for good operation and leave through Z, leading to a chimney.

The catalyzing chambers are prismatic, 3 x 6 x 5.5 m., and are separated by a tight partition. In each of these sections are sheet-iron containers with the catalyzer (a mixture of iron oxide, FeO , and chromium sesqui-

oxide, Cr_2O_3) spread in five layers. There are twenty-four such containers placed in two rows of six in two buildings. (Fig. 5.) At the outside of these rows are placed the corresponding heat exchanger, one double heat exchanger per catalyzing unit. In each section of the catalyzing building there are six Perrot furnaces B placed between the two rows of catalyzers. These furnaces use "Kraftgas" (a mixture of lean gas and coal gas) as fuel, and the hot gases are used for reheating as previously described. The additional supply of nitrogen needed (see p. 305) is brought to the catalyzed mixture through pipes β .

The process requires the addition of about 1,167 tons of water to the gas mixture per twenty-four hours.

The gases leaving the first catalyzing chamber analyze about 28 per cent CO_2 and 2.2 to 3.4 per cent CO; in the gases leaving the second catalyzing chamber the CO content is only from 1 to 1.6 per cent.

The temperature of the catalyzers does not exceed 500 deg. C.

The operation is controlled by:

Sixty thermocouples per catalyzer grouped in three series of twenty, each wired to a switchboard with a

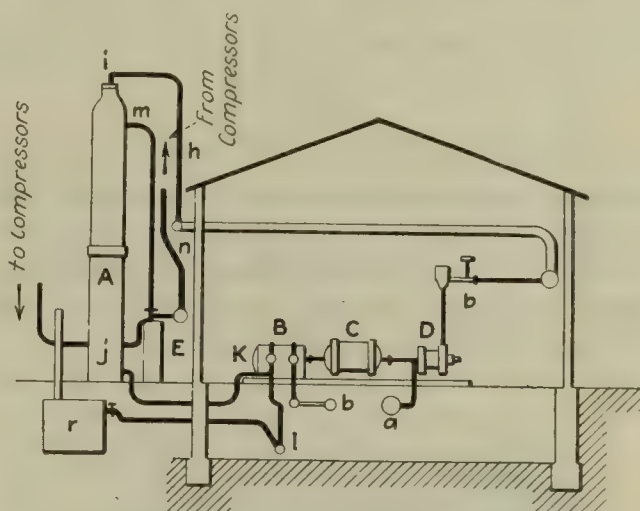


FIG. 6. SCHEMATIC ARRANGEMENT FOR THE ELIMINATION OF CARBON DIOXIDE

single galvanometer. This galvanometer can be connected to any one of the thermocouples.

Three mercury manometers connected to Pitot tubes placed at the outlet of each catalyzing chamber and on the steam pipes.

Six electrically driven pumps for circulating the water, of which three 45-kw. are for tower 1 and three 40-kw. for tower 2. (Fig. 3.)

ELIMINATION OF CARBON DIOXIDE, COMPRESSION AND PURIFICATION

The catalyzed gas is collected in a gas holder, whence it is taken to be compressed. The compression takes place in five stages—namely to 5, 9, 27, 80 and 200 kg. When the gas is at 27 kg. pressure it is washed with water at the same pressure to remove the carbon dioxide. There are twelve compressors, of which six are of the Sulzer type and six of the Schwartzkopf type. Each one of them is driven by a two-cylinder-in-tandem gas motor 800 mm. internal diameter and 2-m. stroke. The total power required to drive the twelve pumps is 12,600 hp.

The gas, compressed to 27 kg., enters at j the absorption towers A (Fig. 6), which are provided with Raschig rings. The dimensions of these towers are 1.2 m. diameter x 12 m. high. Six centrifugal pumps D of the Sulzer type driven by 180-kw. motors circulate the necessary water, which enters the top of the towers

A at *i*. The gas, which leaves the towers at *m*, is led to purifiers *E* and through the pipings *n* back to the compressors. The wash water is sent through pipings *K* to a Pelton turbine *B* direct-connected to the electric motor *C*. The expansion of the compressed water takes place in this turbine and 60 per cent of the original energy required to compress it is thus recuperated. From this turbine the water falls into a reservoir where the CO_2 is separated and sent to a gas holder through pipings *b* and the water thus freed returned through pipings *l* to the water compressors.

There are twelve absorption towers and twelve separators, divided into six groups, each group having its own pump.

The operation is controlled by:

A velocity indicator for the inlet gases.

An indicator giving the volume of the gas taken from the gas holder.

Indicators showing the presence of carbon monoxide in the atmosphere of the building.

About 3,200 cu.m. of water is required per hour. The energy spent to compress the water is about 0.4 hp. per cu.m., when the amount of energy recuperated in the Pelton turbine is taken into consideration.

At the outlet from the towers the CO_2 content of the gas is not more than 0.8 per cent.

ELIMINATION OF CARBON MONOXIDE

A series of tests were made to eliminate the carbon monoxide by the use of an appropriate absorber. After many trials with various absorbers the Badische Anilin- und Soda-Fabrik has adopted an ammoniacal solution of copper formate for the absorption of CO .

The gas, compressed to 200 kg., enters the absorption

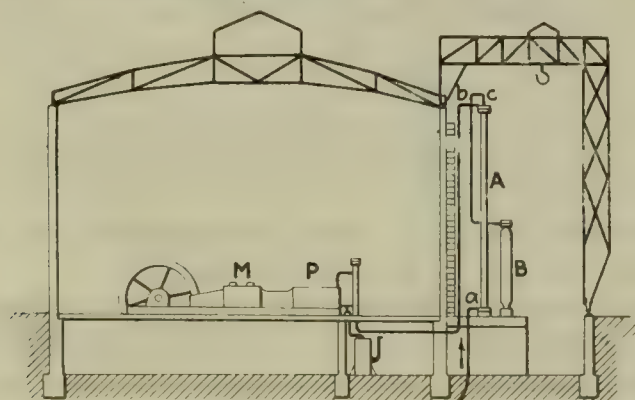


FIG. 7. SCHEMATIC ARRANGEMENT OF INSTALLATIONS FOR THE ELIMINATION OF RESIDUAL CARBON MONOXIDE

towers A (Fig. 7) at the bottom at *a*. There are fifteen towers working in parallel. They are provided with Raschig rings. The ammoniacal solution, compressed to 200 kg. by twelve piston pumps *P* driven by steam engines *M*, is sent to the towers A through *b*. The gas leaves the towers at *c*, enters the separators *B*, where the liquid in suspension is separated, and then to towers with soda lye, where the remainder of CO_2 is removed. The circulation of the soda lye at a pressure of 200 kg. is made by two pumps analogous to pumps *P*.

After expansion the cuprous solution is sent to a regenerating plant, where it is submitted to the action of heat and vacuum.

The hourly consumption of ammoniacal solution is about 40 cu.m., which can absorb about 720 cu.m. of carbon monoxide. The daily consumption of formate is about 320 kg. The hourly consumption of soda lye is about 8 cu.m.

The twelve circulating pumps are on the ground floor

of a 75 x 20-m. building. The towers and the separators are located along one of the long sides of the building. The towers are forged steel tubes 12 m. long, 80 cm. outside diameter and 12 cm. thick. Each tower is provided with a level indicator showing when it should be disconnected for the removal of the lye.

(Part II will be published in a subsequent issue.)

Gutta Gaekwar, a New Base for Chewing Gum

BY FREDERIC DANNERETH, PH.D.

Some time ago our attention was called to a new material which, it would seem, will become of considerable importance in developing products in the industry of plastics. The material is known commercially as gutta gaekwar, and we are advised that it is the coagulated milk juice of latex-bearing trees in Borneo. The product has been refined to a certain extent, so that it appears with the consistency of hard cheese, and it can be cut in slices with a knife. The gutta has a cream white color, but so far as our examination has gone it appears to be a straight natural product, not mixed with other guttas or milk juices.

It is almost tasteless when chewed, has a slightly sweet odor and has about 15 lb. of water in 100 lb. of the material as imported. The resin content of the actual gutta, after the water has been removed, averages 65 to 66 per cent. These resins have a melting point of about 160 deg. C. They have many peculiar and interesting physical properties, of which one is of particular importance—they contain more than 50 per cent unsaponifiable matter, and the unsaponifiables bear a close resemblance to the unsaponifiable matter found in wool grease.

When the original gutta is heated in the oven to a temperature of 100 deg. C. it becomes very tacky, and it is easy to draw "strings" when stirring the mass. From this we conclude that the material will be of interest in cases where a strong "binder" is needed for plastic masses. The material sent to this laboratory was in the form of a brick weighing about 5 lb., but after resting in the dry air of the storage room for a few weeks it lost a large part of its water. The dry material has, however, not lost any of its valuable properties. It may be rendered plastic by heating in a double-jacketed kettle or in an oven. In this condition it may be mixed with powdered minerals such as whiting or iron oxide, or it may be mixed with powdered sugar or powdered starch. Thus it has been possible to produce compact masses which can be formed into a variety of shapes.

The special uses for which gutta gaekwar seems adapted are:

1. As a binder in place of shellac, in preparing plastic masses.
2. As a base for chewing gums (to be mixed with softeners and sugar).
3. As a substitute for chicle (by adding waxes to the gutta).
4. As an organic compounding material in rubber mixes (used for impregnating cotton duck in the manufacture of rubber belting, rubber hose, and rubber packing).
5. As a compounding material in rubber compounds (used in the manufacture of double texture raincloths).

Although this new gutta is not of domestic origin, we feel that its interesting properties may prove of value to some of our colleagues in the organic chemical industries.

Department for Research Chemistry,
Rubber Trade Laboratory,
Newark, N. J.

High-Frequency Induction Steel-Furnace

A Practical Combination of Crucible-Melting Flexibility With the Advanced Practice of Electric Melting
—A Means for Producing Alloys Whose Proportions Are Accurately Reproducible—
Virtually an Electric Crucible

BY E. F. NORTHRUP

THE furnace which we here describe is one of several specific commercial applications of Ajax-Northrup High-Frequency Induction Furnaces which the Ajax Electrothermic Corporation has developed.

This specific form of furnace, which for brevity we designate as a "10-In. Conical Pouring Furnace," is designed for operation with high-frequency current supplied by a standardized high-frequency converter set of 20-kw. capacity. All furnaces which operate with high-frequency current require a frequency of from 10,000 to 25,000 cycles per second.

The high-frequency converter set is a piece of static apparatus which performs the function of converting commercial current of ordinary frequency, usually sixty cycles, into current of the high frequency required. A 20-kw. high-frequency set occupies a floor space of 31 in. front by 41 in. deep and stands 67 in. high. The set is illustrated in Fig. 1.

THE HIGH-FREQUENCY CONVERTER SET

It will be seen from the illustration that the set consists of a metallic cage faced with a switchboard. On the switchboard are mounted a control wheel for varying the power, a main line switch, an indicating wattmeter, and an alcohol dropper. This cage contains all of the parts required for a 20-kw. high-frequency converter. There are but three essential parts of the apparatus, all contained in the cage. These are: Twelve General Electric Co. condensers; a transformer of special design, made by the American Transformer Co., with internal reactances; and a discharge gap. This latter has two electrodes which are raised and lowered vertically over a surface of mercury contained in a metal container. The raising and lowering of these electrodes are effected by means of a hand-wheel on the face of the switchboard, the connection to the electrodes being made through the medium of a flexible shaft. The power delivered by the high-frequency converter set may be varied from zero to maximum by changing the distance of the electrodes above the surface of the mercury. All low-frequency, high-tension circuits are housed in the metal cage, which is itself connected to earth.

The transformer steps the line voltage up to 6,600 volts, but no danger of contact with this high voltage is possible because the high-tension parts are housed in the grounded metal cage. The high-frequency converter set, of standard construction, operates on single phase or one leg of a polyphase circuit of 220 volts and sixty cycles. When used with the furnace about to be described this set delivers current to the furnace at a frequency of approximately 15,000 cycles per second.

The set is designed for continuous operation and

will have a long life, as there are no parts which are moving nor are there any parts which suffer rapid depreciation. The power which is drawn from the supply line is at all times shown by the indicating wattmeter on the face of the switchboard, and this power may be varied by the control wheel in infinitesimal steps from zero to a maximum of 20 kw. No power is wasted in rheostats or other like devices. The current taken by the set is not far different when operating with small power than when operating with large power, and consequently as the set draws more power from the line the power factor improves, reaching at full power over 70 per cent.

THE FURNACE

The furnace which it is the purpose of this article to describe and which is operated with current obtained from the above-described high-frequency converter set, has the following construction:

A strongly built box is made of asbestos board and is approximately cubical in form, being 16 x 16 x 14½

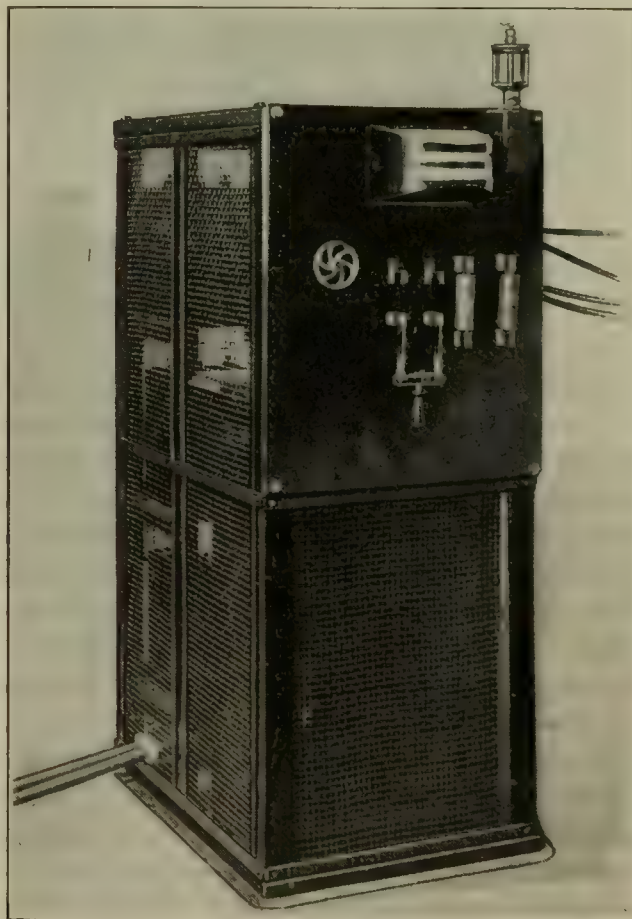


FIG. 1. VIEW OF A 20-KW. HIGH-FREQUENCY SET

in. This box contains the inductor coil, the electrical insulation, the small amount of heat-insulating material required and the crucible in which is placed the metal to be melted. For brevity we shall speak of this as "the furnace."

The furnace is placed on a table made of heavv

asbestos board. This is 20 x 36 in. and stands 15 in. high. The leads from the high-frequency converter set are permanently connected to metal pieces beneath the cover of this table. When the furnace is placed upon the table, contact is made with these metal pieces by two metal feet at the base of the furnace box. The furnace is so designed that when a melt is completed the furnace may be lifted off the table by two men using suitably designed handles and may then be tilted and the contents poured. The handling of the furnace and the pouring are done in the usual manner in which one handles and pours metal from a crucible which is lifted and rotated by a so-called "bale."

CONSTRUCTION OF THE FURNACE

The construction of the furnace proper is exceedingly simple and consists of only two essential parts—the inductor coil and a crucible. The latter fits within the inductor coil, with a suitable small amount of electrical and heat insulation between the two. The inductor coil is conical in form, the large diameter of the cone being uppermost. The diameter of the base of the cone

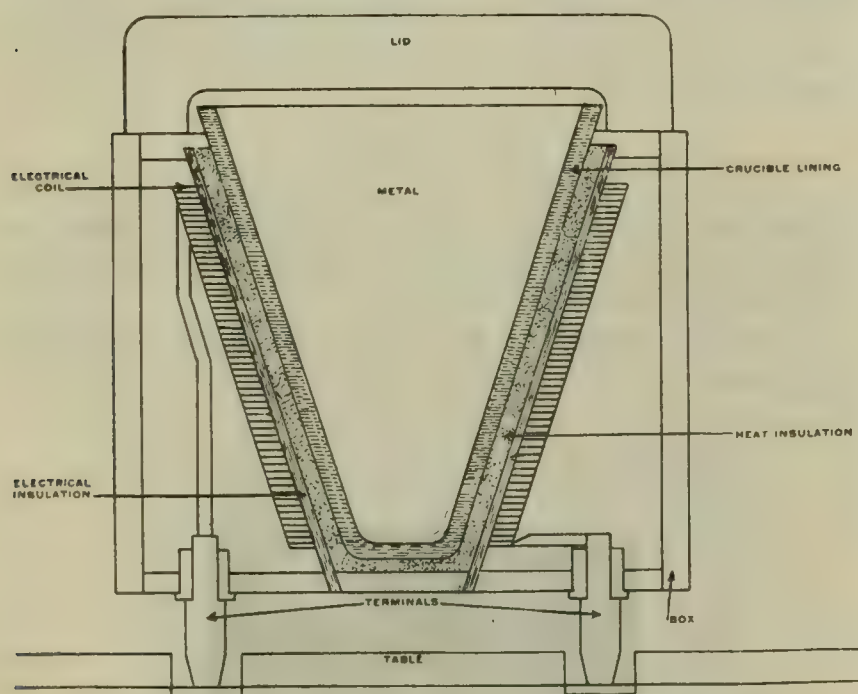


FIG. 2. CROSS-SECTION OF STEEL FURNACE

is $4\frac{1}{2}$ in., the top of the cone is $10\frac{1}{2}$ in., and its vertical height is $10\frac{1}{2}$ in. The inductor coil itself consists of thirty-seven turns of $\frac{3}{8}$ -in. copper tubing flattened and wound edgewise. Arrangement is made for circulating a small stream of water through this copper coil both to maintain it cool and to keep its resistance low. The inside of this inductor coil is lined with a cylinder of micanite (a kind of micanite having no organic binder) about $\frac{1}{4}$ in. thick. This gives both electrical and heat insulation.

The crucible has the same conical shape as the coil and is within it. A space of about $\frac{1}{2}$ in. between the outside of the conical crucible and the inside of the micanite cone is filled with a suitable powdered heat insulator, lampblack being a very suitable material for a steel-melting furnace, although electrically sintered and powdered magnesia or several other materials may be substituted for lampblack where strictly carbon-free melts are demanded. The construction is shown by the cross-sectional view in Fig. 2.

When a crucible has become used up, it is easily withdrawn from the powdered encasement of heat-insulating material and a new crucible inserted in its place. This conical crucible is designed to hold from

50 to 60 lb. of metal of the density of steel, and will melt and pour this weight of any metal of high specific resistance like a ferrous alloy which melts under 1,200 deg. C. Where metals are to be melted which require excessive temperatures, like a very low-carbon steel, it is not desirable to attempt to melt and pour at one time more than 25 lb., though it is possible to pour somewhat larger amounts. In the case of the alloy used in casting the metal parts of typewriters 50-lb. pours have been made with much success.

FEATURES OF THE FURNACE

Any of the metals or alloys which are to be melted can be placed in the crucible in the form of turnings or in the form of masses which may have a subdivision down to the size of a pea, but not in the form of a fine powder. The heating of these metals when above the temperature at which iron loses its magnetism is due entirely to the large currents which are induced in the mass of the metal. When the metal is magnetic, there is further development of heat due to the hysteresis losses caused by the rapid reversals of the magnetism. Iron and steel, therefore, are heated with particular facility because of this fact and likewise on account of the high specific resistance of these metals.

A feature of marked value when melting alloys is the rapid stirring which takes place in the molten metal. This stirring is not a circular motion, but an upward motion in the axis of the pool and a downward motion in the circumferential region. When the power is on, the surface of the metal is not level, but considerably crowned. This stirring action is due solely to the action of electromagnetic forces and is in no sense a heat phenomenon. Its effect in insuring a thorough mix of the components of an alloy is very beneficial. In melting steel all dross of the metal is swept upward to the surface, where it remains. It is possible to pour castings which are very clean and with the constituents of an alloy very homogeneously distributed. For example, the Western Electric Co. has been pouring with a furnace of this general type an alloy of pure electrolytic iron and pure electrolytic nickel. The metal was cast in bars about 20 in. long and $\frac{3}{4}$ in. in diameter. Repeated analyses show that the composition of these bars varied less than 0.01 per cent for portions of the metal selected from different parts of the bar. This homogeneity attainable in an alloy was found to have great value in the case of alloys used for drawing into thermocouple wires.

HOW A POUR IS MADE

When a pool of 20 to 50 lb. of molten metal has formed in the crucible a pour is made as follows: The two handles shown in the illustration, Fig. 3, are attached to opposite side walls of the furnace. The furnace is lifted from its table by two handlers, one of whom rotates the furnace by means of the double handle and makes the pour. It is not difficult to guide the molten metal into a small orifice.

In Table I is given a typical melt made with one of these furnaces. The material to be melted was 20 lb. of steel turnings. These had evidently been gathered off the floor. They contained much admixture of dirt and oil and formed a bulky mass. At the beginning of the melt the entire furnace, including the crucible, was at room temperature. The crucible was filled to the top with steel turnings. This took about one-quarter of the 20 lb. A record of the progress of the melt taken

directly from the note book as there recorded is given in Table I.

Commenting on this melt, it may be stated that we could have continued to add turnings until 50 lb. of

TABLE I. MELT OF STEEL TURNINGS IN 10-IN. CONICAL FURNACE*

Sample consisted of 20 lb. of steel turnings marked 2-A		
Time	Kw.	Notes
12:50	15	Furnace was started at about 100° C. Furnace was packed to within $\frac{1}{2}$ in. of top with steel turnings.
1:05	15	
1:06	17 $\frac{1}{2}$	
1:07	20	
1:08	20	First charge melted at bottom. Poked down and added more steel turnings.
1:10	18	
1:11	20	
1:13	19	
1:15	18	Remainder of the 20 lb. of steel turnings was put in furnace.
1:20	17	
1:23	16	Bottom of mass melted. Poked down with asbestos-board poker.
1:24	18	
1:26	18	Metal nearly all melted.
1:28	18	Put one handful of flux on surface of molten metal.
1:31	20	Melt complete and quite fluid.
1:37	20.5	Poured melt which when cold weighed 16 $\frac{1}{2}$ lb.

*Test by E. F. Northrup and Bert Robbins, Nov. 20, 1920.

the material became melted; but this was not done, as no more material was at hand.

At another time, using the same furnace and crucible, 50 lb. of the metal out of which the castings for type-writer frames are made was melted, with an average



FIG. 3. MAKING A POUR

input of 17 kw., in two hours and twenty-six minutes, and five minutes later poured into molds. The metal was very fluid and fine castings were obtained. The metal is non-magnetic, and the melting was produced solely by the eddy currents induced in the irregular masses of metal placed in the non-conducting crucible. For efficient and rapid melting of a metal of this character a molded carbon or graphite crucible should be used.

SUMMARY OF UNIQUE FEATURES OF FURNACE

The unique features of this furnace may be summarized as follows:

The exterior is at all times at room temperature.

As soon as the metal becomes molten it is actively stirred by an automatic process.

The metal is maintained quite free from contaminating gases, and may be melted quite free from carbon.

The heated mass is heated very uniformly throughout, which makes it possible entirely to avoid metal losses which might otherwise result from the driving off of volatile constituents.

The upper temperature limit obtainable is exceedingly high. No conclusive tests on the maximum temperature obtainable have been made with a furnace of this size and capacity, but it may be conservatively stated that a temperature of 1,800 deg. C. may be obtained.

The control of the temperature is perfect, and inasmuch as the heat is generated directly in the melt the temperature will stop rising instantly when the power is much reduced or cut off.

The furnace permits changing from one kind of melt to another in the shortest possible time. The crucible which carries the melt can be slipped out of its powdered refractory and another put in its place in a few minutes. Thus any metal from one melt which remains on the walls of the crucible will not be present to contaminate the next melt when of a different material.

As all parts of this furnace except the crucible and the melt are substantially at room temperature, the essential parts of the furnace suffer little wear and are little likely to become destroyed. The construction is such that each of the parts of the furnace is easily replaced or renewed, and the construction as a whole is simple and inexpensive.

SIZES AVAILABLE AND POSSIBLE

If a sufficient supply of high-frequency power is available this same general type of furnace could be constructed to melt steel in tonnage lots. At the present time, however, the only furnace for this purpose which has been commercialized as a market product is of the size and character described in the foregoing.

USE OF THIS TYPE OF FURNACE FOR NON-FERROUS, HIGH-CONDUCTIVITY METALS AND ALLOYS

Such metals as brass, copper, gold and silver have too high conductivity to be melted with any satisfactory efficiency by direct induction. To adapt the furnace, therefore, for melting metals of this character it is only necessary to supply a crucible of molded carbon or graphite to replace, or if preferred, to fit into the crucible of non-conducting material used for melting materials of low conductivity. When the furnace is furnished with a crucible of conducting material, the heat is generated directly in the walls of the crucible, and this heat is transmitted to the metal contained in the crucible by conduction and radiation.

A furnace of the size and character described, and arranged for melting copper and energized by a standard 20-kw. high-frequency converter set will melt about 85 lb. of copper an hour, or between 600 and 700 lb. in an eight-hour day.

The theory and possibilities of heating with high-frequency currents were fully set forth by the writer in a paper read at the meeting of the American Electrochemical Society held in New York City April 3, 4 and 5, 1919, the title of his paper being "Principles of Inductive Heating With High-Frequency Currents."

The furnace which it has been the purpose of this paper to describe is only one of many types which have been developed for operation with high-frequency current. Their usefulness has been established in many laboratories and in several industrial plants.

The advantages of heating by high-frequency induction are continually being more thoroughly impressed on the minds of heating engineers. The author personally feels this application of electric methods offers more promising possibilities than almost any other development being made at the present time.

Experimental Shale Oil-Retorting Plant

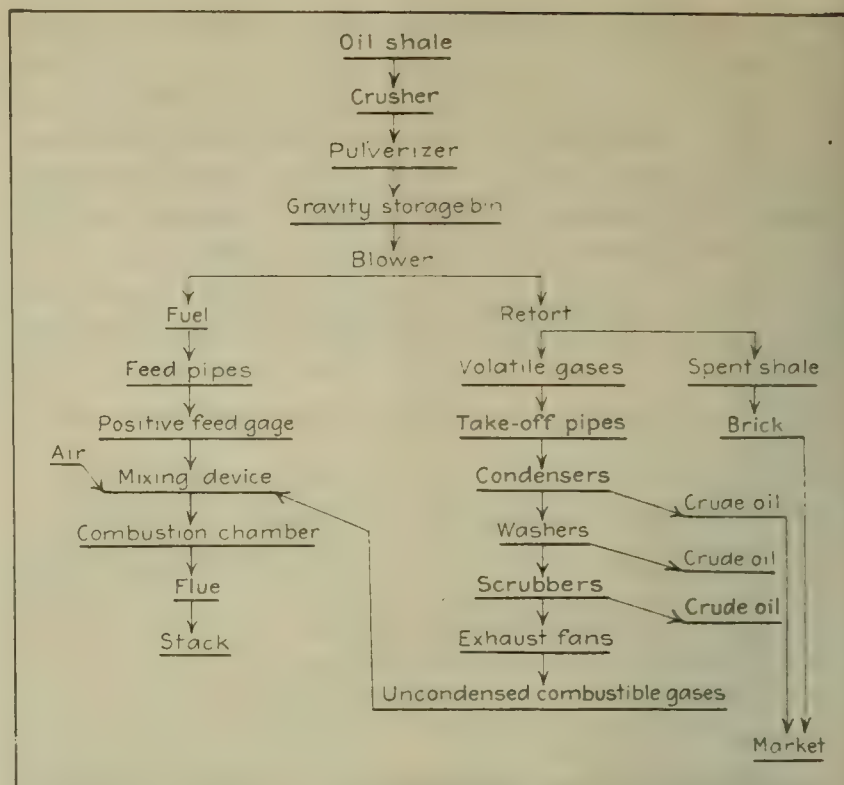
AN INTERESTING development in the process of retorting oil shales is now being tested in a 15-ton commercial unit by the Shale Oil Refining Corporation, of New York, at Denver, Col., using the Johns reduction process.

The shale is first crushed and pulverized so that it passes a $\frac{1}{4}$ -in. screen and is then elevated by a conveyor to a storage gravity feed box. From this box a small portion of the material, mixed with air and non-condensed combustible gas from the retort, is forced by a blower into the combustion chamber under the retort, where it is used as a fuel.

The remainder of the pulverized product is fed into the retort and distilled. A mechanical scraping device spreads about 500 lb. of the crushed shale in a thin even layer about $1\frac{1}{2}$ in. deep over the bottom of the retort, and at the same time progressively moves the material through the retort. By this means the entering shale is subjected to the lowest temperature, and then as it moves along the temperature is increased until by the time the particles reach the hottest part at the lower end of the retort all the oil has been driven out. This process is continuous and takes about twenty-five minutes. The spent shale drops off into either a water or a dry seal and is removed by scraper belts. It may be utilized for the manufacture of brick or for other purposes.

The unit retorts are 23 ft. long, $4\frac{1}{2}$ ft. wide, about 5 ft. high in front and 9 ft. in back and are constructed with a concrete base and ordinary firebrick walls with firebrick lining for firebox and flues. The heating chamber itself extends the entire length and width of the retort and is about 9 in. high. The top is composed of angle-irons and sheet metal plates, laid in loose and covered with sand as a seal. A scraper device is also attached to the top for turning over and moving along the shale on the retort. Lugs are fitted to the top so that it can be lifted off as a unit and repairs easily made on the retort.

Carborundum tile is being substituted for the firebrick because, due to its greater heat conductivity, it



FLOW SHEET

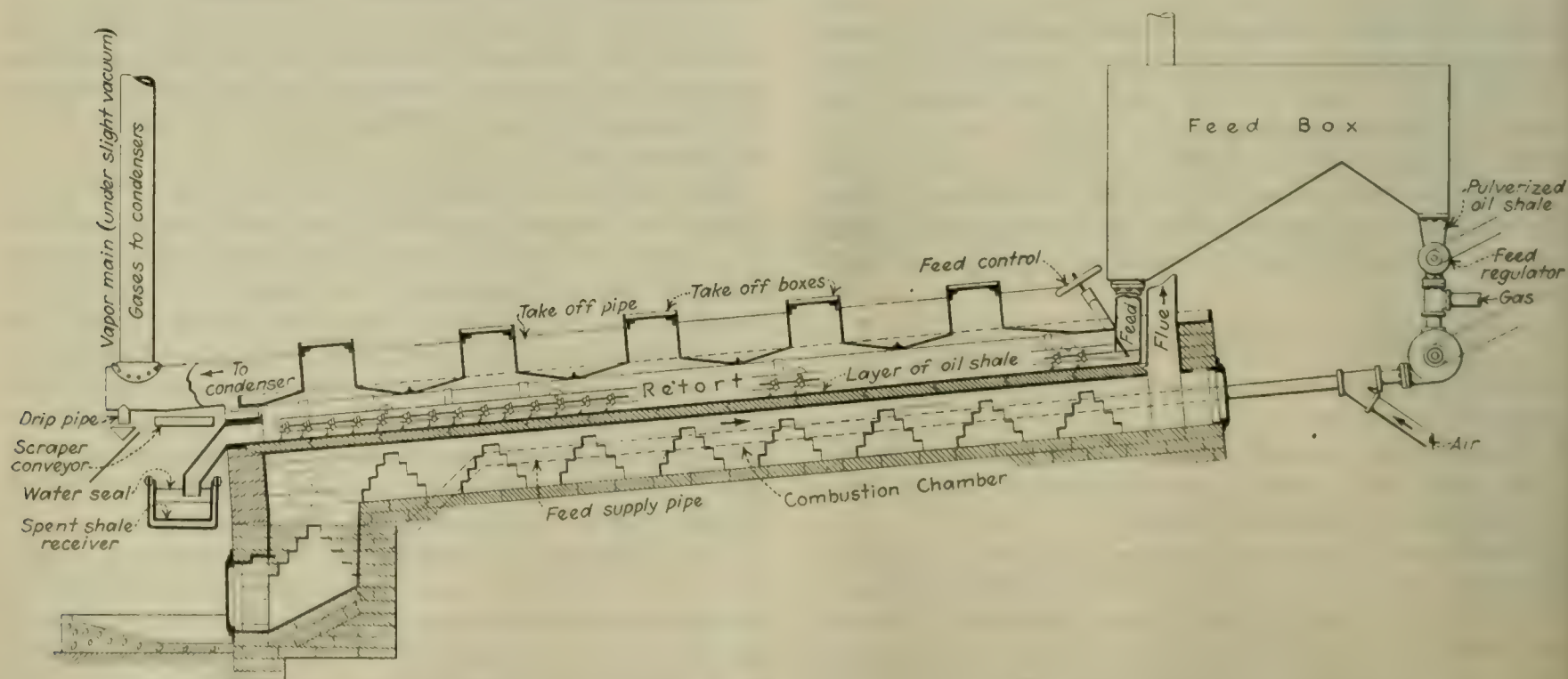
is expected that the capacity of the plant will be increased greatly.

Take-off boxes suitably arranged at various intervals in the top of the retort are designed to carry off the liberated oil vapors to the vapor main as quickly as possible so as to minimize cracking by further heating. The vapors are then carried to the condenser, where they are cooled and crude oil obtained.

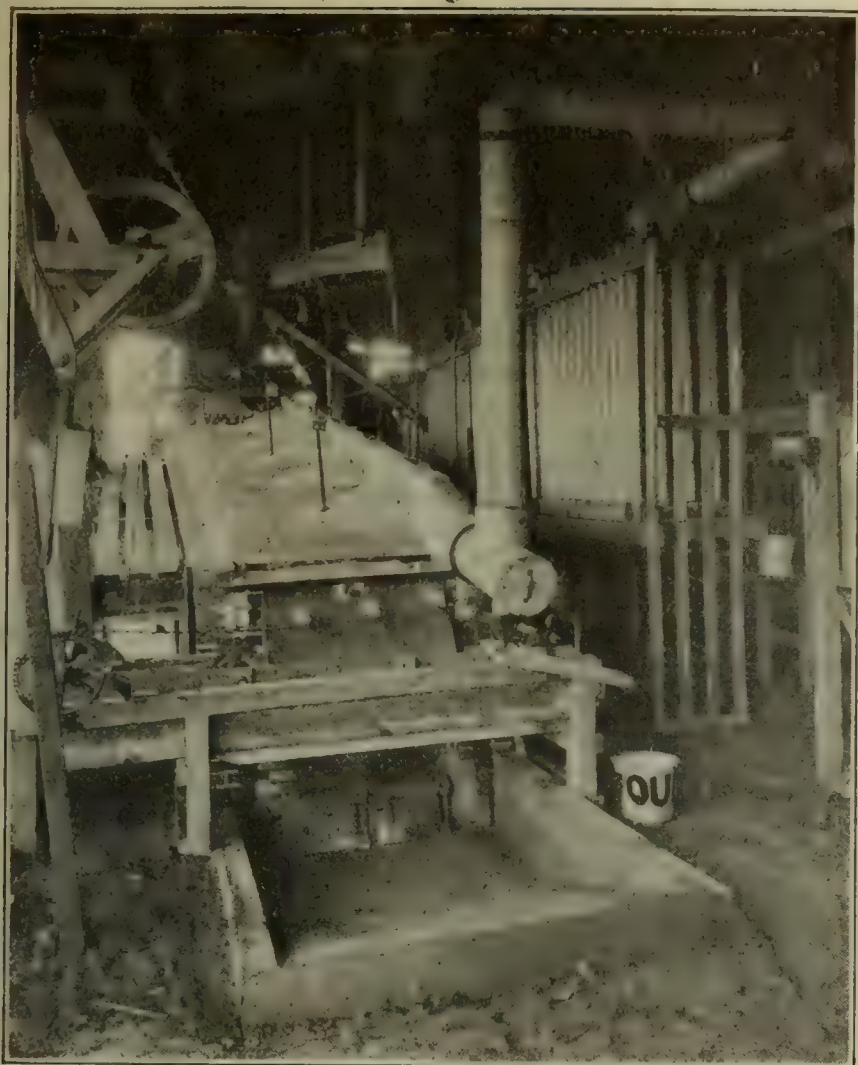
Pyrometers installed at various points enable the workmen to check and control the temperature at any desired point and thereby obtain a more uniform product.

To test certain operating conditions a number of runs have been made. One was of fifty hours duration, two of eighty hours and one of five days. In October, 1920, a test was made before the Oil Men's Convention, to demonstrate the process on a commercial scale.

Samples of distillate taken from four points—the foul main, the first and second condensers, and dry coke scrubber—after being separated from the water and redistilled were found to give a smooth flowing black



CROSS-SECTION OF OIL SHALE RETORT



GENERAL VIEW OF RETORT AND CONDENSER

oil at ordinary room temperature. According to distillation figures, 20 per cent of oil was distilled under 437 deg. F.) 80 per cent at 725 deg. F. and 92 per cent of distillation was carried on till coke formed.

The light oils taken by the absorber oil amounted to only 2 per cent of the total but, for shale oil, this light fraction is of an extraordinarily high gravity and of a low percentage of unsaturated compounds, and could be used to improve the character of the oil obtained from the condensers or else refined by itself.

A 50-ton testing plant, together with an up-to-date laboratory, is to be built by the company in the vicinity of New York City for the purpose of experimenting with oil shales shipped from foreign countries.

Sugar Exports From Cuba to the United States

The increased price of sugar accounted for the large increases in the value of the declared exports from Cuba to the United States during the past year, as compared with 1919, which are shown in the following table:

Items	1919		1920	
	Lb.	Value	Lb.	Value
From Antilla				
Sugar.....	635,663,650	\$37,345,087	585,108,839	\$78,499,816
All other articles.....		1,478,444		2,506,106
Total.....		38,823,531		81,005,922
From Cienfuegos				
Sugar.....	589,617,280	35,172,742	322,524,800	39,470,078
All other articles.....		1,528,273		1,527,108
Total.....		36,701,015		40,997,186
From Caibarien				
Sugar.....	416,243,525	22,509,079	389,943,850	44,798,841
All other articles.....		84,782		70,066
Total.....		22,593,861		44,868,907
From Sagua La Grande				
Sugar.....	464,309,029	25,107,844	447,391,290	50,420,446
All other articles.....		268,083		454,654
Total.....		25,375,927		50,875,100

Synopsis of Recent Chemical & Metallurgical Literature

Synthetic Preparation of Humic Acids.—In the Jan. 10 issue of *Chemical Abstracts*, p. 83, there is a record taken from the *Berliner Berichte* (vol. 53, pp. 1469-76, 1920) of an achievement of leading interest contributed by Wilhelm Eller and Kaete Koch. In this they show that the deep black-brown products formed by the oxidation of phenols in alkaline solution are humic acids. It appears, however, that only such phenols yield humic acid as can, in some way, pass through a quinoid stage as an intermediate product. Thus $m\text{-C}_6\text{H}_4(\text{OH})_2$ forms no humic acid, whereas the compounds obtained from the ortho and para bodies and from quinone have the composition $\text{C}_6\text{H}_4\text{O}_3$. The proof of the identity of this oxidation product with the natural humic acids is difficult, but their physical properties and chemical reactions are such as to leave no doubt of it in the minds of the authors. They hold that there is but one humic acid, but that different phenols yield different humin substances. The nitrogen in natural humic acid is said to be due to impurities. The acid reaction of humin substances, on the other hand, is not due to impurities, but to unchanged phenolic OH groups.

Use of Aluminum for Electric Transmission Lines.—The September, 1920, issue of *Annales des Postes, Télégraphes et Téléphones* contains an important article on the use of aluminum for electric transmission lines by M. DUSAUGEY.* The author, after passing in review the history of the manufacture of aluminum and the important manufacturing concerns in Europe and America, describes the different phases leading to the adoption of aluminum in the electrical transmission industry and to the official specifications of 1913 for aluminum electric conductors. During the war a special official French commission, of which the author was one of the members, made a thorough study of the chemical and mechanical properties of the aluminum to be used and summarized the data obtained under the captions chemical composition, mechanical resistance, limits of elasticity and elongation, softeners and electric conductivity, also giving a long comparative table of the properties of commercial aluminum and copper.

A 99 per cent aluminum containing no other impurities than iron and silicon, with traces only of oxygen and carbon, gives the best practical results. He then enumerates the mechanical properties required and states that it is a very simple matter to obtain the appropriate metal which would enable the substitution of aluminum for copper in transmission cables, with a reduction in weight of half of that of copper for equal electric conductivity. He even states that for high voltage transmission lines (100,000 volts) aluminum is far more efficient than copper. Taking the weight of copper as 100, the author gives the following ratios between the weights of aluminum and copper:

For equal section of conductors.....	30 : 100
For equal heating of the conductors during the passage of the same current.....	42 : 100
For equal conductivity.....	50 : 100

The first ratio is of value especially for telephone and telegraph lines. If m is the ratio of the prices of aluminum and copper the percentage of gross economy realized by the use of aluminum is $e = 100 - 30m$.

The second ratio is of value in cases of interior conduits where the heating of the conductors plays an important part. Here the percentage of gross economy realized by the use of aluminum would be $e_1 = 100 - 42m$.

The third ratio is of value wherever electric conductors are used, and the percentage resulting from the use of aluminum instead of copper would be $e_2 = 100 - 50m$.

With copper, say, at 15c. per lb. and aluminum at 27.5c.

*L'Aluminium et son application aux lignes électriques; *Annales des Postes, Télégraphes et Téléphones*, M. Dusauguey, September, 1920, pp. 366-412.

per lb., the respective economies would be $e = 46$ per cent, $e_1 = 24.4$ per cent, and $e_2 = 10$ per cent.

The following table summarizes partially the comparisons of the different types of electric conductors.

	Commercial Aluminum	Commercial Copper	Aluminum-Steel, 7 Strands	Aluminum-Steel, 37 Strands
Specific weight, g. per c.c.	2.7	8.95	3.55	3.85
Electric conductivity (relative)	60.0	100.0	51.5	49.0
Coefficient of linear expansion	22×10^{-6}	16×10^{-6}	18.2×10^{-6}	17.25×10^{-6}
Breaking limit, kg. per sq. mm.	20	42	29	32
Coefficient of elasticity, kg. per sq. mm.	11 to 12	21 to 25	16	17 to 18
Ratio of sections for equal conductivity	1.666	1	1.943	2.05
Ratio of the diameters for equal conductivity	1.29	1	1.395	1.43
Ratio of the weight for equal conductivity	0.5	1	0.73	0.835

The article concludes with a note giving the official methods for the quantitative analyses for silicon and iron, the aluminum percentage being obtained by difference.

Determination of Silicon: A 2-g. sample is placed in a 250-c.c. porcelain dish. Add 50 c.c. of a mixture consisting of

Nitric acid, c.p. (density 1.42)	c.c. 100
Hydrochloric acid, c.p. (density 1.2)	300
Sulphuric acid, c.p. (density 66 deg. Bé.)	100
Distilled water	100

Ten to 12 minutes is required for complete solution at normal temperature. When the metal is completely dissolved add 15 c.c. H_2SO_4 , c.p. and heat until white fumes appear; cool; add 100 to 150 c.c. H_2O , boil, filter, wash free from sulphates, dry, ignite, cool, weigh. The result is SiO_2 , which is figured to silicon.

Determination of Iron: A 2-g. sample is placed in a 500-c.c. flask. Add 50 c.c. of the mixture

Hydrochloric acid, c.p. (22 deg. Bé.)	c.c. 500
Distilled water	500

Solution takes place at normal temperature or better when heated slowly. When the reaction is completed (no more bubbling) and with a pipette 50 c.c. of preventive solution consisting of

Manganese sulphate, c.p., grams	50
Phosphoric acid, 65 per cent, c.c.	100
Sulphuric acid, c.p., c.c.	100
Distilled water to complete up to c.c.	1,000

Add now 150 c.c. H_2O and titrate with a KMnO_4 solution each c.c. of which is equivalent to 2 mg. Fe.

Surface Tension and Capillary Flow.—In a paper under the title, "The Dynamics of Capillary Flow," read before the American Society for the Advancement of Science, Physics Section, Dr. Edward W. Washburn described a new, very accurate and quite simple method for the measurement of surface tension. For a horizontal tube l cm. long and of the average radius r the flow during the time t will be according to the equation

$$l^2 = \frac{\gamma \cos \theta \, r t}{2\eta}$$

where γ is the surface tension, θ the angle of contact, η the viscosity and $\frac{\gamma \cos \theta}{2\eta}$ might be called the coefficient of penetration.

The tube may be of almost any length, making the method very accurate. If there is any difference in air or hydrostatic pressure at the two ends of the tube, it must be added to the surface tension.

Statistical problems connected with the rise of liquids in capillary tubes have been investigated on both the theoretical and the experimental side, but the dynamical aspects do not appear to have received much attention.

Aside from the theoretical interest attaching to the subject, the dynamics of capillary flow have certain practical aspects in connection with the movements of water or oil through soils, the impregnation of wood and other porous materials with liquids, and the determination of the porosity and true density of porous bodies, as well as offering a new method for measuring the surface tension or viscosity of a liquid.

The rate at which a liquid penetrates a small cylindrical capillary of radius r was shown to be

$$\frac{dl}{dt} = \frac{P(r^2 + 4er)}{8\eta l}$$

where P is the driving pressure, e the coefficient of slip and η the viscosity.

The Penetration of a Porous Body by a Liquid. If a porous body behaves as an assemblage of very small cylindrical capillaries, the volume V of liquid which penetrates it in time t is given by

$$V = k \left(\frac{r}{\eta} t \right)^{\frac{1}{2}}$$

Experiments with mercury, water and other liquids verify the theoretical deductions completely.

In measuring the surface tension by the dynamic method, horizontal capillaries are perhaps the most convenient, although by using the vertical capillary immersed some distance in the liquid and allowing the liquid to drop from a point some distance beyond its equilibrium position, it should be possible to obtain good results.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Continuous Cyanamide Furnace.—Reactions between carbides and nitrogen may be carried out continuously in an annular furnace provided with an endless base plate or table. This table rotates and conveys the carbide which is placed upon it through a counter-current stream of nitrogen. Just before reaching the feeding hopper the finished material is removed by a scraper and discharged from the furnace. The carbide is preferably placed on a layer of inert substance rather than directly on the moving ring. By regulating the temperature and the flow of nitrogen, the reaction is readily controlled. (1,364,157; VICTOR THRANE, of Christiania, Norway; Jan. 4, 1921.)

Separation of Meta- and Para-Cresols.—Commercial cresylic acids contain ordinarily the three isomeric cresols in the same proportions relative to each other as they occur in coal tar. Ortho-cresol may be very completely removed from this mixture by column distillation, but since the boiling points of meta- and para-cresol are so nearly the same, chemical means must be used for their separation. Since it has been found that meta-cresol is more easily sulphonated than para-cresol, several methods have been proposed for the separation of these two compounds by sulphonating the former and removing the unsulphonated latter by means of a solvent. The residue is steam-distilled at atmospheric pressure around 110 deg. C. to break up the meta-cresol mono-sulphonic acid. According to this procedure there is present in the reaction vessel a relatively large excess of concentrated sulphuric acid at the start and a large amount of dilute acid at the finish. This is objectionable because the concentrated acid tends to sulphonate more para-cresol than is desirable and because there is a large amount of dilute acid which is unreactive which increases the cost of the operation. CHARLES R. DOWNS of Cliffside and RALPH S. POTTER of Grantwood, N. J., have discovered that by sulphonating with SO_3 in the vapor phase excess sulphuric acid is avoided and that by diluting with an equal volume of water and vacuum distilling at 70 deg. C., the unsul-

phonated para-cresol distills over. It is recovered from the condensate by extraction, cooling and centrifuging. If it is merely desired to produce a meta-cresol of 80 per cent purity, the vacuum is released and the sulphonated residue in the still is decomposed by heating to about 120 deg. C. and injecting steam. If a meta-cresol of higher purity is desired the sulphonic acid is crystallized out by cooling, filtered off and decomposed by steam. (1,364,547; assigned to The Barrett Co.; Jan. 4, 1921.)

Cyanides and Rich Producer Gas.—The following modification of the process for making cyanides by passing nitrogen over C, Na_2CO_3 and Fe is proposed by RICHARD FRANCHOT, of Niagara Falls: Gas containing 34 to 35 per cent CO is made in a slagging gas producer charged with coke, anthracite or bituminous coal as fuel, limestone as flux, and run with a hot blast so that temperatures of 1,400 to 1,500 deg. C. are reached in the hot zones. This gas is passed over balls or bricks made of magnesia 20 per cent, coke 15 per cent, soda ash 15 per cent and iron or its equivalent as oxide 50 per cent. In the reaction which ensues nitrogen combines to form alkali cyanide and the oxygen in the soda ash is converted into carbon monoxide. As a result the CO content of the gas is increased to over 40 per cent, while the temperature drops from 1,400 to 800 deg. C. The balls are leached or steamed to recover cyanide or ammonia, and re-used until they break down physically. They are then added to the charge in the producer. The iron is melted and may be collected in the usual way, while the silicates, etc., are slagged and the sodium content converted into cyanide, which volatilizes and deposits on the briquets. (1,364,838; assigned to Ferro Chemicals, Inc.; Jan. 4, 1921.)

Nitric Acid.—When sulphuric acid and sodium nitrate are mixed in a still or receptacle there occurs a violent chemical reaction, which results in a high pressure, and in the systems now generally employed this pressure often results in the loss of a large part of the gases due to portions of the system or apparatus being blown apart, and particularly blowing out the putty at the joints of the bleachers and condensers. This difficulty may be overcome by the use of an expansion chamber of 14 in. chemical ware or Duriron pipe, into which the gases from the battery of twenty stills are allowed to escape and mix freely. This results in a more even flow of gas to the bleachers—five in number—in which the acid flowing down from the condensers is bleached by the action of the hot gases about to enter the condensers. (1,361,416; CHARLES L. TAYNTOR, of Claymont, Del.; Dec. 7, 1920.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Non-Fragile Glass.—Non-fragile glass, which can be rolled, forged, extruded, cast, etc., is made by dissolving in the dry state such silicates as micaceous or asbestos minerals in molten glass or similar silicate. The glass, etc., is chosen so as to melt at a temperature below the temperature at which the mica, etc., effloresce. If the product is to be machined, an excess of mica, etc., should be present over the amount required to form a saturated solution. (Br. Pat. 152,780. P. B. GROSSLEY, Calcutta, India; Dec. 31, 1920.)

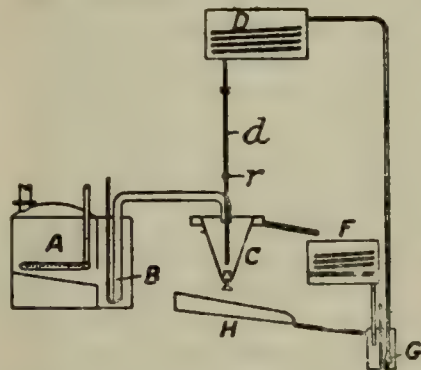
Purification of Zinc.—In the purification of zinc solutions, and in particular the preparation of zinc solutions for electrolysis, silica is separated in a filterable form by adding an alkali or alkaline earth carbonate in slight excess to the neutral or substantially neutral liquor, at an elevated temperature. In an example, a ground zinc sulphide ore is roasted to convert to oxide and sulphate and then after re-grinding is added to hot sulphuric acid of 10 to 15 per cent strength, which may be that obtained from the electrolytic cells. When the acidity has been reduced to 5 per cent, it is still further diminished to 1 per cent by the addition of a mixed precipitate of zinc oxide and carbonate and iron oxide, obtained in a subsequent stage in the purification. Neutralization is finally attained by adding whitening in the form of powder or of a milk made with water. The silica is then precipitated by adding about 10 lb. of whitening per ton of liquor and maintaining the tempera-

ture at 90 to 100 deg. C. for a short time with agitation. After filtration, the silica is washed with water to free it from zinc. (Br. Pat. 152,752. F. PETERSON and METALS EXTRACTION CORPORATION, London; Dec. 31, 1920.)

Coating With Copper.—A copper-salt solution is reduced by hydrazine hydrate in the presence of ammonia, the copper being deposited as a coherent coating on heated, non-conducting, smooth or polished surfaces, such as glass, china, porcelain and the like, in contact with the solution. The coating liquid can be prepared by adding strong copper sulphate solution to a strong solution of hydrazine sulphate in hot water until a faint blue color persists on standing and a pale-blue powder is precipitated. If not for immediate use, the powder may be filtered and dried. When used, it is suspended in cold water, a few drops of cold hydrazine sulphate solution added, followed slowly by a solution of ammonia until the liquid turns dark brown, when caustic soda solution is added until a slight yellow or orange precipitate persists after shaking. The precipitate is dissolved by a little hydrazine sulphate, yielding the clear yellowish or brownish liquid required. (Br. Pat. 152,835. J. D. SMITH, The University, Birmingham; Dec. 31, 1920.)

Ultramarine.—Sulphites or bisulphites of the alkalis or mixtures of these salts are used in the manufacture of blue or green ultramarines to replace wholly or partially the alkali carbonates or sulphates usually employed. The sulphite of soda obtained as a byproduct in the preparation of phenol is particularly suitable for this purpose. In an example, the furnace charge consists of kaolin, sulphite of soda, sulphur and a reducing agent such as resin. (Br. Pat. 152,916. J. B. GUIMET and A. GUILLOCHIN, both of Fleurien-Sur-Saone, Rhone, France; Dec. 31, 1920.)

Purifying Ammonium Sulphate.—The coloring matter usually associated with crystals of ammonium sulphate is removed by agitating the latter, in a detached condition in a clear saturated solution of that salt, maintained slightly acid—if necessary by the addition of sulphuric acid—and floating of the suspended impurities. The agitation may



be performed mechanically, or by blowing with air or steam, but preferably it is effected by means of the saturated ammonium-sulphate solution, which enters at a point near the bottom of the conical-shaped treatment vessel containing the crystals. The rapid stream on entering stirs up the crystals, but as the diameter of the vessel increases

only the impurities remain suspended. The accompanying figure shows the saturator A from which crystals are removed to the vessel C by means of steam lift B. A stream of filtered saturated ammonium sulphate enters by pipe d, and is regulated by valve r. The temperature of the liquor throughout the system is maintained at the same temperature as the crystals coming from the saturator by means of steam coils in the storage tank D and the filter F. The clean crystals are discharged periodically on to the drainer H, the liquor collecting in the sump G, from which it is raised to tank D by means of an air lift. An ordinary saturator may also be adapted for the process. Crystals having been deposited, the passage of ammonia is reduced or stopped. A filtered saturated solution of sulphate of ammonium is supplied near the bottom of the saturator and overflows through a launder and passes to the filter as previously described. (Brit. Pat. 152,766. R. LESSING, London; Dec. 31, 1920.)

Treating Zinc.—Finely divided zinc or zinc dust for use in the purification of zinc solutions prior to electrolysis, for precipitating metals from cyanide or other solutions and as a reducing agent in the preparation of organic compounds is treated with a view to increasing its activity. The zinc may be stirred with boiling water or with a solution of an alkali such as caustic soda. (Br. Pat. 152,997; not yet accepted; ELECTROLYTIC ZINC Co. of Australasia Proprietary, Melbourne, Australia. Jan. 12, 1921.)

Current Events

in the Chemical and Metallurgical Industries

American Ceramic Society to Meet in Columbus

The program of the twenty-third annual meeting of the American Ceramic Society, which occurs at the Hotel Deshler, Columbus, Ohio, Feb. 21 to 24, is on the press and will shortly be in the hands of members.

Nearly twice as many acceptances as last year have been received by the secretary, and over one hundred papers are on the program. The Divisions of Enamels, Glass, Refractories and Terra Cotta will have separate meetings on Tuesday, Feb. 22, with divisional papers. At the same time conferences will be held, with informal discussion, of three groups—Decorative Processes, Heavy Clay Products and White Ware—with a view to the formation of divisions.

The local committee is making attractive plans for entertainment. Section Q, on Monday evening, is open to members and guests, and the events of the evening are shrouded in secrecy. Nobody knows what is going to happen, therefore everybody will be present to find out. The banquet will be held in the spacious ball room of the hotel on Tuesday evening. Special plans are being made for the entertainment of ladies who accompany members.

Department of Agriculture Criticizes Use of Poison Gas for Boll Weevil Control

For the past eight months the Chemical Warfare Service has been engaged in a conscientious effort to be helpful in the matter of boll weevil control. The chemists connected with the Chemical Warfare Service are hopeful that war gases can be used to the benefit of the cotton growers, who suffer losses aggregating hundreds of millions of dollars each year, due to the ravages of the boll weevil. The Department of Agriculture not only has no faith in the successful outcome of the experiments being conducted by the Chemical Warfare Service, but on Feb. 9 issued an official statement the effect of which was to ridicule the idea of any such use of poison gases. Officials of the Chemical Warfare Service resent this attitude on the part of the Department of Agriculture. The statement was issued without conferring with the Chemical Warfare Service and without any effort having been made to ascertain what that branch of the Government service had done in the way of experimentation. As a matter of fact, the work had reached a point where it was being carried on jointly by the C. W. S. and the Agricultural Department of Georgia.

The Department of Agriculture took particular pains to deny a published statement to the effect that the work is being carried on in co-operation with it. It is true that no co-operative contract exists between the two federal agencies, but before embarking upon the experiments, the chief chemist of the Warfare Service conferred with the specialists of the Bureau of Entomology and was assured that they always stood ready to help any plan which had as its object a more effective control of the boll weevil. Supplied with data from the entomologists which would prevent duplication of any work that had been done, the Chemical Warfare Service proceeded with its experiments. No claims have been made for any successes, but when the proper time comes it is admitted that there may be something of a surprise in store for even the department which has been working on this problem with rather qualified success for a long period of years.

Fertilizer Report Soon

A comprehensive report on the fertilizer situation will be made to Congress soon by the Bureau of Soils of the Department of Agriculture. The report is being made in response to a Senate resolution and will contain comment as to prices and the general fertilizer situation.

Approved Patents for Government Employees

The conferees on the Patent Office bill have reached an agreement which includes the proposal that the Federal Trade Commission administer patents issued to Government employees. The conferees also agreed upon the salary scale approved by the House. The Senate made material reduction in this salary scale, but the conferees approved the higher salaries. In fact the bill, as passed by the House, was approved in almost all particulars. The real point of issue in the conference was the retention of the Government employee patent feature of the measure. No opposition of consequence is expected when the conference report is brought up for acceptance. The bill provides important revisions in the procedure in the Patent Office. The section referring to the handling of Government employee patents reads as follows:

That the Federal Trade Commission be, and hereby is, authorized and empowered to accept assignment of, on behalf of the United States, under such regulations and in such manner as the President shall prescribe, inventions, patents and patent rights which said commission deems it to the advantage of the public to be so accepted, as these may from time to time be tendered it by employees of the various departments or other establishments of the Government except employees of the Patent Office, and to co-operate, as necessity may arise, with scientific or other agencies of the Government in the discharge of the duties herein set out, and the Federal Trade Commission is hereby authorized and empowered to license and collect fees and royalties for licensing said inventions, patents and patent rights in such amounts and in such manner as the President shall direct, and shall deposit the same with the Treasurer of the United States; and of the total amount of such fees and royalties so deposited a certain per centum, to be determined by the President, shall be reserved, set aside and appropriated as a special fund to be disbursed as directed by the President to remunerate inventors for such of their inventions, patents and patent rights contemplated by this section as may prove meritorious and of public benefit. Provided, That nothing herein shall be construed to give to said commission or any other governmental agency any authority to engage in the manufacture of any such invention or patented article.

The Commissioner of Patents is hereby directed to grant all patents and record all assignments and licenses contemplated by this section without the payment of any fee.

Symposium on Corrosion

At the coming Atlantic City meeting of the American Electrochemical Society (April 21 to 23) one of the sessions will be devoted to a symposium on Corrosion—in particular, electrolytic corrosion. Among those who will participate are Messrs. A. S. Cushman, D. M. Buck, W. H. Walker, James Aupperle, H. S. Rawdon, F. N. Speller, O. W. Storey, Richardson, Shephard and Gardner. Although most of the discussion will be concerned with the corrosion of iron and steel structures, a number of the papers will be devoted to the disintegration of lead and other non-ferrous metals. The subject of corrosion has been growing in importance owing to the ever-increasing number of electric railway installations, buried cables, metal roofings and inclosures, large metal gas holders, storage tanks, etc. Corrosion is the one topic that interests men of almost every profession: the architect, the electrical engineer, civil engineer, metallurgical and chemical engineer, railroad engineer, surgeon, dentist, paint-chemist, geologist, etc. The Electrochemical Society's symposium on the subject will be the most complete yet organized.

Kiln Drying Course at Forest Products Laboratory

The February course in practical kiln drying will be given at the Forest Products Laboratory, Madison, Wis., Feb. 14 to 25. Instruction in these courses is not confined to any particular kind of kiln, although methods of drying different species of lumber and operation of various types of kilns are discussed. Emphasis is laid on the underlying principles of successful kiln drying and these can be adapted to any conditions. This course will be conducted much like the preceding ones, which have proved more popular than was expected.

Meeting of the American Ceramic Society, Chicago Section

The Chicago Section of the American Ceramic Society met at the City Club on Saturday, Feb. 5, for luncheon and subsequent technical program.

D. T. Sweely, of the Coonley Manufacturing Co., presented a paper on the acid resistance of enameled cooking utensils, which consisted of a series of notes to be given in more detail at the annual meeting of the Ceramic Society in Columbus this month.

Lester T. Wilson, superintendent of the Chicago plant of the National Lead Co., gave an interesting talk on the manufacture of lead products used in the ceramic industry. He described briefly the course of lead from the ore at the mines to the finished product, with references to the old Dutch, Carter and Lennox processes of making white lead and the methods of manufacture of red lead and litharge.

Of all the products which the ceramist purchases for his glazes nothing is perhaps more pure than lead, which has an average purity of 99.96 per cent. The copper content is always low, because copper alloys with lead in the proportion of 0.001 per cent only. The iron found in lead products, which is of course detrimental to the glazes, usually comes from the machinery in which the material is ground. Since the ceramist is interested chiefly in the actual metallic lead content of compounds, he should be careful to compare his market rates in determining whether to purchase white lead, litharge or red lead. The methods of determining weight per cubic inch in lead compounds is not a good test for determining the settling rate of the material in glazes. What the ceramist should determine is the real specific gravity.

The ill effects upon workers with lead are usually greater in plants using lead products than in lead manufacturers' institutions, because the latter realize the danger and take the necessary precautions. The lead industries have practically been legislated out of France and it is interesting to note the present legislation in the United States. There are many means for preventing lead poisoning, all of which the lead producer will gladly make available to the user of the product.

A resolution was passed at this meeting to call to the attention of the American Ceramic Society at the Columbus meeting the necessity for requesting the Lead Institute to furnish all ceramists with necessary information for preventing lead poisoning in clay-working plants.

X-Rays in Industry

Dr. John S. Shearer, of Cornell University, addressed the Connecticut Valley Section of the American Chemical Society in Waterbury, Feb. 5, speaking on "Some Recent Applications of X-rays in the Study of Metals."

In the course of his talk Dr. Shearer sketched briefly the history of the development of our knowledge of X-rays from the time of their discovery a quarter of a century ago. This development, he said, was twosided; on one hand the constant improvement in apparatus culminating in 1913 with the Coolidge hot cathode tube; on the other, a growing knowledge of the laws governing this powerful aid to science, also culminating in 1913 with the work of Laub, who was the first to go beyond studying X-rays by means of absorption.

With powerful sources of X-rays to work with and with the use of crystals for diffraction gratings, thereby rendering it possible to know the positions of atoms in the molecule, a tremendous advance in the study of the fundamentals became possible. Advance in this direction has hardly begun. Phenomena depending upon atomic arrangement, such as amorphous films, surface tension, self-annealing, season cracking, dispersion of excess constituents, may evidently be studied directly with the X-ray, thus securing data which will prove or disprove many accepted theories based only on inference.

Dr. Shearer did not believe that the X-ray would ever become valuable as an instrument for control work, but it has great possibilities in the perfection of processes and study of causes of failure with an eye toward their re-

moval. It is important to note that its use does not injure the specimen.

During the war X-rays proved valuable in investigating the condition of loaded rifle shells. It was possible to check up on the performance of the loading machinery and tell whether or not it was functioning properly; also jacketed bullets could be tested.

Not only metals but wood can be examined. The grain of wood shows up very clearly in an X-ray photograph, and varnish or any other protective coating makes no difference. Consequently the X-ray was used to some extent in airplane construction inspection to see that inferior woods were not substituted for spruce.

In conclusion Dr. Shearer warned his hearers that there were two sources of danger in the use of modern X-ray apparatus: the high tension current used for generating them and the rays themselves, for X-ray burns are quite serious. On the practical side great difficulties must be overcome before X-rays can become useful except in especially trained hands. There is no "foolproof" source of them yet developed.

Research in Explosives and Nickel

Some benefits to industry resulting from research scientifically conducted were interestingly stated by Dr. Charles L. Reese, chemical director, E. I. du Pont de Nemours & Co., and A. J. Wadhams, general superintendent, International Nickel Co., in addresses before the Division of Engineering of the National Research Council on Friday, Feb. 4, at the Engineers' Club, New York.

Dr. Reese emphasized the value to industries of organized research in particular. Some research projects are not immediately productive of financially profitable returns, others yield great savings or large profits immediately. If research be properly organized, or conducted on a co-operative basis by one great industry or a group of industries, a winning average from the accountant's method of keeping score is much more likely to be made. Organization and co-operation, however, must be so conducted that the individual research worker feels no restraint.

Mr. Wadhams told of the hurdles research had to take successfully in order to become established in old industrial plants. Three groups particularly required "converting" the directors, the shop superintendents and the foremen. Success depends largely upon the human qualities of the research personnel and their ability sincerely to recognize the value of the knowledge gained by the practical man in his experience, as well as the knowledge of the laboratory.

Galen H. Clevenger, consulting metallurgist, U. S. Smelting & Refining Co., Boston, presided at the meeting of the Division of Engineering, at which there were present twenty-two members and guests, men of high standing as research specialists or executives in leading industries. The Division's work is directed toward stimulation of research in the industries and bringing about co-operation in the acquisition of new scientific knowledge and its dissemination among engineers and managers of our industries. The division is supported by the National Research Council and by Engineering Foundation, representing the great national societies of Civil, Mining, Metallurgical, Mechanical and Electrical engineers.

Chemists Oppose Packers' Bill

Information reaching Washington is to the effect that manufacturing chemists, as a rule, are opposed to the bill for regulating the packing business. While sentiment among them is thought to be against any expansion of federal regulation of private business, there is a particular reason in the case of the packer bill, since the control is extended to the byproducts of the packing industry. A strict interpretation of the bill probably would enable this federal control to ramify into the fertilizer industry and other chemical activities using any of the byproducts of the packing industry.

The Haugen bill is regarded as being much more desirable than the Kenyon bill, which was passed recently by the Senate.

Dr. Smith Speaks on "Research"

A joint meeting of the New York Sections of the American Electrochemical Society, American Chemical Society, Society of Chemical Industry and Société de Chimie Industrielle was addressed by Dr. Edgar F. Smith Friday, Feb. 11, at Rumford Hall.

Dr. Charles A. Doremus presided. In his introductory remarks he made allusion to the work done by Dr. Smith as a historian of the early American chemists, and outlined some of the activities of James Woodhouse, founder of the first chemical society in America, and of Robert Hare, who did great pioneer work in electrochemistry. He compared this work to that of Benjamin Franklin and showed that the experiments of these two great American philosophers have been of the greatest importance to the development of applied science.

Dr. Smith gave a very interesting talk on "Research," in which he stated that research is a great work, but that to do it successfully the chemical investigator needs to be armed with sound preliminary education in general chemistry and other academic studies so as to enable him better to correlate the results of his work.

Tariff Free List Under Consideration

Consideration of the free list schedule of the tariff bill was begun by the Ways and Means Committee of the House of Representatives on Feb. 11. Many of the raw materials used by chemists are included in this schedule. If these raw materials are to be removed from the free list and made dutiable, it will be necessary to revise the duties asked on manufactured chemicals, since the cost of production would be enhanced by a duty on raw materials.

Since the interest in the articles on the free list is mostly of an individual character, there was concerted action among the manufacturing chemists on comparatively few items. The opposition to a duty on iron pyrites, however, was unified. Since sulphuric acid is such a basic material, the consensus was that pyrites should be continued on the free list.

All Hope for Nitrogen Corporation Bill Dies

Senator Underwood, who championed the bill authorizing the establishment of the U. S. Fixed Nitrogen Corporation, which was passed by the Senate recently, admits that there no longer is hope for the final approval of the bill at this session of Congress. Opposition to the measure in the House was sufficiently strong to prevent its being brought to a vote in the lower chamber. Senator Underwood remarked, however, that the proposal to keep the nitrate plants at Muscle Shoals in stand-by condition is untenable and that sooner or later Congress will be forced to make some disposition of them.

Senator Underwood was successful in his effort to obtain the adoption by the Senate of an amendment to the sundry civil bill appropriating \$10,000,000 for continuing the work on the Wilson dam. It is regarded as probable that this item can be held in the bill, despite the fact that the House refused to amend the bill to that effect.

New Haven Section, A.C.S., Elects Officers

At the annual meeting held Jan. 28 at the Graduates' Club the New Haven Section of the American Chemical Society elected the following officers for the ensuing year: President, Dr. H. Hibbert; vice-president, Dr. M. C. Burt; treasurer, J. L. Christie; secretary, Dr. Blair Saxton; councillor, W. R. Hibbard.

At dinner the members gathered in Kent Laboratory when Dr. S. F. Acree, of Hahnemann Hospital, Rochester, N. Y., delivered a very interesting address on "The Measurement and Significance of Hydrogen Ion Concentration in Chemical and Biological Work." He exhibited his apparatus for determining hydrogen ion concentration, and illustrated his lecture by showing titration curves for pure acids, buffer solutions and extracts such as those from flour, cornmeal and chestnut bark. He pointed out various problems in which hydrogen ion concentration is an important factor. Among those mentioned were bacterial growth, tanning, inversion of sugar, electroplating, precipi-

tation from water solution, plant growth and soil acidity and the growth of chestnut blight and the acidity of bark extract. He further brought out how titration curve may be analyzed back and the acids present in a solution identified. This might prove useful in the study of the decomposition products of such substances as the protein.

Dr. Acree also showed samples of standardized standard indicator and buffer tablets which have proved to be of great convenience, especially to bacteriologists.

Book Reviews

APPLICATION OF DYESTUFFS. By J. Matthews, Ph.D. Pp. xvi + 768; 303 figures. New York: John Wiley & Sons, Inc., 1920. Price \$10.

This volume is an outgrowth of the author's earlier book "Laboratory Manual of Dyeing and Textile Chemistry." It has retained the text-book feature, but has been broadened in scope and detail. A feature of the book is the large number of illustrations of machines that find application in the treatment of the textile fiber from the raw material to the finished product. Emphasis is placed on the dyeing of textiles and particularly the processing of the most important fibers, wool, cotton and silk.

The general scheme of the book is first to study the action of various chemical agents on the fibers and methods of scouring and bleaching them preparatory to dyeing. The dyes are then classified from the standpoint of their application to the fibers. Each class is then presented in detail sufficient to explain the general methods of application and the chemistry underlying the process. No attempt is made to consider dyestuffs from their chemical classification. That dyestuffs are important to many industries that color their products is shown in the use of dyes for coloring of leather, paper, printing inks, etc.

One will find information on the equipping of a laboratory and methods of testing dyes for strength, etc. The history of dyeing, theory of dyeing, dyeing of mixtures of animal and vegetable fibers, methods of textile chemistry, tables of specific gravities and other information regarding the materials of the dyer and an extended bibliography round out the volume.

There is a wealth of general information presented, mention, at least, being made of almost every method of dyeing or related processes that are likely to be used. Only generalizations can be made, as each phase is capable of becoming a highly specialized one. Dyestuffs are individualistic in their properties, and methods of application must change as the materials that are being processed change. Practical contact must be had for a thorough understanding. The book, however, should prove valuable to all those interested in application of dyestuffs or related processes, especially in the textile industry. For the student there is a list of experiments at the end of the chapters that point out the main facts that need emphasis. ELMER C. BERTOLET.

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EMINENT CHEMISTS OF OUR TIME. By Benjamin Harrow, Ph.D. New York: D. Van Nostrand Co. Price \$2.50.

Dr. Harrow, who is associate in physical chemistry at Columbia University, has written a book that was much needed. We need tags for our great men in chemistry. They have done important things, and the world should know them by name. But it doesn't. Their work is very arduous; it calls for such intense application that few of them are known in affairs. They do not grow rich save in rarely exceptional cases, and therefore they do not build palaces or give social parties that are remembered—like the Bradley Martin ball of a generation ago.

In the present volume Dr. Harrow has with great diligence prepared monographs on the following eminent men: Sir William Henry Perkin, Mendeleef, Sir William Ramsay, Theodore W. Richards, van't Hoff, Arrhenius, Morrison, the Curies, Victor Meyer, Ira Remsen and Emil Fischer. At the end of each chapter there is a list of references from which he obtained his information.

As records the monographs are excellent, and the book is enriched with full-page likenesses of each of the subjects treated. It was written for the general public rather than for chemists alone, and while it would have made the work unwieldy if complete lists of the works of the various leaders were given, the author has emphasized the leading contributions of each.

Our only criticism is that the author has not studied his various subjects with such enthusiasm as to give a more intimate touch to his work. We know about the men after reading the several essays, but we do not feel that we know them. There are not many short, fat, tell-tale sentences such as that in regard to the Russian who, on meeting Sir William Ramsay, said, "I am Mendeleef!" That "I am" is significant and explains the difference between Mendeleef and Newlands, and why the former was indifferent as to whether other chemists laughed or cried over the Periodic Table, while the jeers of his fellow members of the Chemical Society of London caused poor Newlands to give it up in despair. We miss the abounding good fellowship of Sir William Ramsay, the subtle refinement and social grace of Theodore Richards, the flirtatious days of van't Hoff as a student, and the persistent flutter of young feminine hearts about him, the joy of companionship which Arrhenius bestows, or the amazing beauty of Victor Meyer as a young professor at Zurich with his singular resemblance to the Christ-face of the Renaissance painters.

These, however, are mere details. Dr. Harrow gives more important information, and the book is at once readable and is enlivened by a number of happy anecdotes. It "belongs" in every chemist's library. ELLWOOD HENDRICK.

Personal

W. E. BURKHARD, formerly chemical engineer with the Perth Amboy Chemical Works, is now chemical engineer with Clark, MacMullin & Riley of New York.

E. K. CHASE, assistant superintendent of the Pueblo plant of the American Smelting & Refining Co., is recovering from appendicitis and leaves for California soon to recuperate.

R. E. DEMMON has been transferred from the main office of the Stauffer Chemical Co. to the Houston, Tex., office, where he is general manager. The sulphur refinery of the company is at Freeport, Tex.

WALTER S. ERNST has recently resigned as chief chemist from the Ironton plant of the Alpha Portland Cement Co. to enter the University of Alabama as a student in the chemical engineering college.

A. E. MACARTHUR, formerly chemist at the Durango plant of the American Smelting & Refining Co., has been transferred to the Pueblo plant to organize and operate the salvage department.

O. E. RUHOFF, formerly chemical engineer for the French Battery & Carbon Co., Madison, Wis., has severed his connection with that company in order to associate himself with the Industrial Research Laboratories of Chicago.

Dr. JOHN E. SCHOTT has recently been appointed assistant professor of chemistry at Pennsylvania State College, State College, Pa.

HOMER STALEY, of the Metal & Thermit Corporation, is spending several weeks in Chicago working out problems at the plant of the company.

MAX SELTZER, who was formerly connected with the Research Laboratory of Applied Chemistry at the Massachusetts Institute of Technology, Cambridge, Mass., is now chemist for the Interstate Chemical Co., of Jersey City.

Dr. CHARLES WADSWORTH, who has recently become affiliated with the Grasselli Chemical Co., is carrying on some special research work at the Chicago plant.

M. M. WOOD is now employed as chief chemist by the Little Rock Picron Industrial Co., Little Rock, Ark., which purchased the picric acid plant built by the Government.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Feb. 14, 1921.

Inquiries of a miscellaneous nature kept the chemical market in an irregular condition during the past week. Business in general was interrupted now and then by intervals of dullness and it appeared that consumers were still doing more meditating than operating. This condition is the result of the acute downward revision of values and the fact that not enough confidence in the future has been restored to instill a more optimistic spirit in the purchasing of materials on a large scale. Compared with the beginning of the year, however, conditions seem more improved and activity shows some expansion. There is no doubt that business is due to become better, but it looks as though the increase will be along gradual lines. Reports of a general improvement were heard from some of the leading textile mills which are distinctly favorable factors for the chemical market. A steady increase in activity was noted from shoe and leather factories, and paper mills were disposing of their stocks at recently reduced prices. The soap industry has shown a somewhat irregular condition, but indications are more favorable than at the beginning of the year as far as activity is concerned.

Quite a satisfactory amount of small lot business was placed during the week. Some large inquiries were also noted in the market, but the wide differential in manufacturers' and second-hand prices had a restraining influence on the consummation of any big business. Several of the smaller chemicals were reduced in price. Such items as cobalt oxide, fluoride of soda, white granular sal ammoniac, prussiate of soda and cream of tartar have sold at lower prices on the spot market. The big items have shown a steadier tendency with the exception of bichromate of soda, which suffered from second-hand competition and closed with a loss of $\frac{1}{2}$ c. lb.

GENERAL CHEMICALS

Resale *bichromate of soda*, standard make, was offered at 8 $\frac{1}{2}$ c. per lb., with odd lot sales reported down to 8 $\frac{1}{4}$ c. The tone of the market appeared rather easy under pressure of resale stock through second hands. Demand was quiet and confined mostly to small lots. Dealers quoted March shipments at 8 $\frac{3}{4}$ c. per lb. Resale lots of *bisulphite of soda* were on the market at 5 $\frac{1}{2}$ c. per lb. against an inside figure of 6 $\frac{1}{4}$ c., which was named by some producers. The demand cannot be termed active, although small lot sales for actual consuming wants were passing. General quotations for resale solid *caustic soda* remained at \$3.85@3.95 per 100 lb. Odd lots of standard material could be purchased at 5 c. per 100 lb. below the general figure. Contracts were held firm by leading producers at \$3.60 per 100 lb., basis 60 per cent, f.o.b. works for prompt and future shipments. Trading was not very lively, although a moderate exchange of carlots was reported among dealers. American *cyanide of soda* is holding steady under limited offerings. Leading producers quote the market at 29 c. per lb. and it is doubtful if any small lots can be purchased under this price in any second-hand quarters. The French is quoted at 20 c. per lb., while Cassell's English is held at 25 c. Sellers of German quote the market at 21@23 c. per lb. according to strength.

Spot prices of *nitrite of soda* have been subjected to considerable irregularity during the past week. Some of the largest dealers have advanced their price to 9 c. per lb., while small lots on spot were obtainable all the way down to 6 c. A moderate improvement from domestic consumers was reported. *Prussiate of soda* closed easy with sellers asking 16 $\frac{1}{4}$ c. per lb. Forward shipments were offered at 15 $\frac{1}{4}$ c. per lb. The demand was quiet in the final trading and a keen state of competition existed among dealers. Light *soda ash*, in barrels closed firm at 2 $\frac{1}{4}$ c. per lb. ex-store N. Y. A fair inquiry was reported for this material in

cooperage, but the resale offerings were small. Single bags were quoted at \$2.05 per 100 lb. Double bags were quiet and rather nominal at \$2.20 per 100 lb. Contract prices remained firm at \$1.72½ per 100 lb., basis 48 per cent, f.o.b. works.

While odd lots of domestic *caustic potash* are floating around the market at 14c. per lb. through second hands, there are sellers of 88-92 per cent KOH imported material at 9c. per lb. laid down in N. Y. The irregularity in price of late has dampened any large buying interest except for actual necessities. Large producers have not announced any new prices so far this year. Spot *oxalic acid* closed firm with 18c. lb. as an inside figure by second hands. In most quarters the market was quoted above this level and the extreme price range is up to 25c. per lb., according to brand and seller. Shipments from abroad were offered at 17½c. in some directions. Enough white granular, high-test *sal ammoniac* is being dumped into the open market to depress prices. There were sellers at the close of the week at 7½c. per lb. The inquiry for this material has not been active of late and there is a keen state of competition existing among holders of imported material.

COAL-TAR PRODUCTS

Appearances during the week in the coal-tar products markets were mostly of an encouraging nature and while here and there an easy tendency was noted, the bulk of the various factors held views that reflected firmness. Activity varied from day to day and during the close of the week the interest of buyers slacked off somewhat and offerings did not attract the same attention. Buyers, however, were in close touch with the market and were ready to pick up any real bargains.

The *naphthalene* season is at hand and speculative buying of the off grades was noted in some directions. The pure white flakes were held firm and the best offering that could be located was at 8½c. per lb. Producers continued to quote 9@10c. per lb. on flakes and 11c. on balls. During the early part of the week *aniline* was fairly steady at 21@26c. per lb., although a lot here and there was offered at 20c., while at the close a seller of a round lot was calling for bids. Supplies of *dimethylaniline*, *beta naphthol*, *para nitraniline* and *para toluidine* were easy and shading in second hands was possible.

Producers of *alpha naphthalamine* continued to quote steady at 40@45c. per lb. Supplies in second hands are reported available in fair volume and with the demand light prices were heard at 38@40c. per lb. Trading in *dinitro chlorbenzene* is reported as quiet with only a light routine movement. Supplies are easy on a basis of 25@30c. per lb., while in second hands shading on firm business is possible. The market in *salicylic acid* is not very active at this time and only small lots are moving into consuming channels. There has been no recent change in prices, which range from 25@30c. per lb. Trading in the market for *para toluidine* is dull with most factors taking care of a moderate routine call which is about sufficient to meet consumers' immediate needs. Prices vary somewhat, depending on sellers, and range from \$1.40@\$1.70 per lb.

RUBBER—WAXES

The crude rubber market was easier during the past week, but toward the close a reaction was noted with higher prices named. Spot ribbed smoked sheets opened at 18½c. per lb. but declined to 17½c., the lowest of the week. At the close, however, a firmer tone developed and prices advanced to 18c. with a few small sales recorded at 17½@17¾c. per lb. Sales of first latex occurred at 19½c. per lb., while sellers were asking 19¾c. March ribbed advanced to 18½c. April, May, June was quoted at 21c. by holders and buyers at 20½c. per lb., but as far as could be ascertained no business was done. For July-December, sellers named 26c. per lb. and buyers 25c. Trading in general was of a small volume, as consuming manufacturers continue to be practically out of the market.

Importers of African and Brazilian *beeswax* reported market conditions as unchanged with prices on a fairly steady basis. African crude wax in carlots was offered at 17½@18c. per lb. for immediate shipment. Brazilian crude

wax was held at prices ranging from 24@26c. per lb. Trading in refined was along routine lines only and prices were more or less nominal. A moderate buying interest was noted for the lower grades of *carnauba wax* and prices closed for the week practically unchanged both in prompt and forward business. The high grades on spot continued in light supply. No. 2 North Country was quoted at 33@35c. per lb., while No. 3 was unchanged at 18@19c. per lb. Spot offerings of *Japan wax* were moderate and prices ruled steady ranging from 19@20c. per lb. Shipment prices showed little change and the situation was regarded as favoring sellers so far as the near future was concerned. Offerings of both crude and refined *paraffine wax* continued on a liberal scale and prices throughout the week were unsettled, the undertone being easy. Export shipments against old contracts were fairly large but new business was reported as dull in nearly all directions. Crude wax, 124-126 deg. melting point, was available in a large way at 4c. per lb., with intimations that this figure could be shaded on a firm bid. Refined, 128-130 deg. melting point, was available at 6½c. per lb.

The Iron and Steel Market

PITTSBURGH, PA., Feb. 11, 1921.

The finished steel market has suddenly started to break. There is not the gradual subsidence that was expected in most quarters, but rather a sharp drop, whereby in a very short time a level will be found that will prove relatively stable, at least until costs can be reduced.

It will be recalled that the steel market of the independents dropped to the Steel Corporation or Industrial Board level in the closing weeks of the old year, bars, shapes and plates showing their drop the day after Thanksgiving Day. A common expectation then was that the independents would promptly begin shading the regular prices by small amounts, whereby in time the market might slowly subside. This expectation was not borne out. Many independents did not cut at all, while others who were disposed to make slight concessions found there was scarcely any business to be obtained that way.

Thus a situation was presented. The Midvale Steel & Ordnance Co. decided to canvass the trade for orders, offering substantial concessions. The canvass occupied a few days, with the other independents watching. Apparently their philosophy at the time was that if the cutting produced much business they would participate and if it did not they would remain aloof. It did not produce much business. Then, it appears, the other independents altered their viewpoint and concluded that the test showed that eventually very substantial reductions would have to occur and that they might as well meet this situation at once. Accordingly a large number of independents yesterday became willing to make substantial reductions, the amount to be determined by the tonnage obtainable and the possibility of avoiding loss either against previous costs or such costs as could be developed by further economy.

FINISHED STEEL MARKET DECLINING RAPIDLY

The finished steel market has accordingly been declining rather sharply in the past couple of days, and there are no prices that are sufficiently fixed to be quoted as the market even for a day. For illustration, merchant steel bars, which had been 2.35c., sold in some fair sized lots at 2.25c., then in a small lot at 2.20c., with possibly some sales at 2.10c., while the latest is that one mill has adopted 2c., not quoting the price openly but being ready to take any order of reasonable size and fair specifications at that figure. In structural shapes 2.25c. has been named, or \$4 a ton decline, without any business of importance developing. Plates had been selling at times for weeks at 2.50c., against the Industrial Board or Steel Corporation price of 2.65c., while in the past few days 2.40c. has been done and quite probably less.

It is of no moment just where the market stands at the present writing. Enough is known to permit a guess to be hazarded as to the approximate level the heavy rolled products will develop in the present movement. The level is about 2c. Shapes will probably be about \$2 a ton above

bars, and plates may not be as much above bars. Before the war plates and shapes averaged quite closely \$2 a ton above bars, but with the large plate-making capacity now in existence a smaller spread may obtain. Until now plates have preserved much of the spread above bars and shapes that the war-time regulation furnished as an incentive to plate manufacture, the war control prices being 2.90c. for bars, 3c. for shapes and 3.25c. for plates.

CONCESSIONS IN SHEETS

Concessions thus far announced in sheets represent about \$3 a ton, outside of prices made by some mills at a distance from Pittsburgh, representing concession of part of the freight advantage. As the system of Pittsburgh basing has not been expected to stand in a period of active competition, such special prices cannot properly be figured back to Pittsburgh and the claim made that the Pittsburgh price itself is cut by the amount shown. In wire products it is not known that more than one producer has departed from regular prices, it being stated that one producer east of Pittsburgh is naming \$3.10 on nails, against the regular price of \$3.25.

NO REDUCTION BY STEEL CORPORATION

The United States Steel Corporation has made a formal announcement that it will not reduce prices or wages, but it would be impossible to name a time for which such a statement would hold good. Such curious views have been spread as to business and economics that the statement may be misinterpreted in some quarters. Conditions in the steel industry are changing and the Steel Corporation will certainly meet at the proper time any important changes that occur. For several weeks, until recently, the corporation operated at about 92 per cent of capacity. In the past fortnight its operations have been sensibly declining, being now probably at about 85 per cent. Further decreases are to be expected. If the operation decreased to 60 per cent, the corporation management would undoubtedly consider the whole subject of prices and wages afresh and might then decide to reduce both.

The Steel Corporation's unfilled obligations decreased by 574,958 tons in January, this being 300,000 tons less than the December decrease. Shipments were slightly less, while actual bookings were hardly increased. A month ago it was commonly reported that toward the close of December the corporation went over its books and carefully cut out all doubtful tonnages, and apparently there were no cancellations of consequence in January. This would account for the divergence. Stated in estimated percentages of the corporation's capacity for a month, the matter may be put thus: December shipments, 94 per cent; unfilled tonnage decrease, 64 per cent; net bookings, 30 per cent, made up of actual bookings of 50 per cent and cancellations of 20 per cent; January shipments, 90 per cent; unfilled tonnage decrease, 44 per cent; bookings, 44 per cent.

PIG IRON PRICES

Foundry pig iron has declined another dollar a ton, to \$28 valley, on a rather small turnover. Bessemer and basic are unquotable. Regular producers state that they have had no occasion, on account of lack of inquiry, to depart from their former quotations of \$32 for bessemer and \$30 for basic, but would welcome the opportunity to do so. It is understood that some odd lots of basic could be picked up from steel interests that do not usually sell in the market at well under \$30. On account of the break in steel prices now in progress and the further decline in foundry iron, it is probable that producers will of their own accord announce new prices, which may be in the neighborhood of \$28.50 for bessemer and \$27 for basic. Such prices would probably represent a loss on the basis of recent costs, but efforts are being made to reduce costs and some of the Connellsville coke operators are anxious to co-operate in such work.

Production of steel ingots in January was at the rate of about 90 per cent of capacity by the Steel Corporation and 28 per cent by the independents. From the present outlook February production may be 80 or 85 per cent by the corporation and about 25 per cent by the independents.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

		Carlots	Less Carlots
Acetic anhydride.....	lb.		\$0.55 - \$0.60
Acetone.....	lb.	\$0.13 - \$0.13 1/2	.13 1/2 - .14
Acid, acetic, 28 per cent.....	100 lbs.	3.00 - 3.25	3.50 - 3.75
Acetic, 56 per cent.....	100 lbs.	6.00 - 6.25	6.50 - 6.75
Acetic, glacial, 99 1/2 per cent, carboys.....	100 lbs.	10.50 - 11.00	11.25 - 11.50
Boric, crystals.....	lb.	.14 1/2 - .15	.15 1/2 - .16
Boric, powder.....	lb.	.15 1/2 - .16 1/2	.17 - .18
Citric.....	lb.		.46 - .48
Hydrochloric.....	100 lb.	1.60 - 1.75	1.85 - 2.25
Hydrofluoric, 52 per cent.....	lb.	.15 - .16	.16 1/2 - .18
Lactic, 44 per cent tech.....	lb.	.10 - .11	.11 1/2 - .12
Lactic, 22 per cent tech.....	lb.	.04 1/2 - .05 1/2	.06 - .07
Molybdic, C. P.....	lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....	lb.		
Nitric, 40 deg.....	lb.	.07 - .07 1/2	.08 - .08 1/2
Nitric, 42 deg.....	lb.	.08 1/2 - .09	.09 1/2 - .10
Oxalic, crystals.....	lb.	.18 - .18 1/2	.18 1/2 - .19
Phosphoric, 1 rtho, 50 per cent solution.....	lb.	.15 - .15 1/2	.16 - .16 1/2
Picric.....	lb.	.30 - .32	.35 - .40
Pyrogallie, resublimed.....	lb.		2.30 - 2.40
Sulphuric, 60 deg., tank cars.....	ton		14.00 - 15.00
Sulphuric, 60 deg., drum s.....	ton	18.00 - 19.00	
Sulphuric, 66 deg., tank cars.....	ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., drum s.....	ton		
Sulphuric, 66 deg., carbo s.....	ton		
Sulphuric, fuming, 20 per cent (oleum).....	ton	23.00 - 24.00	
Sulphuric, fuming, 20 per cent (oleum).....	ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, fuming, 20 per cent (oleum).....	ton		
Sulphuric, fuming, 20 per cent (oleum).....	ton	32.00 - 35.00	40.00 -
Tannic, U. S. P.....	lb.		1.15 - 1.25
Tannic (tech.).....	lb.	.45 - .47	.48 - .50
Tartaric, crystals.....	lb.		.33 - .35
Tungstic, per lb. of WO.....	lb.		1.00 - 1.20
Alcohol, Ethyl.....	gal.		5.10 - 5.50
Alcohol, Methyl (see methanol).....	gal.		
Alcohol, denatured, 188 proof.....	gal.		.65 - .67
Alcohol, denatured, 190 proof.....	gal.		.68 - .70
Alum, ammonia lump.....	lb.	.04 1/2 - .04 1/2	.05 - .05 1/2
Alum, potash lump.....	lb.	.05 1/2 - .06	.06 1/2 - .07
Alum, chrome lump.....	lb.	.13 - .13 1/2	.14 - .14 1/2
Aluminum sulphate, commercial.....	lb.	.02 1/2 - .02 1/2	.02 1/2 - .03
Aluminum sulphate, iron free.....	lb.	.03 - .03 1/2	.03 1/2 - .03 1/2
Aqua ammonia, 26 deg., drums (750 lb.).....	lb.	.07 - .07 1/2	.07 1/2 - .08
Ammonia, anhydrous, cyl. (100-150 lb.).....	lb.	.30 - .32	.33 - .35
Ammonium carbonate, powder.....	lb.	.11 1/2 - .11 1/2	.12 - .12 1/2
Ammonium chloride, granular (white salamoniac) (nominal).....	lb.	.07 1/2 - .07 1/2	.08 - .08 1/2
Ammonium chloride, granular (gray salamoniac).....	lb.	.09 - .09 1/2	.09 1/2 - .10
Ammonium nitrate.....	lb.	.09 - .09 1/2	.10 - .10 1/2
Ammonium sulphate.....	100 lb.	3.30 - 3.40	3.50 - 3.75
Amylacetate.....	gal.		4.25 - 4.50
Amylacetate tech.....	gal.		3.50 - 3.75
Arsenic oxide, (white arsenic).....	lb.	.10 - .10 1/2	.10 1/2 - .11
Arsenic, sulphide, powdered (red arsenic).....	lb.	.14 - .14 1/2	.15 - .15 1/2
Barium chloride.....	ton	65.00 - 70.00	75.00 - 80.00
Barium dioxide (peroxide).....	lb.	.24 - .25	.26 - .27
Barium nitrate.....	lb.	.10 - .10 1/2	.10 1/2 - .11
Barium sulphate (precip.) (blanc fixe).....	lb.	.04 1/2 - .05	.05 1/2 - .06
Bleaching powder (see calc. hypochlorite).....	lb.		
Blue vitriol (see copper sulphate).....	lb.		
Borax (see sodium borate).....	lb.		
Brimstone (see sulphur, roll).....	lb.		
Bromine.....	lb.	.50 - .52	.54 - .56
Calcium acetate.....	100 lbs.	2.00 - 2.05	
Calcium carbide.....	lb.	.04 - .04 1/2	.04 1/2 - .05
Calcium chloride, fused, lump.....	ton	27.00 - 29.00	30.00 - 32.00
Calcium chloride, granulated.....	lb.	.01 1/2 - .02	.02 1/2 - .02 1/2
Calcium hypochlorite (bleach'g powder).....	lb.	.02 1/2 - .03	.03 1/2 - .03 1/2
Calcium peroxide.....	lb.		1.00 - 1.10
Calcium phosphate, monobasic.....	lb.		.15 - .16
Camphor.....	lb.		.80 - .85
Carbon bisulphide.....	lb.	.08 - .08 1/2	.09 - .09 1/2
Carbon tetrachloride, drums.....	lb.	.11 1/2 - .11 1/2	.12 - .12 1/2
Carbonyl chloride (phosgene).....	lb.		.75 - 1.00
Caustic potash (see potassium hydroxide).....	lb.		
Caustic soda (see sodium hydroxide).....	lb.		
Chlorine, gas, liquid-cylinders (100 lb.).....	lb.	.09 - .09 1/2	.10 - .10 1/2
Chloroform.....	lb.		.43 - .50
Cobalt oxide.....	lb.		3.00 - 3.10
Copper as (see iron sulphate).....	lb.		
Copper carbonate, green precipitate.....	lb.	.22 - .22 1/2	.24 - .25
Copper cyanide.....	lb.		.50 - .60
Copper sulphate, crystals.....	lb.	.06 1/2 - .06 1/2	.06 1/2 - .07 1/2
Cream of tartar (see potassium bitartrate).....	lb.		
Epsom salt (see magnesium sulphate).....	lb.		
Ethyl Acetate Com. 85%.....	gal.		1.05 - 1.10
Ethyl Acetate pure (acetic ether 98% to 100%).....	gal.		
Formaldehyde, 40 per cent.....	lb.	.17 1/2 - .17 1/2	.18 - .18 1/2
Fusel oil, ref.....	gal.		3.50 - 3.60
Fusel oil, crude.....	gal.		2.75 - 3.00
Glauber's salt (see sodium sulphate).....	lb.		.20 - .21
Glycerine, C. P. drums extra.....	lb.		3.85 - 4.00
Iodine, resublimed.....	lb.		.10 - .20
Iron oxide, red.....	lb.		1.75 - 2.00
Iron sulphate (copperas).....	100 lb.	1.25 - 1.50	
Lead acetate, normal.....	lb.		.14 1/2 - .16
Lead arsenate (paste).....	lb.	.11 - .12	.12 1/2 - .13
Lead nitrate.....	lb.		.15 - .20
Litharge.....	lb.	.08 1/2 - .09	.09 1/2 - .10
Lithium carbonate.....	lb.		1.25 -
Magnesium carbonate, technical.....	lb.	.10 1/2 - .11	.11 1/2 - .12
Magnesium sulphate, U. S. P.....	100 lb.	2.50 - 3.00	
Magnesium sulphate, commercial.....	100 lb.		1.50 - 1.75
Methanol, 95%.....	gal.		1.28 - 1.30
Methanol, pure.....	gal.		1.60 - 1.65
Nickel salt, double.....	lb.		.12 - .12 1/2
Nickel salt, single.....	lb.		.13 - .13 1/2
Phosgene (see carbonyl chloride).....	lb.		
Phosphorus, red.....	lb.	.45 - .46	.47 - .50
Phosphorus, yellow.....	lb.		.35 - .37
Potassium bichromate.....	lb.	.14 1/2 - .14 1/2	.15 - .15 1/2

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$.35 — .40	\$0.30 — \$0.35
Potassium bromide, granular..... lb.	.35 — .40	.20 — .40
Potassium carbonate, U. S. P..... lb.	.08 — .08½	.45 — .50
Potassium carbonate, crude..... lb.	.08 — .10	.09 — .10
Potassium chlorate, crystals..... lb.	.14 — .14½	.11 — .18
Potassium cyanide..... lb.	.14 — .14½	.65 — .70
Potassium hydroxide (caustic potash)..... lb.	.14 — .14½	.15 — .16
Potassium muriate..... ton	75.00 — 80.00	
Potassium iodide..... lb.	.09½ — .10	3.00 — 3.20
Potassium nitrate..... lb.	.48 — .50	.10½ — .12½
Potassium permanganate..... lb.	.50 — .52	.52 — .60
Potassium prussiate, red..... lb.	.26 — .26½	.53 — .55
Potassium prussiate, yellow..... lb.		.27 — .27½
Potassium sulphate (powdered)..... per unit		2.25
Rochelle salts (see sodium potas. tartrate).....		
Salammoniac (see ammonium chloride).....		
Sal soda (see sodium carbonate).....		
Salt cake..... ton		32.00 — 33.00
Silver cyanide..... oz.		1.25 — 1.44
Silver nitrate..... oz.		.43½ — .44
Soda ash, light..... 100 lb.	2.00 — 2.10	2.15 — 2.25
Soda ash, dense..... 100 lb.	2.15 — 2.25	2.30 — 2.40
Sodium acetate..... lb.	.05½ — .05¾	.06 — .06½
Sodium bicarbonate..... 100 lb.	2.50 — 2.75	3.00 — 3.25
Sodium bichromate..... lb.	.08½ — .08¾	.08½ — .09
Sodium bisulphate (nitre cake)..... ton	7.00 — 7.50	8.00 — 11.00
Sodium bisulphite powdered, U.S.P..... lb.	.05½ — .05¾	.06 — .06½
Sodium borate (borax)..... lb.	.08½ — .08¾	.08½ — .09
Sodium carbonate (sal soda)..... 100 lb.	2.00 — 2.25	2.50 — 2.75
Sodium chl. rate..... lb.	.10 — .10½	.10½ — .11
Sodium cyanide, 96-98 per cent..... lb.	.20 — .21	.22 — .28
Sodium fluoride..... lb.	.13½ — .14	.14½ — .15
Sodium hydroxide (caustic soda)..... 100 lb.	3.85 — 3.90	3.95 — 4.25
Sodium hyposulphite..... lb.		.03½ — .04
Sodium nitrate..... lb.	.06 — .06½	.06½ — .07
Sodium nitrite..... lb.	.30 — .31	.32 — .34
Sodium peroxide, powdered..... lb.	.03½ — .04½	.04½ — .05
Sodium phosphate, dibasic..... lb.		.29 — .31
Sodium potassium tartrate (Rochelle salts) lb.	.16 — .16½	.16½ — .17
Sodium prussiate, yellow..... lb.	1.10 — 1.15	1.20 — 1.40
Sodium silicate, solution (40 deg.)..... lb.	.02½ — .03	.03½ — .03¾
Sodium silicate, solution (60 deg.)..... lb.	1.75 — 2.00	2.25 — 2.50
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	.05 — .05½	.05½ — .06
Sodium sulphide, crystal, 60-62 per cent (conc.) lb.	.04 — .04½	.04½ — .05
Sodium sulphite, crystals..... lb.	.17½ — .18	.18½ — .18¾
Strontium nitrate, powdered..... lb.	.07 — .07½	.07½ — .08
Sulphur chl. ride, red..... ton	16.00 — 20.00	.08½ — .09
Sulphur, crude..... lb.	.08 — .08½	.25 — 3.10
Sulphur dioxide, liquid, cylinders..... 100 lb.		2.00 — 2.75
Sulphur (sublimed), flour..... 100 lb.	.18 — .19	
Sulphur, roll (brimstone)..... 100 lb.		.45 — .47
Tin bichloride, 50 per cent..... lb.	.16 — .18	.19 — .20
Tin oxide..... lb.	.11½ — .12	.12½ — .13
Zinc carbonate, precipitate..... lb.	.45 — .49	.50 — .60
Zinc chloride, gran..... lb.	.12 — .13	.13½ — .14
Zinc cyanide..... lb.	.08½ — .09	.09½ — .11
Zinc dust..... lb.	.03½ — .03¾	.04 — .06
Zinc oxide, XX..... lb.		
Zinc sulphate..... lb.		

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 — \$1.15
Alpha-naphthol, refined..... lb.	1.45 — 1.50
Alpha-naphthylamine..... lb.	.38 — .40
Aniline oil, drums extra..... lb.	.21 — .27
Aniline salts..... lb.	.27 — .30
Anthracene, 80% in drums (100 lb.)..... lb.	.75 — 1.00
Benzaldehyde U.S.P..... lb.	1.00 — 2.10
Benzidine, base..... lb.	1.00 — 1.10
Benzidine sulphate..... lb.	.80 — .90
Benzoic acid, U.S.P..... lb.	.70 — .75
Benzoate of soda, U.S.P..... lb.	.70 — .80
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.30 — .35
Benzene, 90%, in drums (100 gal.)..... gal.	.28 — .32
Benzyl chloride, 95-97%, refined..... lb.	.30 — .35
Benzyl chloride, tech..... lb.	.25 — .30
Beta-naphthol benzoate..... lb.	3.50 — 4.00
Beta-naphthol, sublimed..... lb.	.70 — .75
Beta-naphthol, tech..... lb.	.30 — .35
Beta-naphthylamine, sublimed..... lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)..... lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums..... gal.	.95 — 1.00
Cresylic acid, 95-97%, dark, in drums..... gal.	.90 — .95
Cresylic acid, 50%, first quality, drums..... gal.	.60 — .65
Dichlorobenzene..... lb.	.06 — .09
Diethylaniline..... lb.	1.25 — 1.30
Dimethylaniline..... lb.	.55 — .65
Dinitrobenzene..... lb.	.30 — .32
Dinitrochlorobenzene..... lb.	.25 — .30
Dinitronaphthalene..... lb.	.33 — .35
Dinitrophenol..... lb.	.40 — .45
Dinitrotoluene..... lb.	.25 — .30
Dip oil, 25%, tar acids, car lots, in drums..... gal.	.37½ — .40
Diphenylamine..... lb.	.60 — .70
H-acid..... lb.	1.30 — 1.50
Meta-phenylenediamine..... lb.	1.25 — 1.30
Monochlorobenzene..... lb.	.14 — .16
Monoethylaniline..... lb.	1.80 — 2.00
Naphthalene crushed, in bbls. (250 lb.)..... lb.	.07½ — .08
Naphthalene, flake..... lb.	.08 — .08½
Naphthalene, balls..... lb.	.08 — .08½
Naphthionic acid, crude..... lb.	.70 — .75
Nitrobenzene..... lb.	.12 — .15
Nitro-naphthalene..... lb.	.30 — .35
Nitro-toluene..... lb.	.18 — .25
Ortho-amidophenol..... lb.	3.20 — 3.75
Ortho-dichlor-benzene..... lb.	.15 — .20
Ortho-nitro-phenol..... lb.	.75 — .80
Ortho-nitro-toluene..... lb.	.20 — .24
Ortho-toluidine..... lb.	.25 — .30
Para-amidophenol, base..... lb.	1.90 — 2.00
Para-amidophenol, HCl..... lb.	2.10 — 2.20

Para-dichlorobenzene..... lb.	.15 — .25
Paranitroaniline..... lb.	.85 — .90
Para-nitrotoluene..... lb.	.90 — 1.05
Para-phenylenediamine..... lb.	1.80 — 2.20
Para-toluidine..... lb.	1.30 — 1.60
Phthalic anhydride..... lb.	.55 — .60
Phenol, U. S. P., drums (dest.), (240 lb.)..... lb.	.10 — .12
Pyridine..... gal.	2.00 — 3.50
Resorcinol, technical..... lb.	1.85 — 2.00
Resorcinol, pure..... lb.	2.50 — 2.75
Salicylic acid, tech., in bbls. (110 lb.)..... lb.	.23 — .25
Salicylic acid, U. S. P..... lb.	.27 — .30
Salol..... lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.28 — .32
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.16 — .18
Sulphanilic acid, crude..... lb.	.30 — .35
Tolidine..... lb.	1.35 — 1.45
Toluidine, mixed..... lb.	.40 — .45
Toluene, in tank cars..... gal.	.28 — .32
Toluene, in drums..... gal.	.30 — .35
Xylidines, drums, 100 gal..... lb.	.40 — .45
Xylene, pure, in drums..... gal.	.42 — .45
Xylene, pure, in tank cars..... gal.	.45 — .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 — .35
Xylene, commercial, in tank cars..... gal.	.30 — .35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.24 — \$0.26
Beeswax, refined, light..... lb.	.27 — .28
Beeswax, white pure..... lb.	.40 — .45
Carnauba, No. 1..... lb.	.75 — .77
Carnauba, No. 2, North Country..... lb.	.33 — .35
Carnauba, No. 3, North Country..... lb.	.18 — .19
Japan..... lb.	.19 — .20
Montan, crude..... lb.	.07 — .08
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.04½ — .04¾
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.04 — .04½
Paraffine waxes, refined, 118-120 m.p..... lb.	.05 — .05½
Paraffine waxes, refined, 125 m.p..... lb.	.06 — .06½
Paraffine waxes, refined, 128-130 m.p..... lb.	.06 — .06½
Paraffine waxes, refined, 133-135 m.p..... lb.	.07 — .07½
Paraffine waxes, refined, 135-137 m.p..... lb.	.09 — .09½
Stearic acid, single pressed..... lb.	.12 — .13
Stearic acid, double pressed..... lb.	.13 — .14
Stearic acid, triple pressed..... lb.	.14 — .15

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr., 0.930-0.940..... gal.	\$1.70
Pine oil, pure, dest. dist..... gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75
Pine tar, ref., thin, sp.gr., 1.080-1.060..... gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970..... gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.37
Pinewood creosote, ref..... gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl..... 280 lb.	\$8.00 —
Rosin E-I..... 280 lb.	8.00 —
Rosin K-N..... 280 lb.	8.00 —
Rosin W. G.-W. W..... 280 lb.	8.25 —
Wood rosin, bbl..... 280 lb.	8.50 —
Spirits of turpentine..... gal.	.60 —
Wood turpentine, steam dist..... gal.	.58 —
Wood turpentine, dest. dist..... gal.	.57 —
Pine tar pitch, bbl..... 200 lb.	8.50 —
Tar, kiln burned, bbl. (500 lb.)..... bbl.	15.00 — 15.00
Retort tar, bbl..... 500 lb.	15.00 — 15.50
Rosin oil, first run..... gal.	.50 —
Rosin oil, second run..... gal.	.52 —
Rosin oil, third run..... gal.	.60 —

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41
70-72 deg., steel bbls. (85 lb.)..... gal.	.39
68-70 deg., steel bbls. (85 lb.)..... gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30

Crude Rubber

Para-Upriver fine..... lb.	\$0.18½ — \$0.19
Upriver coarse..... lb.	.14 — .14½
Upriver caucho ball..... lb.	.14½ — .14¾
Plantation—First latex crepe..... lb.	.19½ — .19¾
Ribbed smoked sheets..... lb.	.18 — .18½
Brown crepe, thin, clean..... lb.	.18 — .18½
Amber crepe No. 1..... lb.	.20 — .20½

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.09½ — \$0.10
Castor oil, AA, in bbls..... lb.	.11 — .11½
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.08½ — .08¾
Cocoonut oil, Ceylon grade, in bbls..... lb.	.11½ — .12½
Cocoonut oil, Cochin grade, in bbls..... lb.	.12½ — .12¾
Cor. oil, crude, in bbls..... lb.	.08½ — .09
Cottonseed oil, crude (f. o. b. mill)..... lb.	.05 — .06
Cottonseed oil, summer yellow..... lb.	.08½ — .08¾
Cottonseed oil, winter yellow..... lb.	.09 — .09½
Linseed oil, raw, car lots (domestic)..... gal.	.68 — .69
Linseed oil, raw, tank cars (domestic)..... gal.	.61 — .61½
Linseed oil, boiled, car lots (domestic)..... gal.	.70 — .71

Olive oil, commercial.....	gal.	\$2.00	—	\$2.40
Palm, Lagos.....	lb.	.07½	—	.07½
Palm, Niger.....	lb.	.07	—	.07½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.06½	—	.07
Peanut oil, refined, in bbls.....	lb.	.13	—	.13½
Rapeseed oil, refined in bbls.....	gal.	1.10	—	1.15
Rapeseed oil, blown, in bbls.....	gal.	1.20	—	1.25
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.08	—	.08½
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.05	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.46	—	\$0.48
Yellow bleached menhaden.....	gal.	.48	—	.50
White bleached menhaden.....	gal.	.50	—	.52
Blown menhaden.....	gal.	.85	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	17.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	.....
Blanc fixe, dry.....	lb.	.05	—	.05½
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.18
Chalk, domestic, extra light.....	lb.	.05	—	.06
Chalk, domestic, light.....	lb.	.04½	—	.05½
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04½	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Fla.....	net ton	25.00	—	.....
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	35.00	—	40.00
Graphite, crucible, 90% carbon, Ashland, Ala.....	lb.	.....	—	.09
Graphite, crucible, 85% carbon, Ashland, Ala.....	lb.	.07	—	.09
Graphite, higher lubricating grades.....	lb.	.11	—	.40
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.65	—	.....
Shellac, orange superfine.....	lb.	.70	—	.....
Shellac, A. C. garnet.....	lb.	.57	—	.....
Shellac, T. N.....	lb.	.55	—	.....
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	.....	—	17.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	40.00	—	50.00
Talc, California talcum powder grade.....	ton	20.00	—	45.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	.....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	80-100	.....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	45-50	.....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	.....	55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	.....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	.....
Magnesite brick, 9-in. straight.....	net ton	100	.....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105	.....
Magnesite brick, soaps and splits.....	net ton	120	.....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65-70	.....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56-61	.....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,300	50-60	.....

Ferro-Alloys

All f.o.b. Works

Ferrocen-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrocen-titanium per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.16	—	.....
Ferrocen-titanium per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.16	—	.17
Ferromanganese, 76-80% Mn, domestic.....	gross ton	95.00	—	100.00
Ferromanganese, 76-80% Mn, English.....	gross ton	95.00	—	100.00
Spiegeleisen, 18-22% Mn.....	gross ton	38.00	—	40.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.00	—	2.50
Ferrosilicon, 10-15%.....	gross ton	50.00	—	55.00
Ferrosilicon, 50%.....	gross ton	78.00	—	80.00
Ferrosilicon, 75%.....	gross ton	140.00	—	145.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.55	—	.60
Ferrourenium, 35-50% of U, per lb. of U content.....	lb.	7.00	—	.....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00	—	5.25

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content, less than 2% Fe ₂ O ₃ , up to 20% silica, not more than H 4% moisture.....	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.55	—	.60
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.50	—	.55
Coke, foundry, f.o.b. ovens.....	net ton	6.50	—	7.00
Coke, furnace, f.o.b. ovens.....	net ton	5.00	—	5.25
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	11.50	—	12.00
Fluorspar, lump, f.o.b. Healden, New Mexico.....	net ton	17.50	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	—	25.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.35	—	.40
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.12	—	.....
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.16½	—	.....
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	—	3.25
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	.....
Zircon, washed, iron free.....	lb.	.03	—	.....

Non-Ferrous Metals

New York Markets

Cents per Lb.

Copper, electrolytic.....	12.75
Aluminum, 98 to 99 per cent.....	28.3 @ 28.5
Antimony, wholesale lots, Chinese and Japanese.....	5.25
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	45.00
Monel metal, spot and blocks.....	.35
Monel metal ingots.....	.38
Monel metal, sheet bars.....	.40
Tin, 5-ton lots.....	32.00
Lead, New York, spot.....	4.60
Lead, E. St. Louis, spot.....	4.10
Zinc, spot, New York.....	6.00
Zinc, spot, E. St. Louis.....	5.65

OTHER METALS

Silver (commercial).....	oz.	\$0.66½
Cadmium.....	lb.	1.40 @ 1.50
Bismuth (500 lb. lots).....	lb.	2.25 @ 2.35
Cobalt.....	lb.	4.50
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	70.00
Iridium.....	oz.	325.00
Palladium.....	oz.	65.00 @ 70.00
Mercury.....	.75 lb.	50.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per Lb.

Copper sheets, hot rolled.....	21.00
Copper bottoms.....	33.00
Copper rods.....	28.00
High brass wire and sheets.....	18.75
High brass rods.....	16.75
Low brass wire and sheets.....	27.50
Low brass rods.....	18.50
Brazed brass tubing.....	35.25
Brazed bronze tubing.....	40.50
Seamless copper tubing.....	25.00
Seamless high brass tubing.....	24.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

— New York —

	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	11.50	18.50	10.00	10.50
Copper, heavy and wire.....	11.00	16.50	9.50	9.50
Copper, light and bottoms.....	9.00	14.50	9.00	8.50
Lead, heavy.....	4.00	7.25	4.00	4.00
Lead, tea.....	3.00	5.25	3.00	3.00
Brass, heavy.....	7.00	9.50	7.00	10.00
Brass, light.....	5.50	8.00	5.00	5.50
No. 1 yellow brass turnings.....	6.00	9.50	5.50	6.00
Zinc.....	4.00	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	*Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes.....	\$3.73	\$3.80	\$3.47	\$3.58	\$3.37	\$3.58	\$3.47
Soft steel bars.....	3.93	3.70	3.52	3.34	3.27	3.48	3.52
Soft steel bar shapes.....	3.93	3.70	3.52	3.48	3.27	3.48	3.52
Soft steel bands.....	4.33	4.65	4.22	6.25	.....	.....	.....
Plates, ½ to 1 in. thick.....	3.93	4.00	3.67	3.78	3.57	3.78	3.67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

BIRMINGHAM—The Amer. Cement Tile Mfg. Co., 509 Brown Marx Bldg., had plans prepared for the construction of a 60-200-ft. plant. L. W. Barner, Southern mgr.

BIRMINGHAM—J. E. Brow, comn., had plans prepared for the construction of a 1-story bath house and water-sterilizing plant on Ave. I and 29th St. Estimated cost, \$45,000. J. Kendrick, Birmingham, engr.

California

STOCKTON—A. L. Banks, city clk., receives bids until March 8 for the construction of the south sewage disposal works, including chlorination equipment, settling tank, sludge beds, etc. W. B. Hogan, city engr.

Illinois

CHICAGO—W. G. Uffendel, archt., 39 South State St., will soon award contract for the construction of a 2-story, 116x118-ft. engraving factory on Fullerton and Racine Aves., for J. B. Wiggins, 1104 South Wabash Ave. Estimated cost, \$75,000.

Iowa

DUBUQUE—The Bd. Educ. is having plans prepared for the construction of a 3-story high school. A chemical laboratory will be installed in same. Estimated cost, \$550,000. J. W. Royer, Urbana, Ill., archt.

GILMAN—The Bd. Educ. receives bids March 4 for the construction of a 2-story, 60x100-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$110,000. Keffer & Jones, 204 Masonic Temple, Des Moines, archts.

SHELLSBURG—The Bd. Educ. receives bids until March 11 for the construction of a 3-story, 80x110-ft. grade and high school. A chemical laboratory will be installed in same. Estimated cost, \$140,000. A. K. Rife, secy. J. G. Ralston, 709 L. & J. Bldg., Waterloo, archt. Noted Nov. 17.

Michigan

PLAINWELL—The Bd. Educ. is having plans prepared for the construction of a 2-story, 100x196-ft. high school. A chemical laboratory will be installed in same. About \$175,000. E. S. Batteson, Kalamazoo, archt.

Minnesota

CLOQUET—R. C. Hornby and R. M. Weyerhaeuser, representing owner, plan the construction of a mill to manufacture wall-board from saw mill waste near the Northern Lumber Co. Estimated cost, \$250,000.

HACKENSACK—Bd. Educ., c/o F. R. Ross, Walker, receives bids until March 4 for the construction of a 2-story, 95x102-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$75,000. Liebenberg, Kaplan & Martin, 615 McKnight Bldg., Minneapolis, archts. Noted Dec. 29.

Missouri

COLUMBIA—City plans to construct sewage disposal plant, Imhoff tanks and sprinkling filters. Estimated cost, \$177,000.

ST. LOUIS—L. Haeger, archt., 3844 Utah Pl., will soon award contract for the construction of a 1-story, 50x100-ft. foundry, for The Chester Iron & Fdry. Co., 7000 Vulcan St. Estimated cost, \$30,000. E. A. Linnis, secy.

New Jersey

NEWARK—Barrison & Blase, South St., receives bids Feb. 21 for the construction of a 2-story brick and concrete factory on Governor St. and Marion Pl. About \$75,000. F. Grad, 245 Springfield Ave., engr.

New York

BROOKLYN—Burley Welding Works, 22 Kosciuszko St., will build a 3-story addition

to its factory. Estimated cost, \$50,000. E. M. Adelshon, 1778 Pitkin Ave., engr.

VICTOR—The Victor Plaster Co., recently incorporated to mine gypsum, plans to expend \$140,000 for buildings and equipment. C. A. Huber, 51 Monroe Ave., Rochester, pres.

Ohio

CLEVELAND—Electric Steel & Forge Co., c/o J. H. Foster, pres., 6600 Grant Ave., plans to construct a 1-story steel rolling mill. Estimated cost, \$200,000. J. H. Heron & Co., 1360 West 3d St., archts. and engr.

COLUMBUS—The Ironclay Brick Co., 64 Ruggery Bldg., has awarded the contract for the construction of a 1-story, 60x175-ft. factory on East 2nd Ave. Estimated cost, \$45,000.

WARREN—City has awarded the contract for the construction of a 6,000,000 gal. per day addition to present filtration plant. Estimated cost, \$210,000.

South Dakota

GROTON—The Bd. Educ., School Dist. 33, is having plans prepared for the construction of a 2-story, 118x147-ft. high and grade school. A chemical laboratory will be installed in same. Estimated cost, \$200,000. E. Krueger, pres. E. F. Broomhall, 710 Alworth Bldg., Duluth, Minn., archt.

RAMONA—The Bd. Educ. is having plans prepared for the construction of a 2-story, rein.-con., brick and tile high school. A chemical laboratory will be installed in same. Estimated cost, \$150,000.

WATERTOWN—The Bd. Educ. is having plans prepared for the construction of a 3-story, 152-178-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$250,000. M. Herzel, clk. Tyrie & Chapman, archts. and C. L. Pillsbury Co., engr., 1206 Second Ave., S., Minneapolis, Minn. Noted Dec. 22.

Vermont

WINDSOR—The Windsor Fdry. Co. had plans prepared for the construction of a 1-story, 115x252-ft. foundry. Waldron & Van Winckle, 37 Wall St., New York City, archts. and engr. Noted Dec. 29.

West Virginia

ST. ALBANS—The St. Albans Light & Power Co., Charleston, plans to construct a filtration plant here. Estimated cost, \$75,000. A. Campbell, gen. mgr.

Wisconsin

ST. CROIX FALLS—Bd. Educ. will receive b'ds in the spring for the construction of a 2-story, 53x90-ft. high school. A chemical laboratory will be installed in same. Estimated cost, \$85,000. J. B. Stevenson, clk. W. L. Albam, 347 Endicott Bldg., St. Paul, Minn., archt. Terry & Schulte Engr. Co., 486 Endicott Bldg., St. Paul, engr.

Ontario

LONDON—E. V. Buchanan, engr. Pub. Utilities Comm., Hydro Bldg., plans the construction of a deferrization plant in connection with the water-works system and is in the market for deferrization equipment.

LONDON—Utilities Bd. has awarded the contract for the construction of a filtration plant to remove iron from the water to Permutit Co., 440 Fourth Ave., New York City. Estimated cost, \$40,000.

Quebec

DELSON—The Delson Brick Co., Montreal, will construct a plant here and install equipment.

MONTREAL—F. L. Ross, 7 York Lane, Cote St. Paul, plans to construct a 1-story brick and steel plant for the making of sirup. Estimated cost, \$25,000.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY will hold its annual meeting Feb. 21 to 24 at Columbus, Ohio, with headquarters at the Deschler Hotel.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN INSTITUTE OF MINING AND METALLURGICAL ENGINEERS is holding its spring meeting Feb. 14 to 17 in New York City.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 and 17.

AMERICAN PAPER & PULP ASSOCIATION will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

NATIONAL PETROLEUM CONGRESS will meet at the Hotel Baltimore, Kansas City, Mo., March 22 to 25.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: March 11, American Chemical Society; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

Manufacturers' Catalogs

ACHESON GRAPHITE Co., Niagara Falls, N. Y., is distributing its new catalog on "Acheson Electrodes in Use." It contains photographs of a few of the furnaces in operation, which were chosen as each is typical of the class it represents and the kind of work it is doing. In reference to the pictures of brass furnaces only the arc type or those using electrodes are shown. There are also brass furnaces using Acheson resistor for the heating element.

THE FOAMITE FIREFOAM Co., New York City, is now issuing a monthly magazine called *Industrial Fire Chief*, which is devoted to the advancement of fire-protection engineering. The issue for January, 1921, is vol. 1, No. 4. Well-illustrated articles are included, together with a section on "The Day's Mail," which comprise letters from users of the company's product.

RUGGLES-COLES ENGINEERING Co., New York City, calls attention to Catalog 16, which describes the various types of driers. This company has designed eight distinct types of drying machines, which cover the field of drying as completely as possible. Each type is described and the use to which it may be put, together with illustrations of them.

PITTSBURGH INSTRUMENT & MACHINE Co. has just issued a pamphlet on a continuous and alternating impact testing machine to be used in connection with the testing of airplane, automobile and other machine parts which are exposed to shock.

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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Volume 24

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Number 8

An Important Position Filled

IN THE selection of LAWRENCE WILKERSON WALLACE as executive secretary of American Engineering Council we believe that a wise choice has been made and that the purposes and objects of Council will be forwarded and accomplished promptly and efficiently. A casual survey of Mr. WALLACE'S training and experience together with a knowledge of his personal characteristics and leanings lead us to believe that in him Council has a fitting team mate for Mr. HOOVER. Trained as a mechanical engineer, experienced not only in the practice of his profession but also in the instruction of those who have selected it as their life work, Mr. WALLACE brings to the secretaryship those precise habits of thought and action which mark the engineering executive. But more than this, he brings a genuine sympathetic interest in the human element in industry which gives him a point of view particularly needed in Council's first great work—a survey of industrial wastes. His address on Conservation of Labor, at the meeting of Council in Washington last fall, was one of the high lights of the convention. His broad interest in engineering is indicated by the fact that he has been three times chosen president of the Society of Industrial Engineers.

Mr. WALLACE has been elected to one of the most important and exacting positions in engineering societies, but we feel confident that he will be found active and capable and that American Engineering Council will be able to point to a definite record of achievement under his secretaryship.

Inadequate Support of Foreign Trade Representatives

THE United States today is practically in the position of a business man with many bills receivable who declines to provide collectors to go out and arrange for the settlement of the obligations due him. Foreign nations owe the United States several billion dollars, an important fact which we can all well appreciate when we come to pay our income taxes. The most promising method of securing return for these loans is through the channels of international trade, both with the nations to which the loans were made and with others which are indirectly able to facilitate payment of the loans. The foreign representatives of this Government who are required as one link in our business chain are the foreign trade representatives in the Bureau of Foreign and Domestic Commerce and in the consular service of the State Department. It is of great importance, therefore, that American indus-

try consider how these representatives of American business are to be provided for during the coming year.

According to the House of Representatives' proposals the Bureau of Foreign and Domestic Commerce will have approximately \$900,000 to conduct its affairs during the next fiscal year, an amount equal to less than one-fiftieth of one per cent of the total Government expenditures. This is only 60 per cent of the minimum sum which the Secretary of Commerce believes to be necessary for effective conduct of trade matters. Fortunately the Senate Committee on Appropriations was a little more generously disposed and suggested an increase of \$50,000 in these funds. Certainly it is to be hoped that the larger amount will be provided, though even it is far too small for full attention to this important foreign trade activity.

The Consular Service and the other branches of the State Department dealing with trade matters were provided for most inadequately in the House of Representatives. The appropriation suggested for them was nearly a million dollars less than during the present year. The Senate, however, again comes to the rescue and has by committee action increased the provision for this service to a more nearly adequate sum. In conference this difference between the two houses of Congress will have to be adjusted and here again the far-seeing business men of the country will certainly wish that the larger appropriation be granted, even though it may seem to be an increase in the burden of taxation. As a matter of fact, it is the most far-seeing investment in foreign trade which our Congress can provide.

In dealing with all these matters one must remember that the transfer of money for the payment of international indebtedness is now, even more than formerly, a matter of practical impossibility. Our debtors can repay us only with raw materials or manufactured goods. If we keep in touch with their markets and production conditions we can most effectively learn what and where to buy as well as what and where to sell.

Those nations to which we sell largely will generally be those that are not indebted to us, but rather those from which we draw many of our most important raw materials. Cultivation of friendship and active trade relation with them obviously is as much an advantage as with those from which we desire to secure something in compensation for funds previously loaned. In other words, no matter what nation we consider, it is worth while to have adequate commercial investigators and consular representatives on foreign ground for the advice of American industry.

Iron and Steel Production Costs

ALREADY not a few iron and steel manufacturers have begun to express regret at the course the iron and steel market was permitted to pursue in 1920, when prices advanced sharply partly through competitive bidding by consumers, particularly automobile and parts makers, and partly through producers definitely seeking the highest obtainable prices.

It is being found now that the net results of operations at high prices were not as satisfactory as they appeared to be at the time. There are two chief flaws, one being that the manufacturers do not today find themselves in possession of all the profits they thought they were making, the other being that they do find themselves with very high production costs.

With many manufacturers it was a case of "come easy, go easy." There was no difficulty in obtaining high prices, for buyers came to the plants and bid advanced prices to secure material, but when the pressure was for material and receipts were large altogether unbusinesslike expedients were resorted to with the object of maintaining or increasing production. While the customers of independent steel mills were competing with one another to get steel, for instance, some of the steel makers were competing with one another to get Connellsville coke, with the result that for weeks the market for spot Connellsville coke averaged about \$18 per net ton at ovens, when in May, 1915, the same coke, only much better quality, had sold at \$1.50. Labor was scarce and knew it, so bonuses were paid and men were practically bribed to stay on the payroll.

During the period of inflated prices in steel there was criticism of the mills in some quarters on the ground that the market was "riding for a fall." The probability is that the manufacturers realized that a break was going to come, but reasoned that a break would occur in any event and would be no more damaging if from one height than if from another. That seemed to be fairly good logic had it not been for the constantly mounting costs.

In striking contrast with the course of the independents in 1920 was the course of the United States Steel Corporation, which kept its prices at the Industrial Board schedule of March 21, 1919, and refrained from attempting to swell its production by unusual or competitive methods. The corporation was very short of coke, but made no effort to buy in the open market. It could not furnish all the steel its customers desired, but it refused to let them bid against one another. Thus the corporation has built up its good will. The corporation has high costs, relative to those in the past, but it has not a great deal to liquidate except by a general wage reduction, which will eventually be made.

A difficulty confronting the independent steel producers at this time is that while they are anxious to reduce their costs and get down to a really economical basis it is impossible to reduce costs when there is no operation. At the moment there is not enough business to be had to operate upon, except in a way that would make no real showing as to costs.

The task before the steel industry is, however, a stupendous one. In the years just before the war there was question whether the productive capacity was not somewhat greater than was really needed, for the spells of light operation had been almost as long as the spells

of full operation. There was no calendar year of full operation throughout, after 1906, until the war demand produced full operation in 1916. Nevertheless pig iron capacity is 35 to 40 per cent greater than in 1914 and steel making capacity about 50 per cent greater. It is necessary therefore to produce with the greatest possible economy in order to build up a demand that will employ the capacity.

Decentralization in Technical Societies

IN HIS address last week as retiring president of the American Institute of Mining and Metallurgical Engineers Mr. HOOVER reviewed the Institute's important activities during the year 1920. Among the most important of these he regarded the trend toward decentralization as offering the greatest promise for the welfare and influence of the Institute as a whole. The increase in the number of local sections and their growth as important factors in the life of the Institute he regarded as one of the outstanding achievements of his administration and he commended to his successor in office the adoption of a policy that would foster this tendency.

It is worth recording here that the Mining Engineers are not alone in this decided drift toward enhancing the importance of the local section and decentralizing Institute activities. The other great national engineering societies have been showing this drift in more or less marked degree. The Mechanical Engineers have for some time past recognized the importance of fostering local sections and encouraging them to greater activity and participation in society affairs. The Electrical Engineers also, we believe, have a form of government which results in as much decentralization as is consistent with the conduct of the Institute's business at headquarters. The recent complete change in régime in the Civil Engineers was the consequence of dissatisfaction with highly centralized authority, and a determination to recognize the increasing importance of local sections. And finally it may be noted that the administration of the newly organized Federated American Engineering Societies is convinced that this great body can function to best advantage through the activities of state sections or groups.

Apparently enlightened opinion on the conduct of technical societies has recognized the evils of a highly centralized organization, with its tendency to dominate affairs through a self-perpetuated clique that fears to let the membership get out of hand through too great local activity. It is, of course, recognized that in all national societies there must be enough officers and directors living near headquarters to insure the transaction of regular business, but beyond that there should be no attempt to limit or control the activities of the membership through fear that the local section might grow in power and menace the solidarity of the parent organization. Rather should local sections be encouraged to increase their strength and influence by joining with other local, state and regional societies for participation in local public affairs. Affiliation with Chambers of Commerce and co-operation with representatives of the local government will be found to be fruitful fields of endeavor. From these activities the local bodies will acquire a lively sense of importance, to which the prestige of their national organizations will make a further contribution. With a number of

such flourishing local organizations receiving encouragement and support from headquarters the reaction on the parent organization can have but a beneficial and desirable effect. The day is past when a local section of any national technical society can be a nonentity without contributing toward centralization of authority and rule by clique.

Improvement

In Drill Steels

IT APPEARS from figures presented by B. F. TILLSON before the recent meeting of the American Institute of Mining and Metallurgical Engineers that a perfectly amazing number of breakages in drill steel is accepted as a matter of course by men in charge of rock-drilling operations. Mechanical sharpeners, drilling machines and details of drill bit and shank have been perfected with infinite care, yet one out of every hundred pieces of drill steel tightened in a chuck breaks short across in the shaft before becoming dull. Records for heavy drills have shown a loss from breakage as high as 7 per cent per shift. This involves a waste which is surely worthy of attention.

Disregarding the influence of rough handling underground, and improper operation of the drilling machine, which are evidently matters for the attention of the mining men, the responsibility for this great mortality in drill steel may rest primarily in the stresses imposed in service, in the composition or constitution of the steel itself, or in its heat-treatment during and after forging the shank or bit ("sharpening").

Drill breakage is mostly confined to the shaft of the drill itself. If a portion of the bit flakes off, the drill is ordinarily classed as "dull," and is reforged. Transverse breaks in the drill rod itself, which are the cause of the present inquiry, are often ascribed to the progressive extension of "fatigue checks," such fractures having been induced in test runs after 50,000 impacts. However, it is difficult to see how so few alternations could cause the damage in view of Prof. MOORE'S work at Urbana showing that 100 million alternations at the elastic limit were insufficient to rupture either ingot iron or normalized eutectoid steel, unless the beating of the drill bit against the rock is so timed with the vibrations along the drill shaft as to build up standing waves of high amplitude, or unless the steel is dirty or highly segregated. Hot spots along the length of a drill when in use are ascribed to such stress waves, and their importance was experimentally shown by Dr. BURROWS. Since records at the New Jersey Zinc Co. undoubtedly showed that if a broken drill be resharpened, a second break will occur after a shorter time in service than the first, and a still shorter time after each succeeding repair, Mr. TILLSON argued that fatigue was responsible, but the same facts would result from the cumulative damage done by successive improper forgings and heat-treatments.

But the steel itself may be faulty. The work it must do is most severe. It is continually in the hands of workmen of more brawn than brains throughout its journey from steel plant as drill rod back to the steel plant as scrap. Perhaps it is unfair to expect one rod of uniform composition to be able to be so hard at its point that it will bite into granite, and yet tough enough along the shaft to transmit the impact of heavy driving piston, and at the same time withstand occasional sledge blows from sweating miners.

Many of the breaks exhibit the detail fracture characteristic of transverse fissures in rails, about which so much has been said and so little is known. If these fractures can be readily induced in drill rods, their study may easily throw a great deal of light on sound steel for rails. Undoubtedly segregation at the nucleus has much to do with starting these failures. Segregation occurs every time a steel ingot solidifies and will to the end of time. Some of it can be later removed by correct heat-treatment, but solid non-metallic inclusions—a perfectly normal constituent of steel—remain more or less unaffected. A thorough research into drill steel will have to determine what sonims are harmful and what sonims are harmless.

Those who have watched the mine blacksmith at work, or even observed the elaborate drill-sharpening plant of the Calumet & Hecla company, controlled as it is by the human eye pyrometer, are not surprised at Mr. FOLEY'S analysis showing by far the largest proportion of breakages to occur near ends—where the cold steel rod was heated preparatory to forging, but where it received no working; where it acquired a coarsely crystalline structure and was cooled slowly, receiving no subsequent grain refinement. Undoubtedly these failures were due to faulty heat-treatment, yet if education of the smiths can progress so that the more glaring abuses are prevented it is difficult to see how the remaining failures can be improved short of a complex heat-treatment of the end, or a more simple heat-treatment of the entire rod, either of which is beyond the skill and resources of any but the largest and most progressive mining companies.

Meanwhile cannot metallurgists offer a different kind of steel which is more nearly fool-proof than the plain high-carbon hollow hexagons now so largely bought and broken? An indication that the composition is not beyond improvement is the fact that rods made up of electrically butt welded pieces very seldom break at the welds, where undoubtedly a considerable amount of decarbonized metal exists. If a carburized bit and decarburized shaft is impracticable, cannot alloy steels be substituted for the carbon steels, admittedly less responsive and more "tricky" or tender under heat-treatment than many more complex compositions? It is known that the steel which acquires the full measure of its possibilities after the fewest and least drastic heat-treatments is of such a nature that the transformation starts at locations which are packed closest together. It is also known that a steel exhibiting high thermal hysteresis will acquire similar physical properties despite rather large variations in the quenching and annealing temperatures. Many alloy steels have closely packed crystallization and transformation centers and at the same time a considerable temperature interval between the critical points. Have these steels not been exploited? is the price too high? or are mining men too timid to attempt reforming the blacksmith shop?

Whatever the answer to these queries, we welcome the co-operative investigation of drill steel. The questions raised by a preliminary survey of the problem by mining engineers (not metallurgists) are precisely those which are fundamental to the modern science of physical metallurgy. If investigators in pure science needed justification, they could point to this new inquiry of a distinctly "practical" nature to prove the commercial utility of a study into Fe:C:O equilibrium, the chemical composition of emulsified inclusions, or atomic configuration in metallic crystals.

Notes on French Industries

FROM OUR PARIS CORRESPONDENT

PARIS, Jan. 15, 1921.

THE condition of the French chemical and metallurgical industries at the beginning of 1921 is far from satisfactory. Plants erected during and subsequent to the war have enjoyed a short period of prosperity, but now that German products are again on the French market the competition with home products is strong and greatly in favor of the Germans. The young industries did not develop the vitality necessary to enable them to meet with immunity the present economic difficulties.

STATUS OF THE CHEMICAL INDUSTRIES

The crisis is most pronounced in the synthetic dye industry. During the last few years France made great efforts to develop this industry to a point where she could make 765 metric tons per month (August, 1920), but at present the production is steadily declining, as shown by the figures for September and October—640 and 625 tons respectively. The official figures for the last two months of 1920 undoubtedly will show an even more marked decline. The total production of dyes is hardly sufficient to supply 50 per cent of the total French consumption, which is now about 12,000 tons per year.

During 1920 the Germans supplied 2,255 tons at a cost of 32 million marks, of which 1,275 tons, valued at 19.5 million marks was delivered between May and the end of December, 1920.

The present French tariff on dye importations is of practically no help to the French industry because the import duty is negligible when it is considered that the price of dyes has increased up to tenfold and more.

One of the few successful new chemical companies, the Société Alsacienne de Produits Chimiques, which is in reality the successor to the Société de Produits Chimiques de Thann et Mulhouse, has increased its capital from 16 to 30 million francs and has consolidated with the Société des Produits Chimiques de La Rochelle. The company is now erecting a synthetic camphor plant at La Rochelle. It is worth mentioning that the erection of this plant was decided upon when camphor sold at 85 f. per kg. and that now camphor is quoted at 40 f. per kg. The officials of the company state, however, that the drop in price will not affect them, as they have contracts for the sale of their total production at the former price, and that in addition the cost of the principal raw material (essence of turpentine) has dropped from 1,000 f. to 580 f. per 100 kg.

THE STATUS OF THE METALLURGICAL INDUSTRY

The most optimistic comment that can be made concerning the French metallurgical industries is that better days are expected in the near future. The government hopes to have helped the iron industry somewhat by fixing the price of blast-furnace coke at 135 f. per ton beginning Jan. 1, 1921, which means an abrupt reduction of 40 f. per ton, the price for coke used in all other industries being fixed at 200 f. per ton.

The metallurgical industries of Lorraine suffer the most due to the fact that the sale of the Lorraine plants to French firms after peace was declared took place under very abnormal conditions. The buyers' bids were not based on the actual value of the production capacity of the plants but on the desire to acquire them at any price. The result is that there are now in Lorraine a

number of overcapitalized enterprises of a producing capacity far over the present market demands and which are forced continuously to lower the selling price of their products to meet their most pressing financial needs. The consequence of this abnormal situation is that a number of Lorraine plants and practically all the plants in the Department of Meurthe and Moselle are shut down, a condition without precedent in the history of the French metallurgical industry. It is stated that the producers in the above two departments have about 200,000 tons of pig iron in stock and are anxiously waiting for buyers. What makes the condition even worse is the strong competition of the Germans who take advantage of the abnormal exchange rate of the mark and who again make efficient use of their former dumping policy.

SOYA OIL COMPETING WITH ARACHIS OIL IN THE SOAP INDUSTRY

The Marseilles soap industry is now using great quantities of hardened arachis oil (peanut oil) supplied exclusively by England. The advantages of using the hardened product are an economy of 35 per cent over the use of industrial arachis oil and a harder soap. Encouraged by these results, the Marseilles manufacturers, wishing to become independent of the English supply of this important product, are trying to induce the French producers of arachis oil in West Africa to install their own plants for the hardening of the oil. The hardened oil now sells in Marseilles at 360 f. per 100 kg. The use of soya oil gives results similar to those obtained with hardened arachis oil and Japan is now trying to introduce the use of soya oil by offering it at 340 f. per 100 kg. A strong competition is now going on as to which product shall prevail in the soap industry.

PROGRESS OF THE FRENCH POWDER AND EXPLOSIVES INDUSTRIES

Prof. Haller has recently presented two papers before the Société d'Encouragement pour l'Industrie Nationale de France on the work of French chemists in the powder and explosives industries during the war. The following few figures he mentioned may give an idea of the rapid progress realized.

B-powder (nitrocellulose). The production in August, 1914, was 14 tons per day; in 1917 it reached 367 tons per day.

Nitrated Explosives. The production in August, 1914, was 8 to 9 tons per day; in July, 1917, it reached 700 tons per day.

In 1917 France produced 175 tons per day of chlorated explosives, which were used mostly in the preparation of grenades.

American Chamber of Commerce in France

At the annual meeting of the American Chamber of Commerce in France held in Paris, Jan. 17, 1921, A. M. Thackara, American Consul-General in Paris, spoke on France's export to the United States during 1920. The grand total value of the French export to continental United States and its possessions amounted to \$467,158,848, as compared with \$168,146,032 in 1919.

There are now 978 members, as against 800 in 1919 and 473 in 1918. The officers for 1921 are: Walter V. R. Berry, president; Charles E. Carpenter and A. D. Veil, vice-presidents; W. Morgan Day, treasurer, and V. K. Stevenson, honorary secretary.

American Institute of Mining and Metallurgical Engineers

Abstracts of Papers Presented Before the Winter Meeting, With Notes on the Technical Discussions—
Notable Sessions on Ferrous and Non-Ferrous Metallurgy, Including an Excellent Symposium on
Breakage and Heat-Treatment of Drill Steel

NEW YORK entertained, in the usual manner, the winter meeting of the American Institute of Mining and Metallurgical Engineers, Feb. 14 to 17. Fifty or more papers were presented at fourteen technical sessions, many excellent ones being read from author's manuscript, owing to the fact that the Institute's funds are apparently not large enough to cover the cost of pre-printing them. This results in perhaps more attention to the paper on the part of the members present at the technical sessions, but prevents the attention and profit of the nine thousand or more less fortunate members. Furthermore, some of the metallurgical papers were held over from the Lake Superior meeting, possibly for geographical reasons. Two long sessions, under the able chairmanship of B. F. Tillson, presented a symposium on failures in drill steel, reference to which is made editorially in this issue.

Physical conditions surrounding the meeting were rather better than the average. Programs were carried through promptly and without delays, entertainment features on the whole were quite good, and were enjoyed by members of all ages and their guests. The Institute will perhaps never again be so fortunate as to have Herbert Hoover for president and E. P. Mathewson for host at the same meeting. Edwin Ludlow, the new president, assumed the duties of his office at the closing banquet.

Non-Ferrous Metallurgy

A. B. Young, superintendent of the Tooele Plant, International Smelting Co., described the flue-type treater handling the company's roaster gases, an installation whose details have already been given in *CHEMICAL & METALLURGICAL ENGINEERING* for Dec. 29, 1920, vol. 23, p. 1244. It excited favorable comment as to its economy in first cost and operating charges. It is there used primarily to catch true dust. A. A. Heimrod cited two other installations of this type, of the same size, one precipitating dust whereas the other cleared fume. The latter required about four times the power input.

ELECTROLYTIC ZINC

The paper by Frederick Laist and his associates on Anaconda's Electrolytic Zinc Plant has already been reviewed at length in the columns of this journal (Feb. 9, 1921, vol. 24, p. 245), but the original paper, with its enormous amount of data, should be in the hands of all men interested in this phase of metallurgy. Discussion brought out a very interesting contrast in views. S. C. Bullock, writing from England, emphasized the need of extreme purity in tank solutions, while W. C. Smith described informally the process in operation at Martinez, Cal., developed by Messrs. Tainton and Pring. Using Australasian ore, Mr. Bullock finds that a most elaborate purification cycle is necessary. Nickel and cobalt especially must

be eliminated to less than 0.0001 per cent—in fact nickel was ordinarily kept about 0.00002 per cent; such special efforts were found to pay in a gratifying increase in tank efficiency. Hand-rabbed furnaces were favored in Great Britain. Conversion of 97 per cent zinc to soluble form was not rare, while 90 per cent soluble was regarded as merely fair practice on very difficult Australian ore. Iron was ordinarily removed after filtration; it was removed by aëration and CaCO_3 .

At Martinez the calcines are ordinarily separated magnetically into two portions. The first, or magnetic (iron), portion leached with hot strong acid—27 per cent H_2SO_4 —the spent cell solution. When the free acid has been reduced about one-half, further neutralization is effected by the second or oxidized portion of the calcine. The resulting solution contains as high as 200 g. Zn per liter, and of course must be filtered hot. The purification cycle is relatively simple, but is effected by an unrevealed method; the purification, however, is not nearly as high as otherwise. Cobalt or arsenic can run as high as 30 mg. per liter; antimony, however, is much more troublesome. Clear solution is added to the circulation to keep the heads at about 70 g. Zn per liter. It is electrolyzed until about 30 g. remain, using a very high current density—100 amp. per sq.ft. Electrode spacing is $1\frac{3}{8}$ -in. face to face; voltage is about 4 volts per cell. It is evidently necessary to refrigerate the electrolyte to keep down the I^2R heating. Much glue is used in the cells; about 3 lb. is consumed for every ton of zinc produced. This keeps down the acid mist effectively; indeed the undue formation of mist is an indicator of the need of more colloid. Current efficiency averages 89 per cent of the theoretical electrochemical equivalent of zinc, with an input of 1.77 kw.-hr. per lb. of zinc. The 35-hr. cathode deposits are very dense and smooth, showing no signs of sprouting despite their thickness of $\frac{1}{8}$ in. Average extraction from a 39 per cent ore averaged 87.6 per cent for a fortnight's operations, figured on the weight of cathode sheets, about two tons of which are produced daily in the present plant.

The chairman, E. P. Mathewson, characterized the work of Tainton and Pring as being the final evidence that furnace methods for zinc production are doomed to extinction. Their experiments show that a small plant can be erected having a very large output, and only where natural gas is extraordinarily cheap and electricity extraordinarily dear can retort smelting show advantages in cost per pound of zinc.

STEEL CHIMNEYS IN COPPER PLANTS

"Steel Chimneys and Their Linings in Copper Smelting Plants" was the title of a paper by A. G. McGregor, in which he gave the structural details of a number of such erected in the Southwest, and a

record of their performance. From the data he concluded that unlined steel chimneys or chimneys or dust chambers lined with building tile have not given satisfactory service when used for roaster or reverberatory furnaces, but they have endured for long periods when used for blast-furnace and converter gases. Such results may be expected in ordinary copper plants where no especial effort is made to keep gases at a high temperature. Table I summarizes his data.

Unfortunately no explanation of the corrosion was ventured. Converter gases usually corrode metal flues badly, but Hiram Hixon advanced the opinion

Non-Ferrous Metallography

W. P. Sykes presented a paper on the "Effect of Temperature, Grain Size and Rate of Loading on the Mechanical Properties of Metals." This is a companion paper to one of the same title by Dr. Zay Jeffries,¹ appearing in the *Transactions* of the Institute for 1919 (vol. 60, p. 474), the two men working in conjunction in both researches. There are now two series of metals, W, Fe, Cu and Mo, Ni, Al, which have been carefully studied and the results are available to verify existing generalizations between atomic configuration and various

TABLE I. STEEL SMELTER STACKS

Plant	Location	Date of Erection	Kind of Gases	Diameter of Shell	Height of Stack	Lining		Material	Present Condition of Stack
						Height	Thickness		
Calumet & Arizona.....	Douglas	1913	Roaster	20 ft. 7½ in.	279 ft.	{ 40 ft. 239 ft.	{ 4½ in. 4 in.	Common brick Building Tile	Rebuilt in 1918
Calumet & Arizona.....	Douglas	1913	Blast furnace and reverberatory	25 ft. 9½ in.	305 ft.	305	4 in.	Building tile	Excellent
Calumet & Arizona.....	Douglas	1906	Blast furnace, converter since 1913	15 ft.	200 ft.	....	....	None	Excellent
Cananea Consolidated...	Cananea	1903	Blast furnace	19 ft. 9 in.	170 ft.	{ 85 85	{ 6 in. 4½ in.	Radial block Radial block	Excellent
Cananea Consolidated...	Cananea	1902	Reverberatory	12 ft.	171 ft.	{ 85 86	{ 9½ in. 4½ in.	Fire brick Fire brick	Lining renewed in 1910; upper 75 ft. rebuilt in 1917
United Verde.....	Clarkedale	1915	All departments	30 ft. 9½ in.	400 ft.	400 ft.	4½ in.	Brick	Excellent
International Smelting Co.	Miami	1915	Converter	15 ft.	200 ft.	....	....	None	Excellent
International Smelting Co.	Miami	1915	Reverberatory	22 ft.	300 ft.	100 ft.	4 in.	Building tile	Replaced by brick stack in 1921
Detroit Copper Co.....	Morenci	1899	Converter and blast furnace	13 ft.	165 ft.	....	....	None	Bad corrosion in upper 12 ft. during shut downs.
Copper Queen.....	Douglas	1904	Converter and blast furnace	25 ft.	260 ft.	....	....	None	Excellent
Old Dominion.....	Globe	1904	Converter and blast furnace	14 ft.	200 ft.	....	....	None	Excellent

that this was caused by eddy currents between the hot gas and cold air drawn into the hood, producing a zone locally cooled below the dew point, with a resulting precipitation of acid. Further along, where the gas and entrained air had a chance to become thoroughly mixed and equalized in temperature, little precipitation occurred, with correspondingly small corrosion. His observations from Mexico and Canada convinced him that corrosion of metallic smoke ducts was a matter of humidity—keep the temperature above the dew point within the flue or chimney, and corrosion will occur only at the exit, where the out-flowing gas strikes a very wet or very cold atmosphere.

Forest Rutherford also agreed that the temperature of sulphurous gases should be relatively high if corrosion was to be prevented. During his superintendency at Copper Queen, the main stack—200 ft. high and unlined—venting the smoke from all departments, was kept hot continually. Even when the smelter was shut down a good fire was maintained at the base. This stack is still undamaged. Building tile and lime mortar are to be avoided because of the formation of gypsum with a large increase in volume—thus breaking up the continuity of the material. Roaster and reverberatory gases are different in their nature and corrosive action for many causes, not least of which is the moisture content of the furnace feed.

C. R. Kuzell also pointed out a controlling factor existing at the Clarkedale smelter, where a 30 x 400-ft. brick-lined steel stack discharges smoke from all departments. The ores contain some zinc, and enough of it is fumed during operations to neutralize acidity in the hot gases. Lacking available base of this sort, definite steps would doubtless be necessary to prevent corrosion.

easily observable physical properties. Of these six metals, X-ray investigations indicate that W, Fe and Mo crystallize in the body centered cube. Cu, Ni and Al, together with Pb, Pt, Au and Ag, assume the face centered cubic structure, and when equiaxed hold their ductility to the temperature of liquid air, as does also manganese steel. Here is a little light on the difference between gamma and alpha iron. Manganese steel, which is austenitic, shows a face centered cube under X-ray analysis. Consequently gamma iron is also thought to be of this crystallinity, whereas alpha iron, as above stated, is body centered. In common with tungsten and molybdenum, it is brittle instead of somewhat ductile in liquid air. Magnesium and zinc harden very rapidly under cold deformation, and appear to belong to the hexagonal system. In general, it may also be said that the rate of change in physical properties as the temperature varies is a function of the atomic weight—i.e., a change of say 100 deg. C. will make a greater change in the elongation of tungsten or lead than it will in the elongation of iron or aluminum.

ARTILLERY CARTRIDGE CASES

"Artillery Cartridge Cases" were discussed by J. Burns Read and S. Tour. They pointed out that since these cases are cold-worked from brass disks, it is essential first that the original disk be of good quality; second, that the tools and amount of cold work be correct, and third, the annealing heats between successive stamping or drawing operations be carefully controlled. Formerly only a rather loose chemical specification had to be met, pending final acceptance of the lot by ballistic testing. In the latter, three cases from each lot are fired at 12 per cent excess powder charge.

During the war no lots were rejected at this point, although 123 had to be retested, 72 of which were due to deficiencies in metallic structure and could have been predicted from the records of the metallurgical tests made by the government inspectors.

Physical tests on strips taken from two cases in each lot were utilized principally for the guidance of the manufacturer; good results were ordinarily obtained except at the end of the case, where varied amount of work and consequent error in the reheating temperature caused deviations. These tests have now been well established, and pending the development and general acceptance of a substitute in the form of a hardness test, should be put into the specifications as a requirement.

Microscopic observations on six locations in five cases from each lot proved of extreme importance in the control of correct manufacture. In general, typical micro-sections showed a well-defined re-crystallization at the mouth, hard metal in the wall behind the taper, and well-worked metal in the end.

Mercuric chloride tests on one case were also made for manufacturing control. As is well known, immersion for four hours in a 1½ per cent solution will develop intercrystalline cracks in metal where somewhat severe differential stresses produced by incorrect working or annealing exist, especially if they are tension stresses, and which later would result in those spontaneous and mysterious failures known as season cracking. No connection has been discovered between this test and the others, and whereas it caused many rejections from immature contractors, the difficulties could ordinarily be removed by giving close attention to the tool design, by increasing the work at the last redraw, and by increasing either the time or the temperature of the final anneal.

Session on Metallography of Iron and Steel

"Nitrogen in Steel, and the Erosion of Guns," by H. E. Wheeler, was printed for the Lake Superior meeting of last August, and abstracted in our issue for Sept. 1, 1920 (vol. 23, p. 366), as was also another interesting metallographical paper by Messrs. Hemingway and Ensminger on "Surface Changes in Carbon Steel Heated in Vacuo." Mr. Wheeler's work was on the cause of explosive rupture of gas containers, but in the course of the investigation he noted many similarities to surface conditions in gun tubes. Hardening and embrittling by nitrogen have been recently discussed in these columns by Knight and Northrup² and Fay.³ One statement made by Mr. Wheeler, that "iron nitride is no more metallic than iron oxide, and the writer seriously questions its ever having been found as a metallographic constituent of steel," was taken sharp exception to by both W. R. Ruder and George F. Comstock. These men, together with S. W. Miller, have shown that some nitrogen-bearing constituent is undoubtedly present in fusion welds. This may not be iron nitride, but it is quite distinctive and has been observed in carbon-free iron and steels up to 0.20 carbon, therefore it is not associated with a critical carbon content. Using the word "nitride" to signify this new constituent, it is known that pearlite and nitride cannot be distinguished by HNO₃ or picric acid etching. Ruder

and Comstock have had good results with a modified Stead's reagent,⁴ but the Bureau of Standards was not so successful in its use, since massive nitride is sometimes unattacked. Comstock now reports that a boiling reagent consisting of 10 g. KOH, 1 to 4 g. potassium ferricyanide, in 100 c.c. water, if applied from ten to thirty minutes will give a sharp distinction. Massive cementite is blackened, massive nitride is attacked only slightly, becoming yellowish in tone, while pearlite is etched at an intermediate rate, assuming a distinctly brown tint.

Reaction Between Iron, Carbon and Oxygen

A. Matsubara, of the University of Kyoto, Japan, has made some fundamental studies in the "Chemical Equilibrium Between Iron, Carbon and Oxygen."

The long and painstaking work may be reviewed under several heads:

(1) In properly constructed and operated apparatus, the equilibrium compositions of the gases CO and CO₂ in contact with metallic iron and ferric oxide were carefully measured at 863, 1,070 and 1,175 deg. C. Over 100 separate tests were made in this one study. The net results show that the following percentages of CO are in equilibrium with the following substances at the temperatures stated:

	863 Degrees C.	1,070 Degrees C.	1,175 Degrees C.
Fe ₂ O ₃	0	0	0
Fe ₃ O ₄	25	15	15
FeO.....	67	72	75

The first line means simply that at the temperatures used, Fe₂O₃ dissociates of itself into Fe₃O₄ and O so strongly that any CO present is oxidized to CO₂ and no equilibrium exists; or, putting it another way, any percentage of CO will reduce Fe₂O₃ to Fe₃O₄ at any of these temperatures.

The second line means that Fe₃O₄ is reduced to FeO by any mixture containing more than the percentages of CO given, at the temperatures named.

The third line indicates that FeO is reduced to Fe by any mixture richer in CO than the percentages given.

In each case, the percentage of CO means the proportion it forms to the sum of CO and CO₂ present, ignoring the inert nitrogen which may accompany it in the blast or other furnace. Diagrams are given which summarize the various tests.

(2) From these data, the author has calculated Tables

TABLE I. VALUES FOR FeO:Fe EQUILIBRIUM

Temperature Degrees Absolute	Per Cent CO	(Equilibrium Constant) Log K	Log P	P*
834	0.536	8.2530-10	8.4618-10	0.029
935	0.584	9.4400-10	9.5263-10	0.336
993	0.607	0.0181	0.0461	1.112
1,136	0.659	1.2085	1.1035	12.7
1,236	0.692	1.8914	1.6997	50.1
1,343	0.724	2.5218	2.2432	175.0
1,448	0.755	3.0618	2.6999	501.0

I and II, giving the gas pressures exerted at different temperatures by FeO and Fe₃O₄, respectively, in presence of C as a reducing agent.

It must be remembered that in the blast furnace these are in reality partial pressures, being that fraction of the total tension of the gases borne by the CO and CO₂ present. The author further calculates the simple

²"Some Notes on the Effect of Nitrogen on Steel," vol. 23, p. 1107 (Dec. 8, 1920).

³"Nitrogen and Case-Hardening," vol. 24, p. 289 (Feb. 16, 1921).

⁴Consisting of 0.1 g. mercuric chloride, 0.1 cupric chloride, 20 c.c. concentrated HCl and 80 c.c. ethyl alcohol. This is dropped on the sample, and the pearlite rebrightened by gentle polishing, repeating the process until a satisfactory contrast is had.

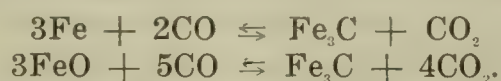
TABLE II. VALUES FOR $\text{Fe}_3\text{O}_4\text{:FeO}$ EQUILIBRIUM

Temperature Degrees T Absolute	Per Cent CO	(Equilibrium Constant) Log K	Log P	P^*
900	0.435	9.0574-10	9.5325-10	0.341
993	0.352	0.0181	0.7366	5.453
1,136	0.255	1.2085	2.3763	236.8
1,236	0.204	1.8914	3.1730	1,489.0
1,343	0.164	2.5218	4.0143	10,335.0
1,448	0.152	3.0618	4.6265	42,320.0

* These values of P represent the total equilibrium pressure of the system containing amorphous carbon.

dissociation pressures of the compounds Fe_3O_4 and FeO , at temperatures from 800 to 2,400 deg. absolute. These data are of great scientific interest, but do not apply directly to blast-furnace practice, where C is always present.

(3) The reactions by which iron absorbs carbon and becomes carburized are next studied. They involve either the action of CO on reduced Fe or of CO on FeO which is being reduced to Fe; that is, either



The results of about forty experiments prove that the first period of carburization in the blast furnace corresponds to the second of these reactions, and at a later stage to the first reaction; there exist transitional equilibria between. These reactions proceed from left to right at fairly low temperatures. Table III gives the percentage of CO present at equilibrium in each of these reactions at various temperatures, and in other extensive tables the equilibrium pressures exerted at various temperatures for various percentages of CO.

TABLE III. EQUILIBRIUM POINTS OF CARBURIZING REACTIONS

Temperature Deg. C.	Percentage CO at Equilibrium	
	$3\text{Fe} + 5\text{CO} \rightleftharpoons \text{Fe}_3\text{C} + 4\text{CO}_2$	$3\text{FeO} + 2\text{CO} \rightleftharpoons \text{Fe}_3\text{C} + \text{CO}_2$
685	.....	55.48
743	.....	75.49
744	.....	76.00
761	.....	80.81
772	80.22	.....
810	84.58	.....
814	.....	88.09
857	.....	89.68
907	89.15	.....
909	.....	92.45
963	.....	93.90
965	91.05	.....
968	.....	93.90
968	.....	94.28
1,014	93.12	.....
1,065	.....	96.64
1,070	.....	97.27
1,176	97	.....

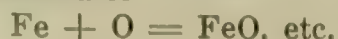
Three applications of these principles are studied—viz., to case-hardening, malleabilization, and blast-furnace reactions.

In *case-hardening*, the author shows that Schenck's assumption that the isothermals of $\text{Fe:Fe}_3\text{C}$, $\text{FeO:Fe}_3\text{C}$ and FeO:Fe meet in a common point is untenable and contradicted by his data; this renders Giolitti and Carnavali's diagram, based partly on Schenck's assumption, also untenable, and leads to a quite different diagram. These matters have been discussed in METALLURGICAL & CHEMICAL ENGINEERING, April 1, 1917 (vol. 16, p. 385), and will be treated at length subsequently.

In *malleabilizing* that which it is desired to oxidize is iron carbide and not iron itself. The reaction should, therefore, be confined to



and not to be extended to



Then, it is clear that the oxygen-dissociation pressure of the gas surrounding the cast iron that is to be

malleabilized should be always a little higher than corresponds to the $\text{Fe:Fe}_3\text{C}$ equilibrium proper to the adopted pressure; any larger excess of oxygen pressure should be avoided, as otherwise iron would be oxidized. This regulation of pressure can be performed by one of the following methods:

1. By the regulation of the velocity at which CO_2 , O_2 or air is introduced into the reaction vessel.

2. By the regulation of the composition of the oxidizing gas; for instance, the ratio of CO:CO_2 when a mixture of these gases is employed, the ratio of $\text{O}_2\text{:N}_2$ when air is employed, etc.

By the analysis of the escaping gas the oxygen pressure of the reacting gas is easily determined, it is only necessary to determine the ratio $\text{CO: (CO + CO}_2\text{)}$ in the gas, for the volume percentage of oxygen is negligible.

In the *blast furnace*, the influence of varying temperatures, varying pressures and varying compositions of gas form a highly complex problem. Assuming the CO plus CO_2 to constitute an average of 36 per cent of the volume of the gases in the furnace, the sum of their partial pressure is fixed, and the problem becomes soluble. Taking the pressure and temperature distribution in the furnace as determined by Schlesinger as typical, the partial pressures of CO plus CO_2 at the determined pressures become known, and the equilibrium conditions can be studied at various points in the furnace. This study leads to a remarkably instructive diagram, which shows in brief, that ferric oxide and magnetic oxide are reduced to FeO easily, but that the main reducing power of the furnace is used for the reduction of the ferrous oxide at 900 to 1,000 deg. C. The reactions are further effected by the displacement of equilibrium due to the CO_2 from the limestone. The effect of removing moisture and enriching the blast in oxygen are evidently deducible from a study of the equilibria data determined in this investigation.

Fluorspar Industry in Germany

The largest fluorspar fields in Germany are situated in the Hartz, Upper Palatinate, Thuringian Forest and Black Forest. The best quality is produced in the Upper Palatinate. The fluorspar found in the Upper Palatinate contains generally from 95 to 98 per cent of fluoride of calcium and relatively little silicic acid.

Most of the fluorspar is consumed at present by the iron industry. In the case of this kind of utilization, broken materials suffice. Other consumers are the glass industry and the chemical and enamel industries. These utilize fluorspar in a milled form, and together they use much less than the iron industry alone. According to a rough estimate made before the war it is calculated that the quantities supplied, respectively, to the individual industries are approximately as follows: Iron and metal smelting industry, 79 to 84 per cent; glass industry, 10 to 15 per cent; chemical industry, 5 per cent; enamel industry, 5 per cent; optical industry, 5 per cent.

The utilization of fluorspar in the iron industry has made steady progress in consequence of the shortage of coal since the armistice, since fluorspar increases the fluidity of the fusible material and thus effects an economy of fuel, although at the cost of the quality of the resulting product. Consequently, it is probable that post-war statistics will show an increase of the consumption of fluorspar by the iron industry at the expense of that of the glass industry.



Armour Fertilizer Works—I

New Plant at Chicago Heights, Ill., Now in Operation—Model Chamber Process Producing Sulphuric Acid From Sulphur—Methods of Tower and Chamber Construction and Liquid-Handling
Mark Advance Practice in Chemical Engineering

BY CHESTER H. JONES

THE new plant of the Armour Fertilizer Works which has recently been brought into full operation at Chicago Heights, Ill., is an admirable example of what may be accomplished by the application of chemical engineering and the science of chemistry in the design of process and the operating control of a most essential industry. An extensive variety of mixed fertilizers for adaptation to any combination of soil and crop is produced with the control so carefully worked out in the blending of each lot of material that the actual chemical formulas may be stamped on every sack before shipment to the trade.

Mixing under the supervision of the chemist is, however, only a feature of the final stages of manufacture which will be later described.

One of the important initial steps is the manufacture of sulphuric acid from sulphur. The large building on the left in the illustration at the top of this page houses the sulphuric acid plant complete with the chambers as seen on the left, the towers in the intermediate high bay and the sulphur burners in the lower lean-to on the right.

This is probably one of the finest chamber plants in the United States. All the piping, flues, pumping systems, chambers, coolers, towers and tanks are so designed as to contain and convey the materials without the least evidence of mist, spray, fume or acid slop

at any point in the process. The stack where the final gases are emitted to the atmosphere with the plant in full operation never displays the slightest visible trace of either mist or niter fume.

SULPHUR BURNING

The commercial sulphur is obtained from Southern companies, and arriving in box cars is shoveled to the storage pile in the end of the burner room. Thence it is drawn in wheelbarrows weighed over a Standard

platform scale and delivered to the burner doors as shown in Fig. 1. Twenty-four tons of sulphur is consumed every twenty-four hours to produce about 117 tons of 50 deg. Bé. H_2SO_4 . The burners were designed by Armour Fertilizer Works engineers, the construction being essentially two units of six chambers each with common brick walls and firebrick arches and linings. Steel buckstays and rods support the walls and arches and the doors and frames



FIG. 2. TOP OF BURNERS AND EXIT FLUE

are made of cast iron. This constitutes all the metal work. There are no moving parts, sulphur simply burns on the hearths. Air is admitted in sufficient quantity to volatilize the sulphur to sulphur dioxide, the reaction being completed by the time the gases reach the exit flue. Fig. 2 shows this flue over the top of the burning chambers. It is placed between the two units, drawing gas from a common header. It is constructed from sheet steel lined with a double course of firebrick.

Located near the foot of the stack are three niter

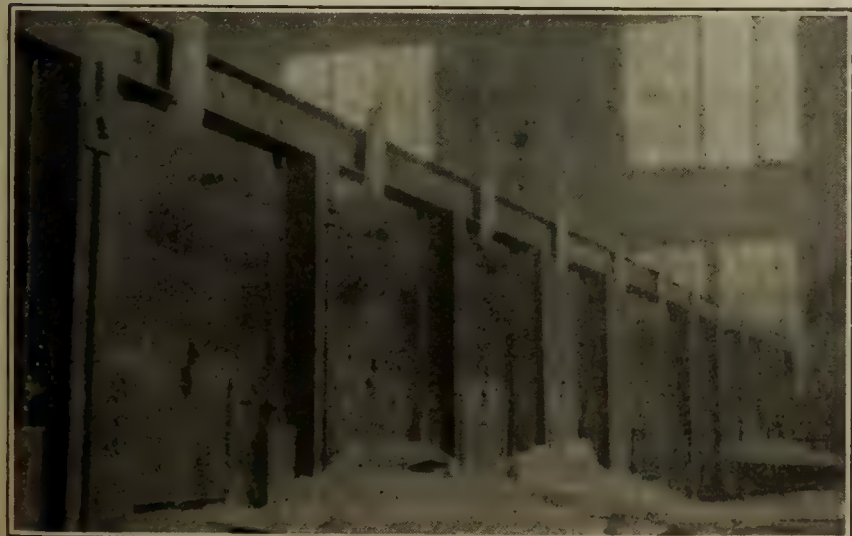
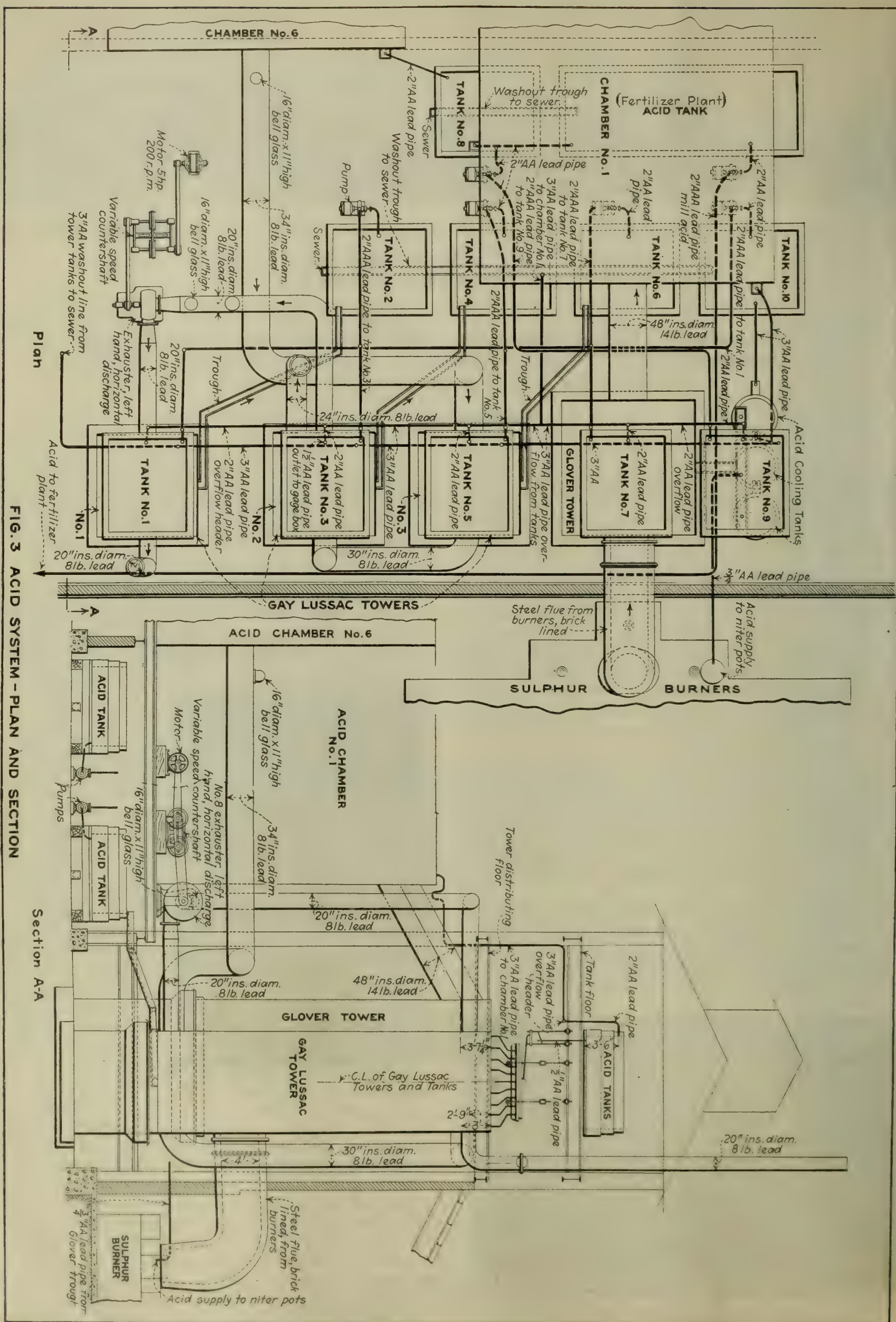


FIG. 1. FIRING DOORS OF SULPHUR ROASTERS



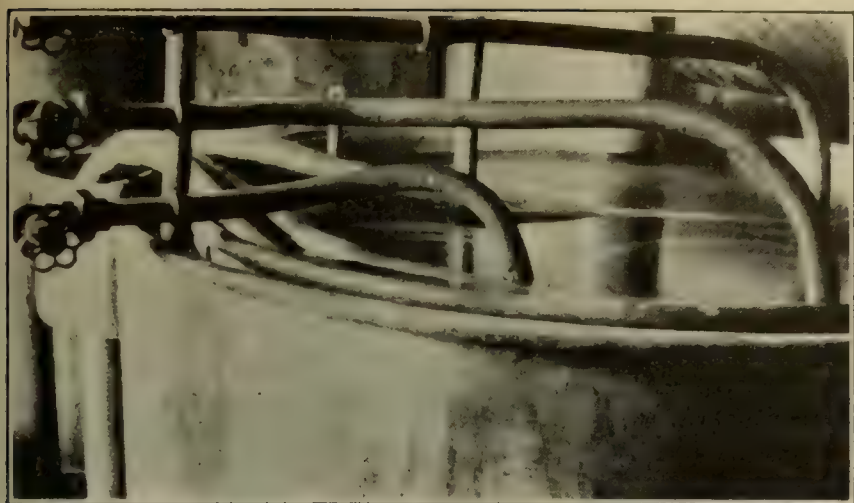


FIG. 4. ACID COOLER, SHOWING COILS BENEATH SURFACE

pots each 5 ft. long by 3 ft. wide by 3 ft. deep, cast by the Chalmers-Williams Co. The Chilean nitrate purchased on the open market is put into these pots and treated with sulphuric acid piped from the Glover tower outlet trough. (See Fig. 3.)

ACID TOWERS

The piers and floors supporting the brickwork of the towers proper are reinforced concrete. The steel framework surrounding and supporting the brick structure is heavily painted with asphaltum, and lead sheet is burned around the steel footings to protect from possible acid fume or slop. The lead pans (40-lb. lead) in which the brick floor of each tower is laid are first lined with asbestos paper and a $\frac{3}{4}$ -in. layer of sulphate of lead mud.

GLOVER TOWER CONSTRUCTION

Three courses of brick laid flat constitute the floor of the Glover tower. Above the brick arches checkerwork of chemical brick is laid on edge for twenty-eight courses, commencing with 3-in. spaces between brick at the lower course and having $1\frac{1}{4}$ -in. spacing on the top course. The space above the checkerwork is filled for a distance of 9 ft. with quartz graded up from 6-in. size to 4-in. on the top layer. This completes the packing. The brick walls grade up from 20-in. thickness in the space occupied by the arches to 8 in. thick at the top of the tower. The brick is laid in silicate of soda up to top of lead pan (19 in.), the remainder being laid dry. The brickwork is surrounded outside with sheet lead supported by steel framework. The top is 14-lb. sheet lead.

GAY-LUSSAC TOWER CONSTRUCTION

These three towers are constructed after the same manner as the above except the space above the arches is filled with 6-in. diameter by 6-in. long spiral chemical tower packing for about forty-five layers and with 3-in. diameters by 3-in. long spiral rings for sixteen layers' distance at the top. The walls are 10-lb. lead sheathing with 4-in. brick lining laid dry. The top is 12-lb. lead sheet. All lead is supported from steel framework.

ACID COOLING TANKS

The coolers shown in the plan (Fig. 3) located at the foot of the Glover tower are further illustrated in Figs. 4 and 5. They are arranged to convey the acid either three in series or so that the first cooler may be bypassed. The acid is delivered from the last cooler at 60 deg. Bé. and 100 deg. F. (38 deg. C.).

Each cooler is supplied with five separate streams of

water as shown by the piping in the foreground, Fig. 5. Four of these leads connect into the four lead pipe coils seen beneath the surface of the acid in Fig. 4. After passing through these coils the waste cooling water empties into the basin at the left. These four waste pipes are shown leading into this catchbasin. It will be noted that the tanks have double walls with an annular space between. This space receives the fifth stream of cooling water from the vertical header, as shown in Fig. 5, and is discharged by a short connection to the same catchbasin as the four coil waste leads. There is space within each cooling coil for the addition of auxiliary coils as increased rate of plant operation may demand. The sixth lead as noted at the top of the manifold in Fig 5 is connected with an extra coil so inserted.

The acid flows from the Glover to the inner tank of the rear set (see Fig. 5) and overflows to the inner tank of the second set, thence to the third set. The complete flow of acid through the system of pipes and receiving tanks may be traced in Fig. 3. Water in this locality is very scarce, so all waste water from the coolers is carried to the cooling pond shown in front of the acid plant in illustration top of page 333. This water is handled by a 175-gal. Gould centrifugal pump direct-driven by a General Electric motor.

ACID-PUMPING SYSTEM AT TOWERS

The usual method of elevating acid over the towers by compressed air acid lifts has been departed from in the construction of this plant and after some experiments and tests the centrifugal pump was decided upon. Various economies have been claimed by manufacturers of both types of apparatus and each type has its merits as applied to individual installations and particular kinds of acid pumped. In this case the pumps have been operating continuously over a period of some months with a satisfactory showing.

The location of these pumps in the basement is shown in Fig. 3, and the illustration Fig. 6 is an interior view of the basement along the line of pumps and between

the two rows of tanks. These machines are manufactured by the Chemical Equipment Co., Chicago, and are direct-connected to 5-hp., 1,750 r.p.m., three-phase, sixty-cycle Westinghouse induction motors, operated through controllers and cut-out switches of the totally inclosed type. These latter are seen mounted on the steel columns in Fig. 6 and are manufactured by the Trumbull Electric Mfg. Co., Plainville, Conn. Each pump has a $2\frac{1}{2}$ -in. suction and 2-in. discharge. The flow is controlled by a valve on the suction side so that a small



FIG. 5. ACID COOLERS, SHOWING COOLING WATER SUPPLY PIPING

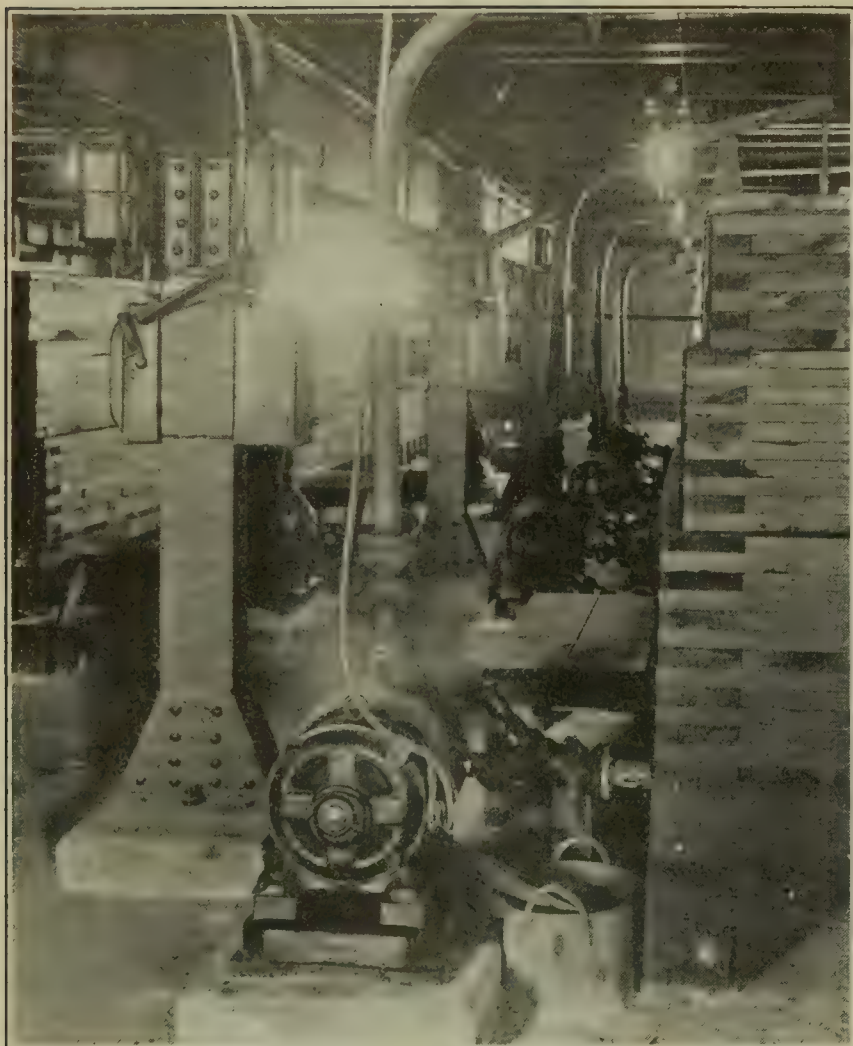


FIG. 6. ACID PUMPS AND TANKS IN BASEMENT

amount of air is drawn in through the stuffing box, obviating any acid leakage at this point. No vibration is noticeable when the pump is running at full speed, and it is therefore not necessary to bolt the base plate to the concrete foundation. All seven tanks on the first floor are independent, one pump drawing from each tank. The large tank on the left rear, Fig. 6, contains the supply of 53 deg. Bé. acid for the fertilizer plant. The connections for all pumps, including the line to the fertilizer plant, are shown in Fig. 3. Note that all lead plugs about the acid plant, upper right hand, Fig. 7, are conveniently operated by levers connecting to plunger rods made adjustable by means of set screws.

TANK FLOOR

The top floor over the acid towers supports five acid tanks as shown in plan and elevation, Fig. 3, and illustrated in Fig. 7. These tanks, as well as those in the basement, are built up from 2 x 8, 2 x 6 and 2 x 4-in. timbers laid on side, as shown, the whole being painted with black asphaltum, and lead lined. Each tank is equipped with splash box, shown near the posts, Fig. 7,



FIG. 7. ACID TANKS OVER TOWERS

and on the right in Fig. 8, with double float siphon and with float connected to telltale in basement for determining height of acid.

Fig. 8 shows the inside of one tank containing acid. The two large floats with the container between and into which the bent pipe leads constitute the double float siphon. This is so arranged as to deliver acid to the distributors on the floor below under constant head and flow. The large telltale float appears in the lower right-hand corner. The splash box in the upper right-hand corner receives the acid as it is pumped up from the basement tanks.

DISTRIBUTION FLOOR OVER TOWER

Fig. 9 shows one of the distributing pans with leads running into top of tower. The horizontal, lead-covered, steel rods carry the straps, which in turn support the lead roof of the acid tower proper. The pan, consisting of timber frame, lead-lined, is supported on two 6-in. double channels suspended from the roof trusses by 1-in. rods, each provided with turnbuckle adjustment.

An interior view looking down on top of the pan, Fig. 10, shows the rectangular gage box on the left, the

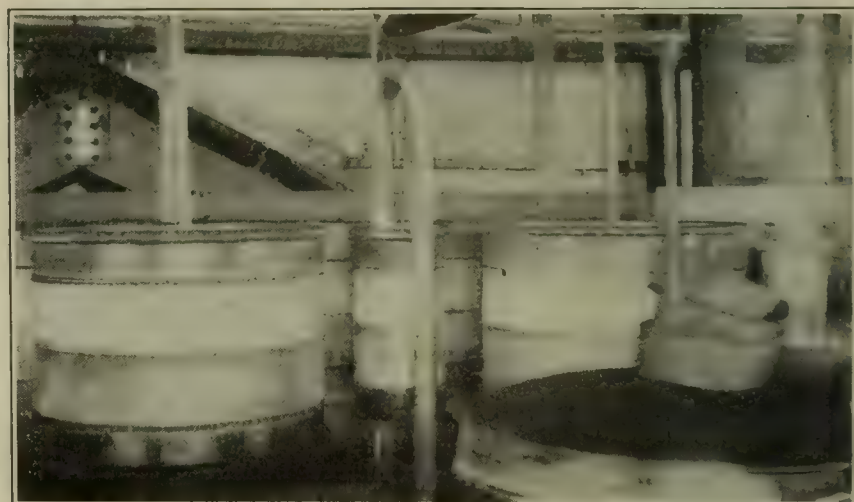


FIG. 8. INSIDE OF ACID TANKS

lead pipe leading from the bottom of this gage box into the side of the dome-shaped splash box. This latter is located in the center of the pan and permits the acid to flow into the pan through perforations. This in turn flows into the lutes, which are sealed to prevent the escape of tower gases by inverting ordinary glass tumblers as customarily practiced. The pipe leading into the top of the gage box, on the left, Fig. 10, comes directly from the double float siphon, as described, on the floor above. The complete arrangement appears in outline in Fig. 3.

As indicated in Fig. 3, the chamber system consists of six chambers in series. The fume passes from Glover



FIG. 9. DISTRIBUTION PAN ON TOWER FLOOR

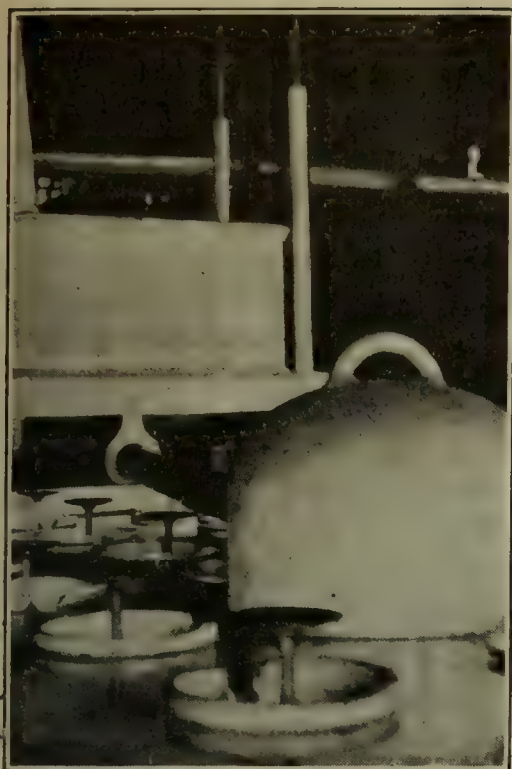


FIG. 10. INTERIOR OF DISTRIBUTION PAN

and 3, the other between 3 and 4. These increase the efficiency of the system by serving as additional acid-making areas. They are built after the manner of the Gay-Lussac towers and filled with thirty-three layers of 6-in. spiral chemical tile.

The entire chamber system is supported on steel columns from beneath and each tower and chamber is constructed with steel framework, the whole being housed in a steel building sided and roofed with Keasby & Mattieson acid-proof corrugated asbestos.

The method of supporting the lead curtain walls of the chambers is well shown in Fig. 11. The steel channel girts with flanges turned upward carry 4 x 4-in. timbers rounded on the upper side. V-shaped lead straps were burned onto each lead sheet as erected, with the straps bent over the rounded timber and nailed as shown. When the weight of the curtain was thus gradually thrown on these straps they were slightly torn at the nail holes, permitting an equalizing sag at various points and so distributing the load as to obviate any wrinkles in the curtain. The excellent results obtained are evident to the most critical inspector. The roofs of the chambers were supported by loops of lead strap from I-beams in the same way as shown in the case of the tower roofs. (See Fig. 9.) Other evidences of excellency in the lead worker's art



FIG. 11. SIDE OF ACID CHAMBER

tower to chamber 1 and leaves chamber 6 by way of the overhead fume line, thence through Gay-Lussac towers 3 and 2. From tower 2 it is drawn through the Pratt exhauster, delivered to Gay-Lussac tower 1 and proceeds onward through the system. The exhauster is driven by a variable speed reducer as shown in Fig. 3, which permits changing the speed of the exhauster while running. Two intermediate towers are located in the chamber system, one between chambers 2

are shown in Figs. 11 and 12. The funnel in Fig. 11 is used for washing out the trough inside the chamber which slants downward to the test basin shown in Fig. 12. Here the hydrometer tests are taken, as well as the temperature readings from the thermometer directly above.

ACID SYSTEM AND SPRAYS

All chamber pans are so interconnected by lead piping that acid may be drawn from any single chamber or combination of chambers. Mixing acid for the fertil-

izer plant is drawn from the first chamber. The weak acid is carried over the Glover tower. No steam is furnished to the system. The water is introduced at the tops of the chambers through a series of stone cap and spiral $\frac{3}{4}$ -mm. Monarch sprays. The weak acid in the Glover tower generates enough steam in the gases to be effective through the first three chambers, but is supplemented by the water sprays beginning with the second chamber. The sprays are supplied with water from a pair of air pressure tanks located in the



FIG. 12. TEST BASIN ON SIDE OF CHAMBER

basement, connected up with the National Brake & Electric Co. automatic air compressor, maintaining a constant head of 70 lb. While one tank fills with water from the mains the other is emptying under pressure to the spray system.

The operation of the entire sulphuric acid unit has exceeded the expectations of the designers. The visitor after viewing the installation and its operation would call it a perfect acid plant.

The fertilizer plant and acid phosphate manufacture will be described in a subsequent issue.

Varieties of Kongo Trees Producing Tannin

According to a recent article in the *Exportateur Belge* there are numerous trees in Kongo with barks rich in tannin. Among these is the Mwena, a species of mangrove abounding on the banks of the Lower Kongo and its tributaries, the bark of which contains a minimum of 15 per cent of tanning matter, the trunk and the roots producing an extract running from 50 to 55 per cent of tannin. The wood itself, which is hard and undecaying, is a valuable byproduct adapted for use in the construction of piling, railroad sleepers and ships. Several varieties of the *Terminalia* give barks which render a dry extract entirely soluble when cold and containing 62 per cent of tannin. This extract produces an extremely light and well-tanned leather.

Other varieties of native trees also produce tannin extracts, hence the tanbark industry is one of great potential importance for the Kongo.

Causes of Piping in Aluminum Ingots

Measurements of Piping and Solidification Shrinkage Show That the Volume of a Pipe Is Dependent on Four or Even More Definite Factors, and That It Is Not a Specific Property of a Metal or an Alloy

By JUNIUS DAVID EDWARDS* AND HAROLD T. GAMMON†

IN THE preceding papers (CHEMICAL & METALLURGICAL ENGINEERING, Vol. 24, Nos. 2 and 5, pp. 61 and 217) the density of aluminum and the copper: aluminum alloys at temperatures from 20 to 1,000 deg. C. were given. From these data the complete density curves were constructed for this range of temperatures, and the solidification shrinkage was estimated with good precision. Solidification shrinkage is responsible for the piping of the metal when it is cast, and because the extent to which piping occurs is a factor in determining the suitability of a metal for casting purposes it seemed desirable to analyze the relation between the amount of shrinkage and the observed piping. An attempt has therefore been made to determine quantitatively the amount of piping which occurs in casting aluminum and some of its alloys. Although this attempt was not entirely successful, mainly because the amount of piping which occurs is far from being a definite quantity, nevertheless the work has led to a much clearer conception of the factors controlling the formation of pipes in castings. This article is in the nature of a memorandum of experiments completed and conclusions reached, rather than a complete summary of the problem.

MECHANISM OF FORMATION OF PIPES

Before considering the problem of the pipe it will be well to consider the volume changes which occur on freezing. In Fig. 1, Curve A, is shown the relation between temperature and specific volume, which is the volume in milliliters per gram of pure aluminum. Starting with the liquid metal, the contraction on cooling is slow and uniform until the freezing point is reached; at this temperature a large contraction in volume takes place during the solidification. The solid metal then contracts slowly, but at a somewhat different rate from the metal in the liquid state. Curve B shows the same relations for an alloy of aluminum with 4 per cent of copper. The most characteristic difference to be noted is that solidification no longer takes place at constant temperature, but over a considerable range of temperatures, amounting in this case to approximately 100 deg. C. Curve C shows the change in specific volume of the alloy of aluminum with 8 per cent copper. This is somewhat different than in the preceding case, because part of the solidification takes place at constant temperature. The 8 per cent copper alloy contains approximately 15 per cent of the eutectic mixture when it has cooled to a temperature of 540 deg. C. and this eutectic freezes at constant temperature in exactly the same way as a pure metal. These three curves show the characteristic volume changes on freez-

ing of the pure metal and two of its important binary alloys.

Briefly, the formation of the pipe in casting an ingot takes place in somewhat the following manner: The metal which is in contact with the walls of the mold cools to the freezing temperature first, and there solidifies to form a solid shell which grows in thickness by the continued solidification of the metal. Because there is a contraction in volume of the metal upon solidification, the level of the liquid contained within this shell of frozen metal is continually lowered during the course of the freezing. If no additional metal is supplied during the freezing process, a conical-shaped cavity known as a pipe is formed. The main function of the gates and risers is to supply the metal required to keep the mold completely filled during the solidification and consequent contraction of the metal contained in it. With reference to Fig. 1, Curve A shows that the contraction on freezing in the case of

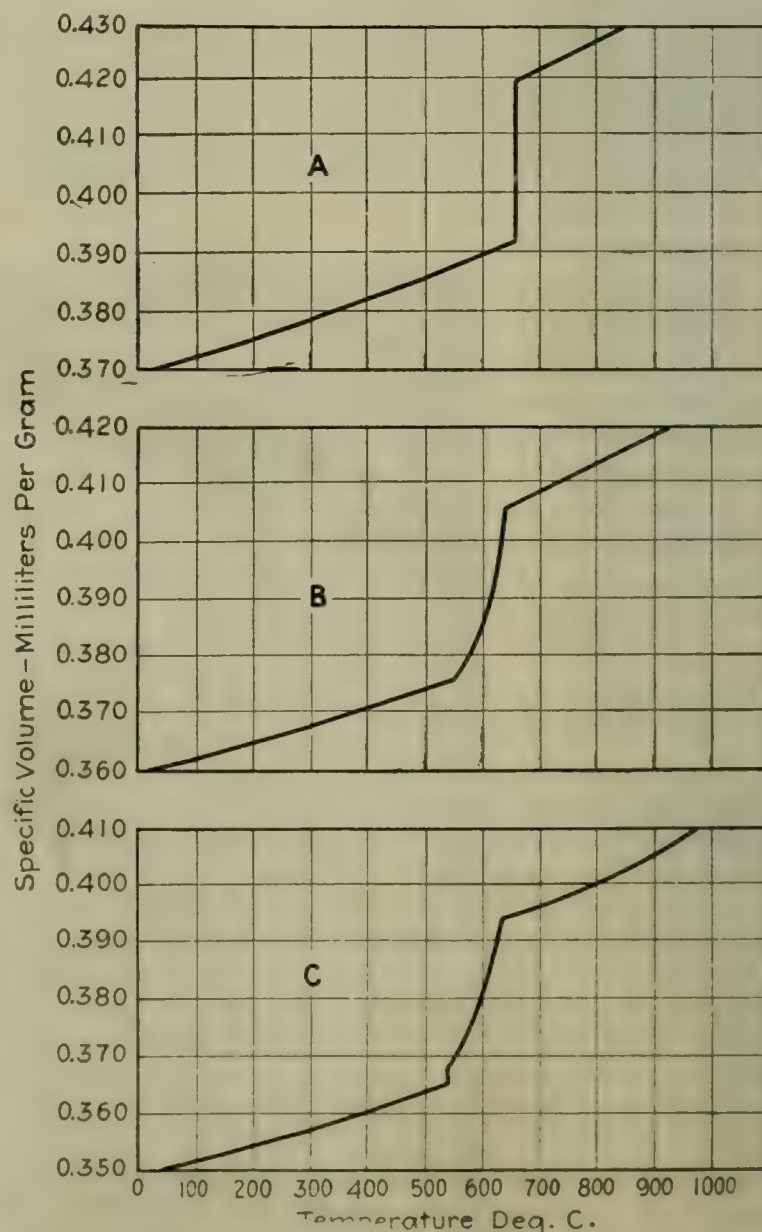


FIG. 1. RELATION BETWEEN TEMPERATURE AND SPECIFIC VOLUME

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†Chemist, Aluminum Company of America.

pure aluminum is about 6.6 per cent, and consequently 6.6 lb. of aluminum must be fed into the casting from the gates for every 100 lb. of casting. In the case of the 4 per cent and 8 per cent copper alloys the contraction upon freezing is of approximately the same magnitude.

The volume of the pipe is not, however, necessarily equal to nor proportional to the contraction upon freezing. In the case of pure aluminum the two are very nearly alike. That this is nearly so comes from the fact that the shell first formed in the casting of the pure metal is quite rigid, and the contraction during freezing necessarily appears in the form of a central cavity. In the case of the alloys, however, the solid which separates during the first part of the freezing process is a network of crystals more or less interpenetrated by liquid. This mixture may be quite plastic and the shell which first forms in the mold is not so rigid as in the case of the pure metal. This is of advantage in casting practice, because it permits the casting to adjust its form somewhat upon cooling without straining the cores or other fragile parts of the mold. As a result, the mixture of partly frozen metal within the mold behaves as if it was still liquid for a considerable interval of temperature below the commencement of freezing. As a consequence the volume of the pipe which is formed with the alloys is less than is the case for the pure metal. The apparent volume of the pipe may also be reduced in some cases by the formation of a porous structure at the top of the ingot, gate or riser where the final freezing occurs. This happens if the network of crystals at the surface possesses sufficient rigidity to allow the eutectic to withdraw from between the crystals during its solidification, thus leaving voids in this part of the metal. Part of the pipe is then disseminated and concealed within the body of the metal.

EXPERIMENTAL METHOD

The following method was employed to determine the relative piping effect with different metals: A graphite crucible having a capacity of approximately 225 c.c. was filled with slightly more than that volume of molten metal, after which a hot iron plate was pressed down upon the surface of the crucible and the metal. The plate forced out the excess metal so that the crucible contained exactly its known volume of metal at that average temperature. After the metal had solidified, the ingot was removed and the exact volume of the pipe was determined by filling with mercury and then weighing the mercury. A piece of paraffine-coated paper with a straight edge was wrapped tightly around the ingot and fastened in place in order to sharply define the upper edge of the pipe in case it was irregular or not level. An attempt was made, by controlling the pouring temperature, to have the metal freeze sharply at the edge of the crucible, so that the volume of the pipe might be sharply defined. This was a difficult condition to obtain with most of the alloys. The pipe in the ingot is measured at room temperature, and is therefore smaller than it was at the freezing point of the metal, because of the shrinkage of the metal in the solid state. The correction for this has been calculated from the solid shrinkage of the metal and the volume of the pipe then expressed as a percentage of the volume of the mold, which volume was the original volume of the ingot before cooling.

The solid shrinkage, which is the relative change in

volume of the solid metal in cooling from the freezing point to room temperature, was determined by casting in a sand mold a bar about 2 ft. long. The ends of the mold were formed by two graphite blocks which were rigidly held a known distance apart by steel plates; these were so arranged that the heat from the metal did not cause any appreciable expansion of the steel plates before the metal in the mold had set. The space between these graphite blocks was filled with solid metal at the freezing point. Knowing the distance between the graphite blocks and the length of the bar when cold, the shrinkage expressed in inches per foot of original length may be readily calculated.

The results of a series of measurements on the volume of pipe and the solid shrinkage of aluminum and some of its alloys with copper are given in Table I.

The observed piping effect with the aluminum was 7.7 per cent, and with the 8 per cent copper: aluminum

TABLE I. THE PIPING EFFECT IN ALUMINUM AND ITS ALLOYS

Composition	Volume of Crucible, ml.	Pouring Temp., Deg. F.	Solid Shrinkage, Inches per Ft.	Volume of Pipe, ml.	Corrected Volume of Pipe, ml.	Piping Effect, Per Cent
Aluminum, 99.4%.....	239	1,550	0.21	17.4	18.3	7.7
Al+ 4 Cu.....	223	1,300	0.19	9.6	10.0	4.5
Al+ 6 Cu.....	223	1,300	0.18	9.4	9.8	4.4
Al+ 8 Cu.....	239	1,300	0.18	8.7	9.1	3.8
Al+ 10 Cu.....	223	1,300	0.17	6.8	7.1	3.2
Al+ 12 Cu.....	223	1,300	0.17	6.7	7.0	3.1
Al+ 31 Cu.....	223	1,300	0.15	12.4	12.9	5.8

alloy was only 3.8 per cent. This at first appears anomalous, in view of the fact that the solidification shrinkage is approximately the same in both cases (6 to 7 per cent; see "Mechanism of Solidification of a Copper: Aluminum Alloy," CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, No. 5, p. 217). A reasonable explanation for this difference in behavior has already been given in a preceding paragraph. It may be illustrated more clearly by reference to Fig. 2, where the

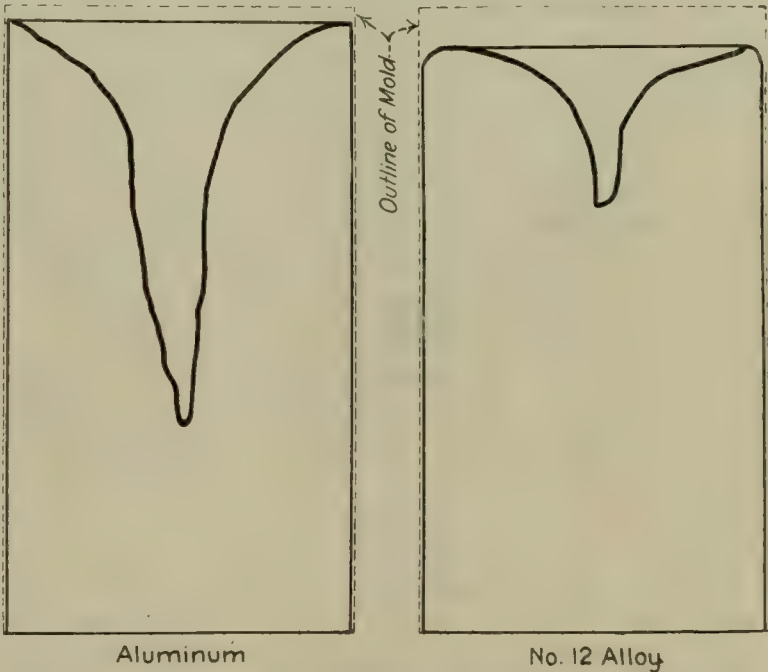


FIG. 2. VERTICAL SECTIONS THROUGH CENTER OF INGOTS

experimental ingots for the pure aluminum and the 8 per cent copper alloy are shown in section. It will be noted that the ingot of No. 12 alloy is shorter than the aluminum ingot and that the upper edges are very much rounded off, whereas in the aluminum ingot the metal has frozen sharply at the edge of the crucible. In the aluminum ingot the total contraction during solidification is represented by the volume of the pipe. In the alloy ingot part of the contraction has been

taken up by a readjustment of the shell initially formed in the mold, a fact which is attested by the appreciably shorter length of the alloy ingot. This difference in length is more striking when it is considered that the linear shrinkage of aluminum after solidification is greater than that of No. 12 alloy. In the case of the ingot of No. 12 alloy shown in the figure, its average length was about 11.2 cm., whereas it should have been nearer 11.7 cm. in length if the crystals had remained in place as they solidified at the walls. When allowance is made for this fact, it is found that the total solidification and liquid shrinkage was about 6.3 per cent, which is in fair agreement with the contraction indicated by the graph, making due allowance for the approximate nature of the measurements made on the ingot.

The piping effect gradually decreases with increase of copper, but there is very little decrease noted beyond 10 per cent. However, the sample containing 31 per cent copper and which is very nearly of eutectic composition shows a larger pipe than some alloys of lower copper content. This is what might be expected from our analysis of the mechanism of piping, because the eutectic alloy in freezing behaves essentially as the pure metal. Consequently there should be some alloy of intermediate composition which would show a minimum piping effect.

The volume of pipe formed in any given alloy is a complex function of the following factors: (1) The percentage contraction during solidification; (2) the rate of solidification during the freezing interval; (3) the temperature range of the freezing interval; (4) the size and form of the mold and probably some other conditions. Because the volume of the pipe is dependent on conditions external to the metal, it is not even certain that different alloys would give the same relative piping effect in one mold that they would in another. It is, accordingly, impossible to describe piping as a definite property of a metal. The contraction upon freezing is, however, a perfectly definite property which can be defined and measured and is the fundamental cause of piping. The values given in the table should therefore be considered in the light of this discussion whenever any use is to be made of them. It should also be borne in mind that the casting properties of a metal are not solely defined by the piping effect. It is only one important factor to be considered. A low solid shrinkage, for example, is of course very desirable in a casting alloy in order that the strains which are set up in a casting on cooling may be reduced to a minimum.

SUMMARY

A method of determining the piping effect in metals is described, and the results of measurements on a series of copper:aluminum alloys are given. It is shown that although the solidification shrinkage of a metal is responsible for the formation of the pipe, it is not necessarily proportional to it. The good casting properties of the 8 per cent copper alloy are not to be ascribed to a low solidification shrinkage (which it does not possess), but to the manner in which it freezes. The explanation given is not offered as a general formula for all alloys, but it is thought that the results obtained may be suggestive and helpful in many other cases.

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Graphite Situation in Ceylon

Consul Robert L. Keiser of Colombo reports that the graphite trade of Ceylon reached a minimum in 1919, dropping from an exportation of over 33,000 tons in 1916 to 6,671 tons in 1919. The first five months of 1920 showed a slight increase, 4,235 tons having been exported. Of this amount the United States took 2,800 tons, or about 70 per cent of the total.

COMPARATIVE EXPORTS FOR RECENT YEARS

Exportation for the last four years has been as follows, the figures for 1920 being for five months:

Countries	1917, Tons	1918, Tons	1919, Tons	1920, Tons
United States.....	21,965	8,178	3,995	2,800
United Kingdom.....	4,600	6,386	2,260	1,062
India.....	145	293	88	31
Australia.....	237	288	146	188
Japan.....	.....	61	80	117
All other.....	200	11	102	37
Total.....	27,047	15,217	6,671	4,235

The great slump in exportation has led to the closing of the majority of the small mines. During the peak of production (1917) about 1,300 mines were in operation, but at the beginning of 1920 less than fifty mines were working. It should be noted, however, that most of the mines in operation are those which are able at short notice, or with little preparation, to mine the bulk of the production.

COMPARATIVE PRICES

The average value per ton of all grades of graphite exported in 1913 was \$110 (330 rupees) and in 1917 about \$300 (900 rupees). In 1918 this figure decreased to about \$100 (300 rupees); in 1919, to \$104 (260 rupees); in 1920, to \$105 (230 rupees). It is difficult to estimate these values in terms of dollars, owing to the rapid fluctuation of exchange.

It is interesting to note that in 1913 the average value of graphite exported to the United States, United Kingdom, and Germany (these being the three largest consumers in the order named) was about the same for each of these countries. In 1918 the average value of the graphite exported to the United States was about \$130 per ton, against \$80 for the United Kingdom, and a general average of \$100. In 1919 the imports to the United Kingdom averaged \$70 per ton, while those to the United States were valued at \$130, the general average having been \$104. Statistics for the 1920 period show that the average values of exportation to the United Kingdom and the United States are again about the same, namely, \$108 and \$113, respectively.

No statistics are available covering production costs. The producers claim that on the present basis of prices there is not sufficient profit to make production interesting to them. Since 1913 wages have increased about 25 per cent. Barrels for packing, which formerly sold for 12.50 rupees, now cost 25, and the increased cost of explosives is large. It is therefore evident that but little profit is left to the miners at the present average price.

With the exception of three companies the mining operations are all in the hands of natives. There is no restriction against foreign companies owning mining properties or carrying on mining operations.

The Ceylon government assesses an ad valorem duty of 3 per cent on all graphite exported from the island.

Plant Design for Hot-Gas Pyrolytic Distillation of Shale

Description and Plan of a 2,000-Ton per Day Shale Oil Plant Operating on Indirect Heating Process
Employing Hot Gases for Conveying Reacting Heat and Resultant Oil
Vapors From Pyrolysis of the Shale

By LOUIS SIMPSON

AT THE present time it is no longer necessary to point out that the consumption of hydrocarbon oils has overtaken the supply; that the amount of such oils obtainable from the hitherto source of production is probably close to the maximum and that the world's ever-increasing requirement must in the future be secured from new sources of supply.

It is probably superfluous to state that such much-to-be-desired new sources of supply have been found in the oil-yielding shales, sands and rocks that are known to exist on all continents and in many districts of each continent. Admitting that such new sources of supplies exist, it must be confessed that the crux of the whole question is the availability of economic methods by which the volatile contents may be recovered from them at a cost that will give sufficient monetary return upon capital invested in their operation.

The world's requirements cannot be satisfied unless works of commercial capacity are operated. Even shales that are relatively lean in volatile contents must be profitably retorted where conditions are not unfavorable. It is not sufficient that works and processes be developed that will commercially retort shales very rich in kerogen. It is not desirable that shale works be erected for the production of other than standard oil products with the expectation that these specialties can be marketed at high prices. The markets for such specialties would soon become oversupplied, with the result that their manufacture would cease to be remunerative.

It is necessary that works be erected and processes used that will make possible the retorting of relatively lean shales at a profit when selling the manufactured products in markets that are not likely to become depressed through competition.

FUEL SUPPLY MOST IMPORTANT QUESTION TODAY

The year 1920 has proved that a constant and an assured supply of fuel at reasonable prices is the most important question on this continent today. Without an adequate supply of fuel there would have to be a reconstruction of the industries of many parts of the American continent. The present development of hydro-electric power and the possible future development of such power may mitigate but cannot solve this difficulty. Fuel to produce light, heat and power, fuel that can be readily and, as to cost, reasonably transported to the place where it is to be consumed, is today a necessity.

Years ago the world relied upon the combustion of wood and peat for the required heat and upon the combustion of fats and oils (vegetable, animal and fish) for the very indifferent quality of light with which the inhabitants of the world had to be content in those days. Today the wood and peat are largely replaced by coal, hydrocarbon oil, natural gas and electricity. Of these

the natural-gas supply will give out before many years, while the cost of coal is likely to be much higher in the future than it was before the war. Today, for reasons appreciated by combustion and power engineers, oil has become a factor fully as important as coal, and, as the economic possibilities of liquid fuel become more widely appreciated, it is likely to become of even greater importance.

THE COMMERCIAL PLANT

Outside of Scotland, the works constructed up to date to undertake the retorting of oil-yielding shales, while fairly numerous, have been relatively small. The limited capacity of these works has been fatal to their commercial success. A commercial retort plant must be of a capacity sufficient to warrant the employment of and the expenditure upon:

1. The necessary technical staff.
2. Machinery of a capacity that will permit of economy of operation.
3. Labor-saving devices.
4. Railway sidings, roads, pipe lines, tank cars and vessels, with their several necessary auxiliaries.

The overhead charges in a works of small output, retorting lean shale, would probably eat up all the profit. This is no new problem in the mining industry. Mineral deposits that are lean must of necessity be mined and treated in a large way, and when so handled have often been proved to be more profitable than richer deposits.

It is fortunate that in the oil-shale industry the underlying chemical principles that govern the retorting of the shale have been established and proved years ago. Today all that remains to be determined, besides the more perfect elucidation of some of those principles, is the most economic application of those principles under the local conditions existing. The Scotch operators fought this question out in Scotland over twenty years ago and devised retorts and methods that suited their special local conditions. Unfortunately the local conditions that once existed in Scotland no longer exist there in their entirety, and are not duplicated on the continent of America.

During the last twenty years many and very important advances have been made in the science and art of combustion, in the conservation of heat and in the production of power and heat; also in the conveying and crushing of ores and similar raw material, in the pumping, softening and filtration of water and in labor-saving machinery generally. Moreover, the laws that govern aggregates are better understood, and during recent years notable advances have been made in the production and in the use of measuring, indicating and recording instruments to measure the flow, temperature and quality of gases, etc., which make possible the refinement of processes not possible when these processes

are directed by rule-of-thumb methods. These advances have made possible economies hitherto unthought of. Some of these improvements have been adopted in part in Scotland, but the majority have not been adopted, as this would have entailed an almost complete rebuilding of the several plants.

PLAN OF A COMMERCIAL PLANT

A commercial retort plant should be planned so as to be:

1. Condensed into an area as small as possible without being congested.
2. Fire-resisting and fool-proof.
3. Capable of continuous operation for a long period.
4. Not requiring frequent attention for small repairs.
5. Should require an irreducible minimum of manual labor.
6. Also the minimum consumption of heat, power and water.

GOOD ENGINEERING WORK ESSENTIAL

These requirements indicate that it is not so much the services of an expert chemist, whether for research or for planning, that are called for, but the services of chemical, combustion, power and mechanical engineers. It is with no desire to belittle the work that can be done, and, indeed, which it is hoped will be done by the research chemist toward the elucidation of certain chemical reactions which at present are not fully understood and other and similar details about which reliable information would be of immense help, but it would appear to be very necessary to point out that the problems that surround the construction of a commercial retort plant are not of a character that a research chemist, and a research chemist alone, can best solve.

The retort plant described in this article is the result of six years' constant development work. It is based upon the employment of chemical principles accepted by the Scotch operators, but the application of these principles has been made to conform to modern practice. This application has been carefully scrutinized and has been approved by chemists expert in gases. The writer has for thirty years made power production a study, having designed and constructed the first hydro-electric power plant operated in Canada. In planning that power plant new improvements were made that since have become standard. The economical production and transmission of power is a science, and the application of this science is influenced to a greater extent than is usually appreciated by the varying factors of local conditions, hence experience is of unusual importance, and the use of theory unattended with experience may result in trouble. As local conditions generally vary within wide limits, it is necessary to plan those parts most affected so that modifications may be made without disturbing the plant as a whole.

PLANS AND LAYOUT OF PLANT

The plant, as illustrated in Fig. 1, is designed to retort 2,000 tons of shale each twenty-four hours. The process commences with the crusher house. The shale is assembled in the works, as shown in the drawing, by the use of an aerial conveyor, such method of assembling possessing certain advantages when used under the conditions usually found in Canada. Such alterations as are necessary to make the crusher department suitable to operate in connection with any other system of assembling can easily be made, as such alterations will

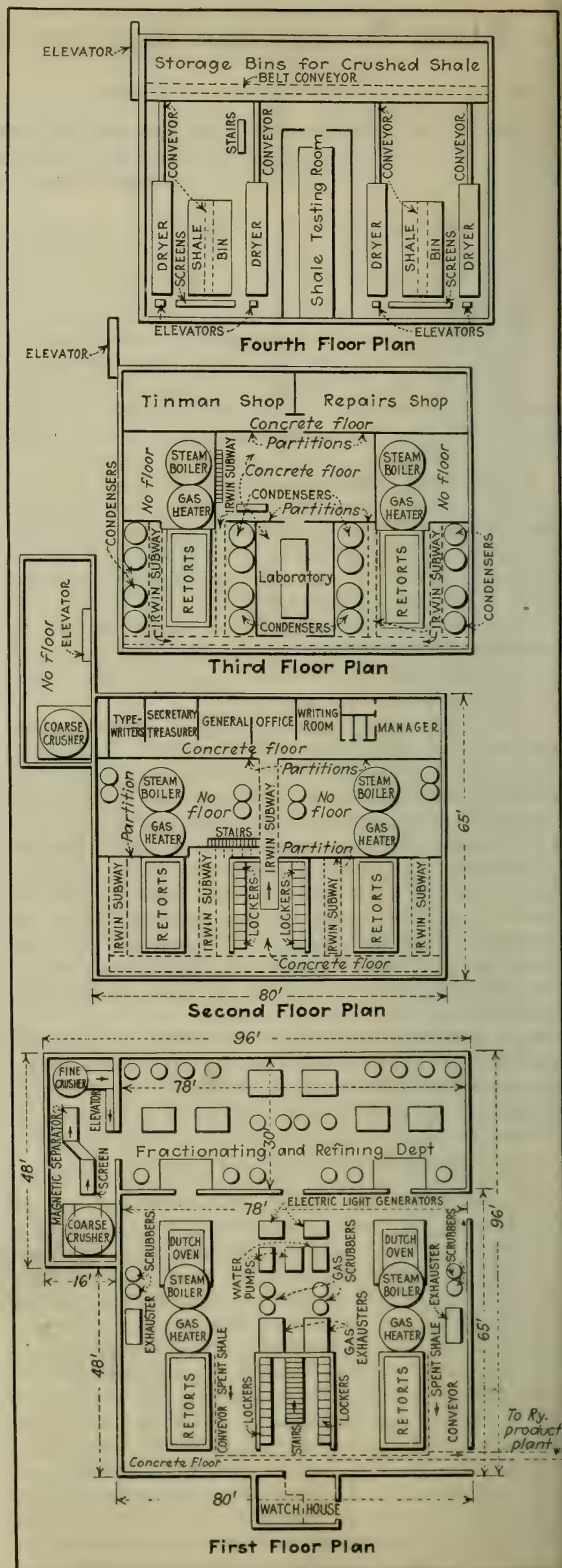


FIG. 1. FLOOR PLANS OF PLANT

be simply matters of detail. The byproduct departments are not shown, their consideration being left for another article. The plan of works exhibited is so arranged that a byproduct plant can be added without disarranging the oil-recovery plant proper.

The crusher plant consists of a coarse crusher, a fine crusher, two screens to remove the "fines" and to return the oversize to the crushers, and a magnetic roller to remove "tramp iron."

The fine-crushed shale is elevated to a shale bin of large capacity located on the top or fourth floor. From this bin the shale is conveyed into and through driers, and from the driers passes through special screens to obtain the removal of the last of the fines, and then is

the shale into each chamber in a constant dribble. The feeder is so designed that the top of the shale in each chamber assumes the shape of a pile with two long sides or slopes, thereby presenting the greatest possible surface to the action of the preheated gases with which the space unoccupied by the shale is kept filled.

RETORTING CHAMBERS

Each chamber of the double retort is rectangular in shape at the feed end. The two chambers of each double retort combine to form one chamber at the discharge end, where are located two discharge rollers, which by rotating keep the charge of shale in constant movement, passing down and through the chambers.

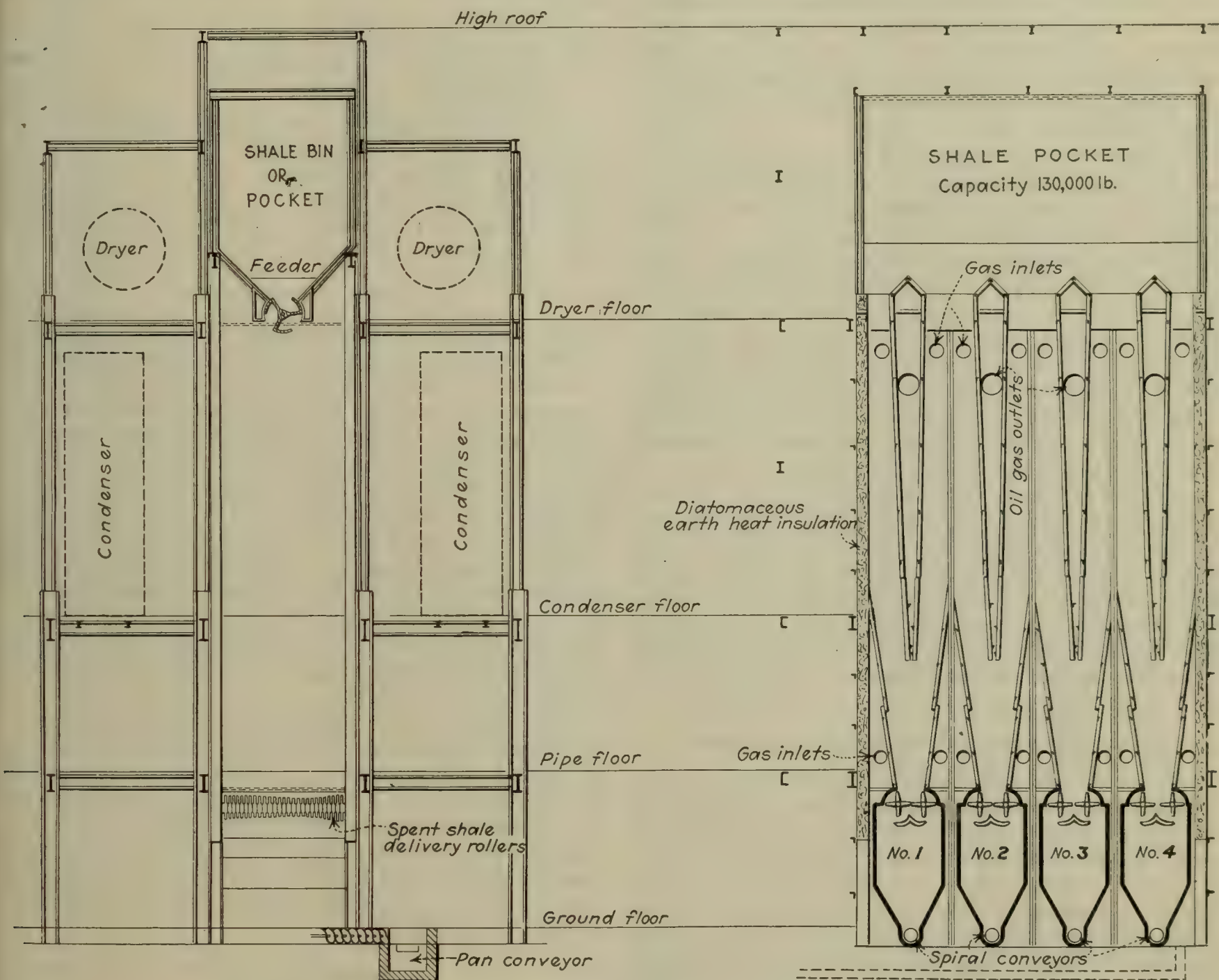


FIG. 2. CROSS-SECTION OF RETORT CHAMBERS

conveyed into the feed bins, situated over each bench of retorts. Under certain local conditions these driers may be dispensed with. The driers are heated by the waste products of combustion of the steam boilers after those products have yielded the major part of their contained heat during their passage through the gas preheater. The objective of these driers is to enable the shale to be passed into the retorts, at all times of the year, possessing a similar physical condition. From the shale bins over the retorts the shale is passed into each of the two chambers of the four double retorts (four double retorts form a bench of retorts) by special but very simply constructed feeders. These feeders pass

The chambers are so designed that this movement is constant and is not subject to obstruction. The heat required to secure the eduction of the volatile contents is supplied by the admission of preheated gases, the product of a previous operation. These gases are admitted into each chamber at several points, two of which are located at the feed end of the chamber. The volume of these gases can be regulated. It is claimed that not only do these preheated gases heat the shale to the necessary temperatures for eduction but that they:

1. Act as a carrier for the oil vapors formed by pyrolysis.

2. Act as a diluent, lowering considerably the vapor pressures and temperatures required for eduction.

The gases and oil vapors are removed from the chambers at several points through apertures specially designed, so that they will not become clogged through the accumulation of deposits, which deposits can be conveniently and quickly removed as formed.

The light-oil-vapor-gas mixture comes over first, and the vapors are condensed by being passed through water-cooled condensers. The heavy-oil vapors are removed and condensed separately. The fluidity of both these gas-vapor mixtures is greatly increased by the thinning action of the gases used for heating the shale. The presence of these gases also mitigates, if it does not altogether prevent, certain troubles that at times are likely to occur in the condensers. The partial fractionation of the light-oil vapors from the heavy-oil vapors also makes possible economies in the topping of the light oils and the economic production of the highest grade of fuel oil.

The water used for condensing the light-oil vapors is used afterward in the heavy-oil vapor condensers, from which it is delivered at a temperature sufficiently high to permit its being fed directly to the boilers.

The retort chambers are fabricated of steel plates. The bench of retorts is inclosed on all four sides by two walls of steel plates, placed some inches apart, the inner plates being welded together so that they are gas-leak-proof. The space between the two rows of plates is filled with heat-insulating material such as kieselguhr.

The division plates that form the several chambers are fastened to the inner of the two plates that form the walls of the bench. As none of these plates are subjected to a critical temperature, it is evident that these parts of the retorts will last for many years. It is also evident that the shale retorted in these chambers, subjected as it is to a regulated heat, every piece of shale being also subjected to the same temperature, will, however rich in kerogen the shale may be, never become burned on to the sides of the retort and thus cause "bridging" of the shale within the retort, and it is also certain that none of the educed gases are likely to be cracked.

COOLING CHAMBER, CONDENSERS AND SCRUBBERS

After being removed from the retort the spent shale is passed into a cooling chamber. When passing from the rollers into this chamber the spent shale is deflected toward the walls of the chamber. These walls are constructed of steel chambers, which are cooled by water. When certain qualities of shales are retorted these tanks can be used to generate low-pressure steam, which as generated is passed into and among the spent shale. The cooled spent shale is removed from the cooling chamber and by the use of suitable conveyors is transported to the byproduct plant, where it is treated specially to recover the maximum yield of ammonia at the lowest cost.

The oil vapor condensers are located on the third floor close to the retorts the vapors from which are to be condensed. Each double retort has two condensers, one for the light-oil vapors and the other for the heavy-oil vapors, the pipes connecting each condensor with its retort being each less than 10 ft. in length. The fixed gases pass into main pipes and are exhausted into gas washers, one for the purpose of recovering the non-condensed gasoline and the other to recover any ammonia that may have been carried away with the gases. From the latter washer the gases pass to gas

holders, from which supplies are drawn to provide gas fuel for the boilers and gas to be heated in the preheater. It is arranged that when in regular operation there shall be burned under the boiler just enough of the gas to maintain a constant quantity of gas stored in the holders.

GAS CYCLE

The steam is generated in vertical water tube boilers of special construction supplied with gas burners of suitable design. The gas preheaters are so constructed that they can be operated constantly for long periods of time and at the greatest efficiency. By the arrangements provided the efficiency obtained from the fuel gas burned will be very high.

The gas cycle is as follows:

1. Gas holder to steam boiler.
2. Steam boiler to gas preheater.
3. Gas preheater to driers.
4. Driers to byproduct recovery or to the air.
11. Gas holder to gas preheater.
22. Gas preheater to retorts.
33. Retorts to condensers.
44. Condensers to exhausters and washers.
55. Washers to gas holders.

POWER DISTRIBUTION

The manner in which the power required is provided is new and is probably unique. By referring to the illustrations it will be noted that no central power house is provided. The power within the works will be generated by individual steam turbines taking steam from the steam boilers at high pressure and passing the condensed steam to the byproduct plant, where it is used in the process of manufacturing. The individual steam turbines used are dust-proof, gas-proof and fool-proof. They will require no more, if not less, attention than do electric motors, will require but small repairs and can be operated continuously for unusually long periods. The total cost is less than that of a central power house with electrical transmission and electric motors and the steam efficiency is higher.

The topping of the light-gas oils is arranged for in the fractionating and refining department. Should it be desired to fractionate and refine the heavy-gas oils an addition for this work would be located directly behind the building in which the light-oil gases are treated. The byproduct department in which the spent shale would be treated for the recovery of nitrogen and (in a few cases) of potash would be located to the right of the retort building.

FIGURES ON COST

Figures on the cost of operating such a works are not usually a criterion of much importance, especially as there are very many different methods of stating such costs. The writer has preferred to adapt a method used for many years in other industries, in which the cost of wages in each department is given separately, while the repairs, depreciation and overhead are given separately but as affecting the whole manufacture. As wages differ greatly, it has been thought reasonable to give the days' labor required calculated at an average rate of \$5 per day, a day usually being one of eight hours' work. With these data it is easy for any one to calculate the costs under such local conditions as may exist. The cost of mining and assembling vary within wide limits, from the low cost of excavating by power-

operated excavators under ideal conditions to deep mining. Such costs may vary from 25c. per ton up to and over \$2 per ton.

Crushing.....	10 men at \$5 per day...	\$50, or 2.50c. per ton
Retorts.....	15 men at 5 per day...	75, or 3.75c. per ton
Power.....	9 men at 5 per day...	45, or 2.25c. per ton
Spent-shale.....	6 men at 5 per day...	30, or 1.50c. per ton
Warehouse.....	11 men at 5 per day...	55, or 2.75c. per ton

Total wages.. 51 men at \$5 per day.... \$255, or 12.75c. per ton

Salaries, including foremen, chemists and management, \$1,120 per week.....	8.00c. per ton
Repairs.....	5.00c. per ton
Taxes, insurance and sundries.....	5.00c. per ton
Depreciation.....	15.00c. per ton
Bond interest.....	15.00c. per ton

Total..... 60.75c. per ton

The foremen should be expert artisans, expert in their several trades, and would thus be competent to attend to any small or minor repairs requiring attention.

It is very evident that a well-designed and well-constructed plant can be operated at a low figure per ton if of commercial size. The cost per ton, excluding depreciation and bond interest, certainly need not exceed 35c. per ton, and where wages are paid at a low rate need not exceed 25c. per ton.

Every important section of the plant is provided with recording thermometers, gages and meters, so that the management can ascertain at a glance how everything is operating. The results obtained from each and every double retort can be accurately ascertained.

Oil Seeds in India

In a recent letter from Trade Commissioner Batchelder he states that in normal years India produces well over 5,000,000 tons of oil seeds, worth about £50,000,000, one-third of which is usually exported. No other country produces such a variety, which includes cotton seed, rape seed, peanuts, sesame seed, mowra seed, poppy seed, niger seed, linseed and castor seed, as well as copra. Linseed, niger seed and poppy seed were formerly used in paints and varnishes as liquid drying oils, and rape seed was employed for industrial purposes, but linseed and rape seed can be refined for the production of margarine, and much rape seed is being used for this purpose on the Continent of Europe. Copra and mowra yield solid fats, while liquid non-drying oils are expressed from cotton, sesame, rape and castor seed, and from peanuts. India furnishes 98 per cent of the castor seed of the world, the oil from which is considered the best lubricant for airplane engines, and also supplies 100 per cent of the mowra, 100 per cent of the niger, 65 per cent of the rape and 76 per cent of the poppy seeds of the world.

Production of Coquito Nuts in Mexico

A recent report from Consul McConnico, Guadalajara, Mexico, states that the coquito palm grows abundantly in the States of Colima, Jalisco, Nayarit and Sinaloa, and that quite an industry has been established in gathering and preparing the small oil-bearing nuts for the market. The estimated annual production of these nuts in the district referred to above is 5,000 tons, valued at prices varying from \$150 to \$250 per ton. Ten years ago, before the value of the nut was really appreciated, the price did not exceed \$40 per ton. Soap manufacturers of Guadalajara and Mexico prize the nuts very highly because of the oily substances derived from them and consume practically the entire production in the manufacture of soap.

The Dimensional Limitation of Successive Heat-Treatments of Carbon Steel

By W. P. WOOD

WHILE concerned with the metallurgical inspection of aircraft engine parts, the following situation came many times to the writer's attention: Forged alloy steel parts, such as connecting rods, came from the heat-treating department to be inspected. The length and other dimensions were checked upon suitable gage blocks and the Brinell hardness was taken. Several of the pieces would be acceptable from the standpoint of dimensions, but would be too hard or too soft. These would be returned to be heat-treated a second time. This procedure might be repeated three or four times upon the same pieces. It was noted that after one or two such successive heat-treatments many of the pieces would have to be rejected on account of failure to fit the gage blocks; in other words, they had shrunk during the heat-treatments.

It seemed that if some information were available concerning the causes and amount of this shrinkage, much time and trouble might be saved. With this thought in mind, the present investigation was started.

Through some rather rough preliminary experiments it was demonstrated that this shrinkage is much more marked in some alloy steels than in carbon steels, but it was deemed best to study the carbon steels first, since the phenomena of their structure and treatment have been more thoroughly demonstrated.

PROCEDURE

Steels of the following carbon content were used: 0.11, 0.32, 0.44, 0.55, 0.64, 0.74, 0.82, 0.99 and 1.14 per cent. Manganese was in the neighborhood of 0.50 per cent and sulphur and phosphorus were both 0.05 per cent or below. Uniform samples 1 cm. square and 10 cm. long were machined from the annealed bar stock. Enough samples were prepared so that several checks could be run.

The length of each sample was carefully measured in a micrometer, the design and operation of which may readily be understood from the accompanying illustration Fig. 1. In making all measurements, the samples were always placed in the micrometer in the same position. The micrometer was frequently checked with a standard 10-cm. block.

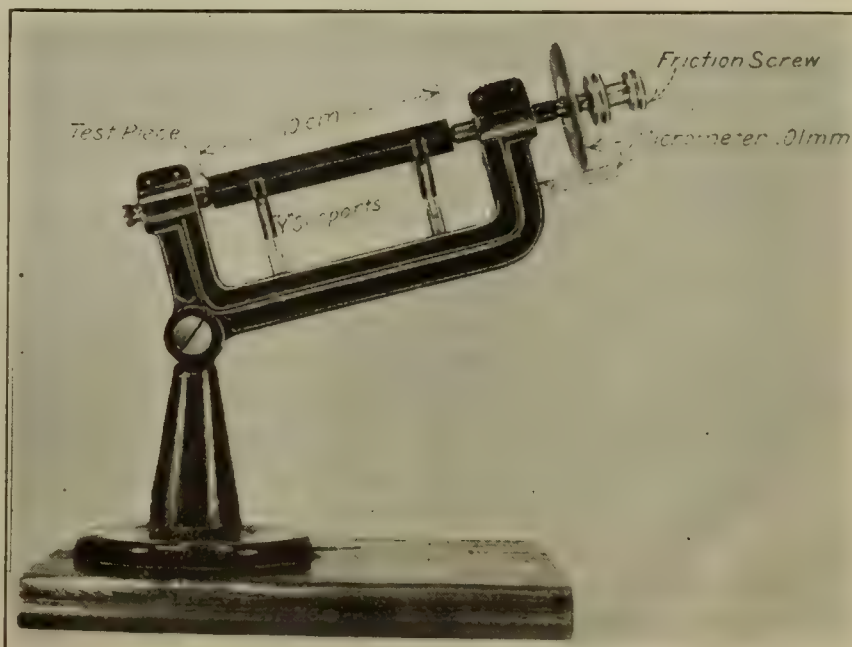


FIG. 1. MICROMETER AND FIXTURE FOR LENGTH

It was felt that more comparable results would be obtained if all samples were subjected to the same heat-treatment. The treatment selected was a hardening quench in oil from 900 deg. C., followed by a draw at 600 deg. C. The high drawing temperature was used in order to bring to a maximum all the possible effects which the draw might produce.

A Hoskins muffle furnace was used and a reducing atmosphere maintained by keeping a layer of charcoal about an inch thick over the floor of the furnace. Temperatures were measured by means of a millivoltmeter and a platinum thermocouple which was protected from the reducing atmosphere of the furnace by being inclosed in a fused silica tube. The samples were supported upon horizontal chromel wires and were placed parallel and close to thermocouple. After temperature had been reached, the pieces were allowed to soak for twenty minutes before removal from the furnace. After each hardening and drawing operation the length of the pieces was again measured. Almost no oxidation of the pieces was noted, although each had more or less "oil scale" upon it which was readily scraped off by a slight pressure with the blade of a knife or the finger nail.

Each sample was given three successive heat-treatments, a complete heat-treatment being the hardening quench and draw.

RESULTS

The results are presented in the accompanying graph Fig. 2, representing the shrinkage due to the successive heat-treatments, plotted against carbon content. The zero line is placed in such a position that shrinkage may

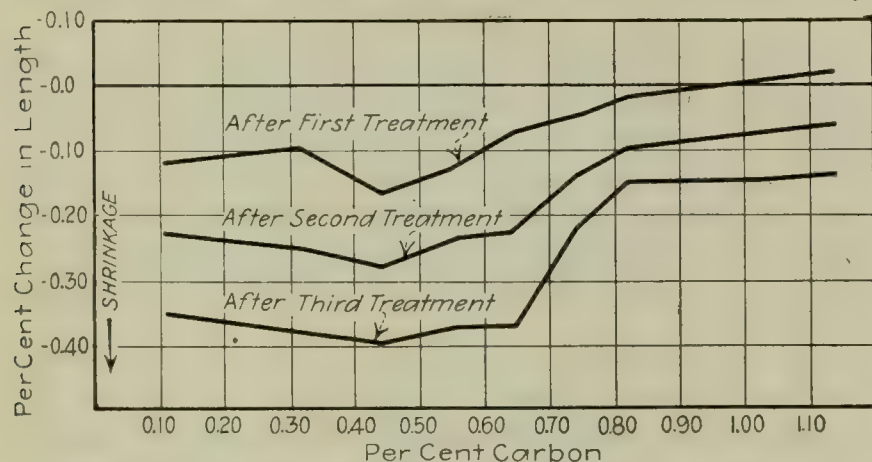


FIG. 2. CHANGE IN LENGTH AFTER REPEATED HEAT-TREATMENT

be plotted as a negative and expansion as a positive quantity. The ordinates represent percentage of the original length of the pieces, and the abscissæ represent increasing carbon content.

It will be noted that as the carbon content increases the shrinkage after hardening and drawing decreases. This condition leads one to the conclusion that at least two opposing agencies are influencing the changes in length of the steel.

Considerable light is thrown upon this subject by the work of J. H. Andrew¹ and others in a paper presented before the British Iron and Steel Institute at the May, 1920, meeting. These authors demonstrate by a set of skillfully prepared curves that as carbon steels are slowly heated to 1,000 deg. C. two opposing influences affect the steels—namely, (a) The change from alpha to gamma iron, which is in general of the nature of a contraction, and (b) the solution of carbide, which causes an expansion. As the per cent of carbon

increases, this so called "carbide expansion" increases. In steels carrying less than 0.70 per cent C the expansion is completed in the critical range. In steels carrying more than 0.70 per cent carbon this expansion continues above the critical range. It is concluded by the authors that this continued expansion is not altogether due to solution of carbides, but is continued by the dissociation of carbides in solution.

In the light of what has been said in the preceding paragraph, it may readily be perceived why high-carbon steels exhibit less change after hardening than low-carbon steels.

A glance at Fig. 2 reveals the fact that after the first complete heat-treatment the hypo-eutectoid steels were shorter than they were in the annealed state. The eutectoid steels had not changed much in length and the hypereutectoid steels showed slight dilatation. This condition was one that seemed logical when all of the circumstances were considered.

When a quenched steel is drawn one may presumably conclude that a reversal of all the effects occurring when the piece was first heated will tend to take place. In those steels which carry larger amounts of carbon and have undergone greater expansion we would not expect to find as great an amount of shrinkage relative to original length after a drawing operation.

Two possible reasons occur to the writer in explanation of the observed fact that the hypo-eutectoid steels were shorter after heat-treatment than in the original annealed state. One lies in the possibility that the cooling after annealing did not give as much time for the reversal of the "carbide expansion" as did the draw following the hardening quench. If this were true, the annealed pieces were in a slightly expanded condition when measured.

The second possibility lies in the more rapid contraction of the outer skin of a piece of steel when quenched. J. E. Stead² has mentioned an interesting instance of this in the case of a cylinder of steel which was subjected to many repeated quenchings. After a time the cylinder actually began to assume the shape of a sphere due to the more vigorous contraction of the outer portions of the piece. The length of the cylinder thus tended to decrease.

As a result of the second and third heat-treatments a rather uniform shrinkage in all the steels was noted, not so marked, however, in the case of the eutectoid and hypereutectoid steels. Here the most feasible explanation seemed to be the greater contraction of the outer portions of the specimen of steel during a quench as mentioned in the preceding paragraph.

In conclusion it may be said that the effect of heat-treatment upon the length of carbon steel sections is the result of three influences—the allotropic change in the iron, the solution and dissociation of the carbides and the more rapid contraction of the outer portions of steel objects upon quenching. The net result upon the length of the piece is the algebraic sum of changes in length caused by these three factors.

The hypo-eutectoid steels appear to shrink more rapidly than the others, and thus it would not seem advisable to repeat heat-treatments as often upon these steels as might be possible with precisely machined eutectoid and hypereutectoid steels.

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¹J. Iron & Steel Inst., vol. 101, p. 527.

²J. Iron & Steel Inst., vol. 83, p. 235.

Manufacture of Synthetic Ammonia at Oppau, Germany*—II

Catalysis of the Nitrogen-Hydrogen Mixture—Description of the Catalyzing Plant—Extraction of the Ammonia Formed—Description of the Ammonia Oxidation Plant and Its Operation—Description of the Absorption of the Nitrous Vapors Plant and Its Operation

THE research work of Le Chatelier and Haber has shown that the union of nitrogen with hydrogen is facilitated by an increase in pressure, whereas the increase in temperature lowers the proportion of the ammonia formed but increases the velocity of the reaction. The theoretical maximum of ammonia which can be obtained at 600 deg. C. under a pressure of 200 atm. is from 8 to 9 per cent. It is therefore necessary to absorb the ammonia as fast as it is formed while maintaining a continuous circulation of the gas. The Badische Anilin- und Soda-Fabrik accomplishes this by the use of water instead of by liquefaction of the ammonia, which proved to be costly and at the same time does not insure complete removal of the ammonia formed and also forms obstructions when the temperature falls below the melting point of ammonia. By the use of water as ammonia absorber some water vapor is introduced in the circuit and this eliminates the use of some catalyzers, but it has been proved that this moisture is practically without effect on the efficiency of catalyzers with iron as base.

The destructive action of the hydrogen on the walls of its recipients when the temperature is above 450 deg. C. and at high pressure has caused a series of difficulties and even accidents. It was therefore necessary to use special means for the manufacture of catalyzing apparatus. It would seem that under the above conditions of temperature and pressure the hydrogen diffuses through the metal and combines with the carbon of the steel, giving methane, thus producing blow-holes of appreciable sizes which weaken enormously the resistance of the metal.

DESCRIPTION OF THE CATALYZING PLANT

The Oppau works has two catalyzing plants. The most recent one consists of fifteen separate chambers (Fig. 8) situated in one building, each having a catalyzer A , with its heat exchangers E, E' . The roofing is very light so as to minimize the damage in case of an explosion of the apparatus. A thick wall separates the chambers from the compartment containing a battery of ten circulating pumps P of a total power of 4,000 hp. driven by steam engines M , and, superposed at different levels, twenty-four dissolving tanks, eight coolers K and separators d_1, d_2, d_3 .

The catalyzing apparatus (Figs. 9 and 10) is formed of a steel tube *A*, 12 m. high and 1.10 m. exterior diameter. It ends at each extremity by a flange and is closed by a steel cap *B* fixed with 9-cm. diameter bolts. The cap at the bottom is a truncated cone (16 deg.) which fits into a similar form at the extremity of the tube and is driven into its final position by a hydraulic press. The tube *A*, of 12 cm. wall thickness, has a series of holes from 1 to 5 mm. diameter spaced at regular intervals which serve probably for the escape of the diffused

hydrogen. It is lined with a similar tube *C* (Fig. 11) of soft steel about 2 cm. thick, whose extremities are hammered into the conical part and then the cap is fixed. A concentric steel tube *D* is separated from the tube *C* by a space of 1 to 2 cm. and kept in place by a series of wedges. It is through this empty space between the tubes *C* and *D* that the nitrogen required to counteract the diffusion of the hydrogen is supplied. The tube *D* is lined with a heavy refractory wall *E* formed of superposed cylinders, and finally the inner iron tube *F*, of heavy walls, which contains the catalytic mass. This is the constitution of the upper part only; the lower part of the apparatus constitutes a tubular heat regenerator.

The catalyzer is surrounded by an insulating envelope, leaving between them a small annular space in which cold air may circulate.

The two heat exchangers G_1 and G_2 (Fig. 9) placed near the catalyzers are 8 m. high, 0.90 m. exterior diameter and contain each from 130 to 140 tubes.

Each apparatus comprises also a circulating pump of 0.6-m. stroke, 0.4-m. cylinder diameter driven by a 750-hp. steam engine.

At the outlet of the regenerators the catalyzed gases are brought to the ordinary temperature by eight cool-

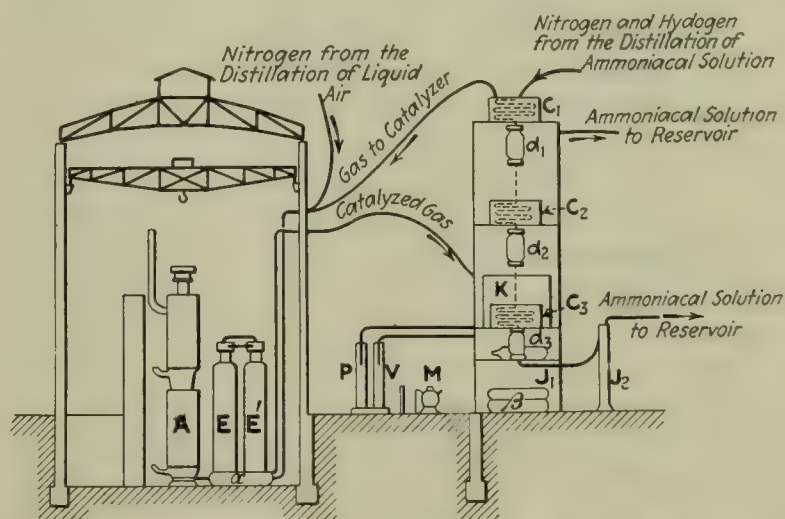


FIG. 8. SCHEMATIC ARRANGEMENT FOR THE CATALYSIS
OF $N + H_2$

ers K (Fig. 8), each one being formed of twelve to sixteen series of five tubes 7 m. long, 7 cm. diameter, connected in parallel to parallelepipedic collectors of 12-cm. sides, the whole being inclosed in a sheet-iron vat in which circulates a rapid stream of cold water. The condensed water is collected in horizontal cylinders J_1 . From the coolers the gases enter dissolving columns, each of which consists of three vats C_1, C_2, C_3 (Fig. 8) with pipe coils. These vats are superposed and spaced from 6 to 7 m. apart. They are connected to the vertical cylinders d_1, d_2, d_3 , in which the liquid separates from the gas. The capacity of these separators is 200 liters.

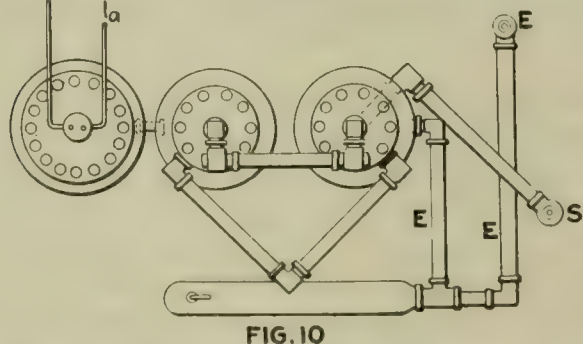
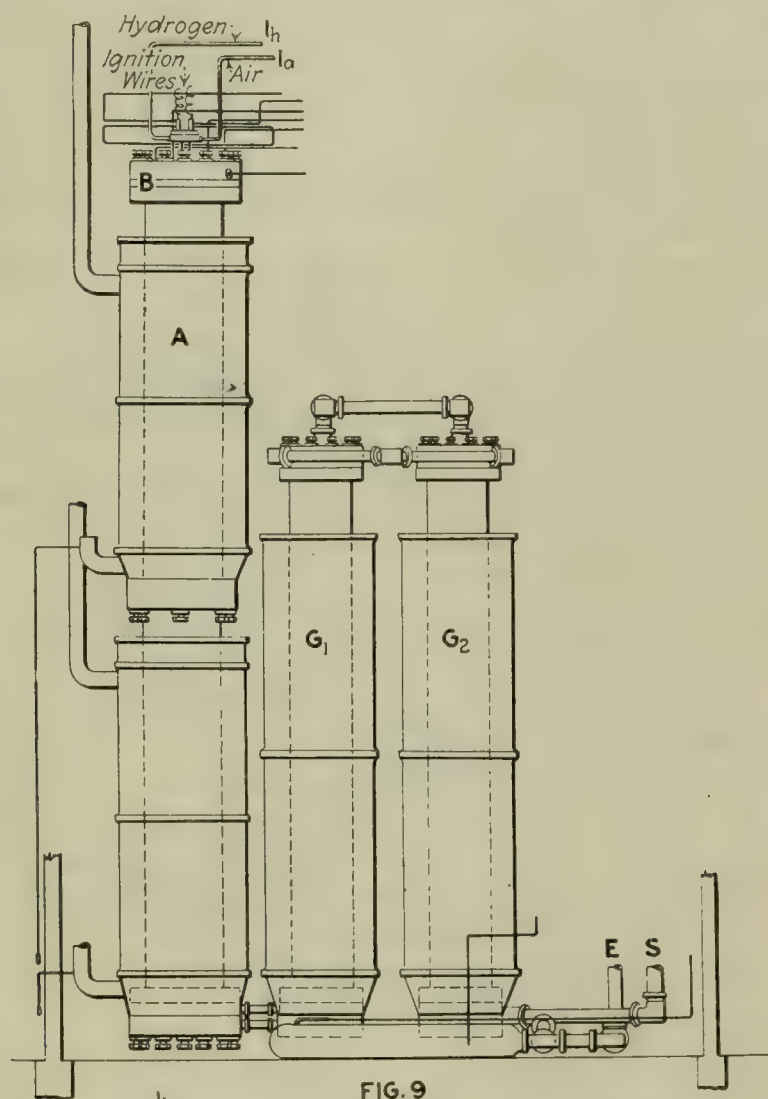
The vats are 1.8 m. high, 3.5 m. diameter and contain twelve concentric steel coils of 5 cm. diameter of the same length and whose corresponding extremities are

*From *La Technique Moderne*, November, 1920, pp. 449-460.
For Part I see *CHEMICAL & METALLURGICAL ENGINEERING*, vol.
24, No. 7, p. 305, Feb. 16, 1921.

fixed to a manifold, the lower part of which is connected to a separator. The vat contains the cooling water. The dissolving water, compressed to 200 atm., is divided as uniformly as possible for each of the coils. Indicators permit observation of the liquid stream entering each coil. This water circulates from vat to vat, starting at the top, the separator of each vat being connected to the top of the coil in the vat immediately below. The solution leaving the last separator enters the receivers J_2 .

These receivers are provided with indicators which show when the level of the liquid reaches the maximum. A series of valves permits the emptying of the liquid with successive expansions into closed reservoirs of about 20-cu.m. capacity, these reservoirs being designed to resist internal pressures of from 2 to 3 kg. Nitrogen and hydrogen, which dissolve along with the ammonia, are recovered from these reservoirs and sent back to the gas holder for the mixture $N_2 + H_2 + CO_2$.

The operations are controlled by a series of measur-



FIGS. 9 AND 10. ARRANGEMENT OF THE CATALYZERS AND HEAT EXCHANGERS

ing apparatus—namely, thermocouples, measuring burettes, registering apparatus for hydrogen content (based on the velocity of diffusion of the gas through a very small orifice), registering manometers, Bosch balances and registering apparatus for the velocity of the gaseous currents.

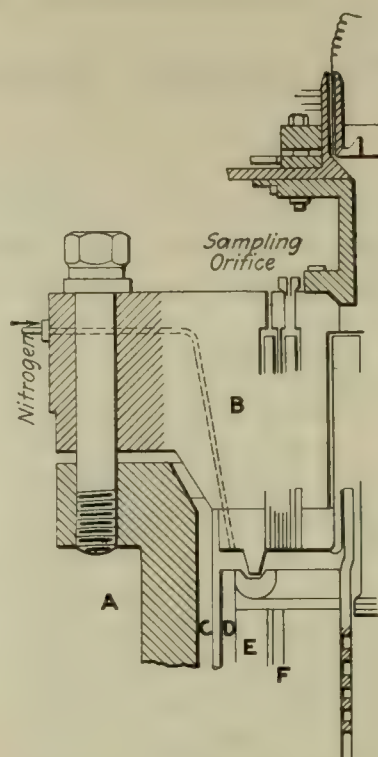


FIG. 11. DETAIL OF TOP OF CATALYZER

and hydrogen. The gases of the blowpipe are injected at a pressure of 200 atm. The ignition is produced by a platinum wire maintained at red heat to produce the union of oxygen and hydrogen in case the first of these gases should accidentally reach the blowpipe.

About 18,000 cu.m. of the gaseous mixture passes each furnace per hour, producing about 20 g. of ammonia per twenty-four hours.

The difference in pressure of the gas between the inlet and outlet from the circulating pumps is generally between 4 and 5 atm. and was never higher than 15 atm. The temperature of the gases at the outlet from the heat regenerators is between 140 and 150 deg. C. The ammoniacal solution contains about 25 per cent ammonia.

EXTRACTION OF THE AMMONIA

The ammoniacal solution is pumped by a centrifugal pump through a meter and into a 2,500-cu.m. reservoir. From the reservoir the liquor enters at *a* (Fig. 12) the heat exchanger *R*, thence through *b* to the top of the tower *A*. This tower is 2 m. diameter, 10 m. high and well insulated. Steam is injected at the lower part of the tower at *c*. The liberated gas and the steam pass through a cooler located on top of the tower. This cooler contains 525 horizontal tubes of 8 mm. diameter through which cold water circulates. The ammonia escapes through pipe *d* into a collector *D* which is common to all the twenty-four towers in the building and thence to a 12,000-cu.m. gas holder which contains water covered with a layer of oil to retard the saturation with ammonia. The water of solution and the condensed vapor, which now contains only less than 0.0005 ammonia, leaves through *f* at the lower part of the tower and passes through the regenerator *R*, whence a part goes through *g* to the dissolving apparatus and the other part to the boilers.

DESCRIPTION OF THE AMMONIA OXIDATION PLANT, AND ITS OPERATION

The Badische Anilin- und Soda-Fabrik oxidizes the ammonia by a catalytic mass which appears to be a mixture of oxides of iron, manganese and chromium agglomerated with bismuth chloride.

There are two oxidation buildings. The newer one

consists of three groups of two Rateau ventilators direct-connected to a 200-hp. steam turbine. The ventilators are of different sizes. The smaller ventilator of each of the groups circulates 36.8 cu.m. ammonia per minute, the larger ventilator brings in 46.6 cu.m. filtered air per minute. The three groups send their gases into a 2-m. diameter 10-m. long horizontal cylinder located underground and in which the mixture takes place. From this reservoir the gas mixture arrives through pipings *a* (Fig. 13) to eight regenerators and thence to sixteen oxidation furnaces *B* placed in two rows along the building. The oxidized gases enter the tubes of eight waste heat boilers (not shown in Fig. 12). A series of sixteen gas furnaces *C* serve for the heating of the oxidation furnaces.

The catalyzing apparatus grouped by twos consist of cylinders 3.5 m. external diameter and 5.5 m. high. They are well insulated. The upper part of the cylinder is closed by a brick top provided with a central opening *c* for the escape of the heating gas. A brick partition divides the chamber into two nearly equal parts. This partition is plane and horizontal at the top part and spherical at the bottom part. It is provided with 15-mm. holes spaced at about 8 cm. centerlines. These holes are slightly closed. The contact mass in sizes of 5 to 8 mm. is placed over this partition in a uniform layer of about 5-cm. thickness. The oxidized gases after leav-

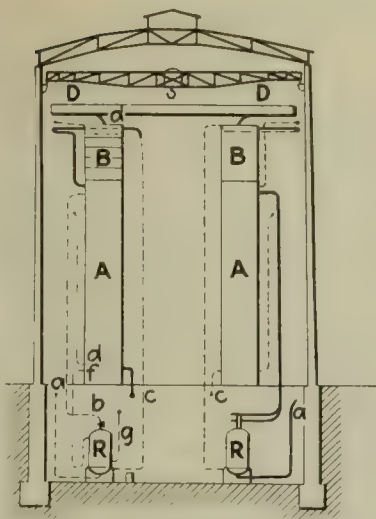


FIG. 12. SCHEMATIC ARRANGEMENT OF EXTRACTION OF AMMONIA

desired composition, the required amount of air or ammonia is added.

Each furnace oxidizes about four tons of ammonia per day with an efficiency of 80 per cent. The duration of contact is about one-half second.

At the Oppau plant from 180 to 200 tons of ammonia could be oxidized per day, but it would seem that at present only eighty tons per day is oxidized.

ABSORPTION OF NITROUS VAPORS

The nitrous vapors obtained by oxidation of the ammonia are absorbed by water, giving a 50 per cent solution of nitric acid, or by a sodium carbonate solution, giving a mixture of nitrate and nitrite of sodium.

The plant contains five stone or brick towers (I, II, III, IV and V, Fig. 14) and two brick columns (VI and VII) lined outside with sheet iron.

The gases arrive in tower I. This tower has a decag-

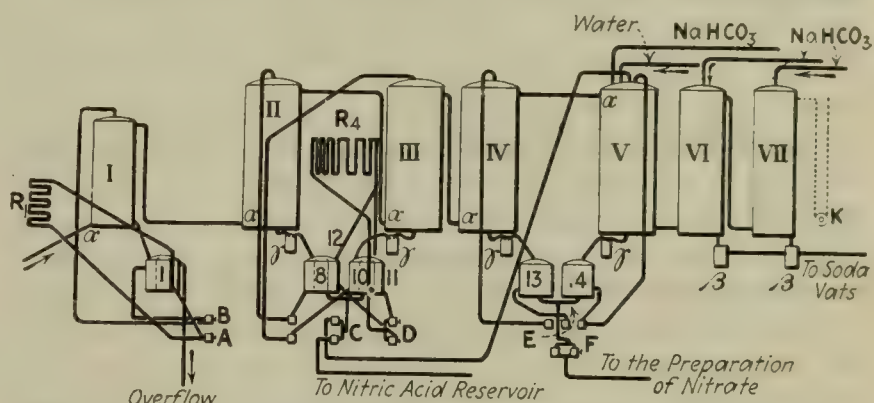


FIG. 14. SCHEMATIC ARRANGEMENT FOR THE ABSORPTION OF NITROUS VAPORS

onal section 5 m. in diameter and 15 m. high. Towers II and III are cylindrical, 7 m. in diameter and 20 m. high; towers IV and V have a decagonal section 6 m. in diameter and 20 m. high. All these towers are lined inside with 20-cm. thick acid-proof layers. The two columns VI and VII are used for the circulation of soda solution. The towers and the columns are filled with Raschig rings and stand on foundations 5 ft. high.

There are three towers I, to which correspond six reservoirs (1 to 6) 2.5 m. in diameter and 4 m. high. Between the towers II and III, IV and V there are also six reservoirs (7 to 12 and 13 to 18). These twelve reservoirs are 3.5 m. in diameter and 4 m. high. All the reservoirs are of brick, tarred inside and connected by stoneware piping. In the piping of the last four towers there are stoneware valves for sampling the liquors. All the pipes leading to towers of the same order are connected to a horizontal manifold. A stoneware overflow pipe is provided for each reservoir and the overflow escapes through underground channels.

The circulation of the acids is maintained by centrifugal pumps made of a 15 to 18 per cent Si pig iron called Elianite, and which are driven by electric motors.

There are two groups of two pumps A and B (Fig. 14) for the three towers I, a group of four pumps C and one group of two pumps D for the towers II and III, a group of four pumps E and one group of two pumps F for the towers IV and V.

The circulation of the sodium carbonate and nitrate solutions is made by two groups of two pumps driven by 110-kw. motors.

Other pumps serve for the circulation of cold water, warm water or soda solutions to the top of tower V.

The solution of filtered nitrates is sent to the reservoirs by six pumps. Two pumps collect the solutions of nitrate and carbonate spilled on the floor of the build-

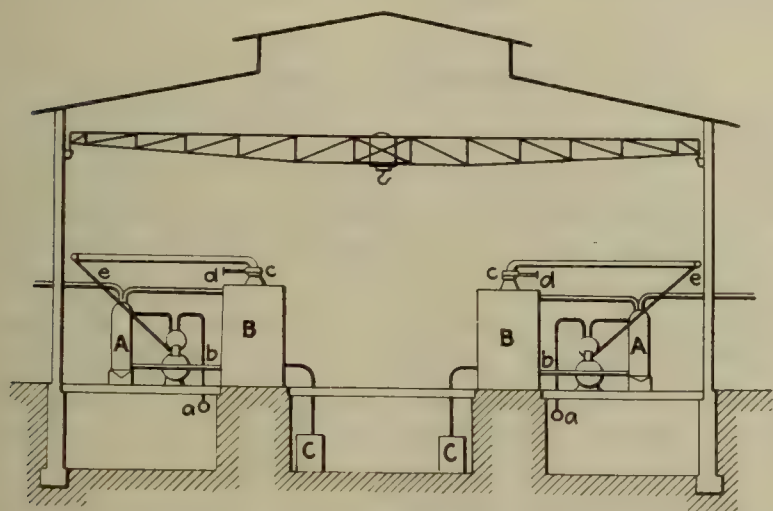


FIG. 13. SCHEMATIC ARRANGEMENT OF THE INSTALLATIONS FOR THE CATALYTIC OXIDATION OF AMMONIA

ing the regenerators are received into condensation towers.

The operation is kept under control by:

Peep-holes which permit observation of the catalytic mass, which is to be maintained at red heat.

Thermocouples giving the temperatures at different points (inlet and outlet of regenerators, inlet to boilers.)

Recording velocity indicators of the gaseous currents and manometers.

Gas-testing apparatus at inlet and outlet.

When the temperature tends to exceed the desired value a bypass valve brings in a part of gas which does not pass through the heat exchanger. This addition is made through piping *e*. If the mixture has not the

ings and send it to the reservoirs. A ventilator driven by a 130-kw. motor is placed on the outlet piping for gases, and two others serve to send air into the pipings bringing in the nitrous vapors.

All these pumps and ventilators absorb a total of 2,000 kw.

The acid collected at the bottom of the towers I, II and III is cooled in refrigerators *R*. These refrigerators are composed of thirty-six horizontal tubes connected in three groups and cooled by cold water sprays.

The gas arriving at the lower part of the towers I at *a* leaves at the top, enters the towers II at the lower part, and so on up to towers IV, whence the gases enter the towers V at the upper part.

The pipings of the towers III are connected to a single horizontal pipe which permits to bypass any one tower of the last three groups.

In the soda columns the gases enter at the lower part and leave at the upper part.

In the towers I, in which the temperature is about 50 deg. C., the acid obtained is of 35 per cent concentration; in the towers II the temperature is about 40 deg. C. and the acid is of 40 to 50 per cent concentration; in the towers III the temperature is 35 deg. and the acid is of 25 per cent concentration. The towers IV and V are at a temperature approaching the atmospheric temperature and they contain a diluted acid which is used for the production of sodium nitrate. Eighty per cent of the oxides of nitrogen is transformed into acid, 15 to 16 per cent into nitrates and 4 to 5 per cent is lost. The daily production of nitric acid would be about 264 tons.

Sulphuric acid is used for the concentration of the nitric acid in six cylindrical columns 10 m. high. These columns are steam heated. Two of the columns are of stone; the others, of more recent construction, are built of sectional Elianite tubes 75 cm. long, 1 m. in diameter, 4 cm. thick, connected by conical joints. These columns are provided with loosely laid Raschig rings. Sulphuric acid enters at the top of the column, nitric acid is supplied by two tubes entering the column respectively at 2 m. and 3 m. from the top of the column. Steam enters at the bottom in the center. The concentrated nitric acid vapors leave at the top of the column through Elianite pipes and enter the water-spray-cooled refrigerators. The condensed acid is collected in a reservoir. The non-condensed vapors are led by stoneware pipes to the nitrification towers described above.

The sulphuric acid is denitrated in columns analogous to those for concentration but only 6 m. high.

The denitrated acid passes through tubular coolers, and enters two lead-lined vats 4 m. high and 5 m. in diameter provided with seven cooling coils and thence to eight Kessler concentration apparatus 4.5 m. long, 3 m. wide and 1 m. high. These are heated with Kraftgas.

The nitration of sodium carbonate takes place principally in vats 3 m. in diameter, 2.5 m. deep, lined inside with brick and provided with wooden agitators. The carbonate solution used in these vats comes from a special dissolving building or from the Solvay soda plant. The acid vapors are brought in by three pipes.

The nitrous and nitric vapors liberated in the reaction are led to the bottom of column VI. The nitrate-nitrite solution after filtration is collected in three reservoirs 10 m. high and 3.5 m. in diameter.

(Part III, the last, will be published in a subsequent issue.)

Condition of the German Sugar Industry at Close of 1920

Germany is confronted with the problem of increasing its sugar production to meet domestic needs, reports Howard W. Adams, representative of the Department of Commerce, Berlin. In the sugar-production year 1919-20 there was a total of 269 sugar-beet mills in operation in Germany, as against 307 for 1918-19. Since the latter period thirty of the 307 mills referred to passed out of German jurisdiction along with those territories transferred from Germany under the treaty of Versailles.

SUGAR-BEET PRODUCTION IN 1919-20 SHOWS LOWEST AVERAGE FOR MANY YEARS

The sugar-beet production in Germany during the period 1919-20 attained an average of only 19 metric tons per hectare (hectare = 2.47 acres), the lowest average for many years. This diminished production is ascribed in part to the bad weather conditions existing at the time of planting and to the inadequate cultivation of the crops, due to the lack of labor and strikes. The first examination of the plants disclosed the fact that the average weight of the root was only 88 g., as compared with the preceding year's weight of 173 g., and a sugar content of 11.7 per cent, as against 12.4 per cent for the preceding year. The final examination of the plants showed a somewhat increased average sugar content, but considerably smaller beets—namely, 342 g. weight and 20.9 per cent sugar content, as against 504 g. and 19.8 per cent, respectively, for the year previous. Then a further setback to production occurred in the form of frost, which set in just at harvest time and as a result prolonged the work of completing the harvest with an accompanying heavy loss in sugar.

DOMESTIC PRODUCTION INADEQUATE TO GERMANY'S NEEDS

The net sugar production for 1919-20 amounted to a total, in round numbers, of 733,000 tons of raw sugar, as compared with 1,346,000 tons produced in the preceding year. Consequently, the domestic production was inadequate to meet the country's needs, which during the preceding year amounted to about 1,000,000 tons. It therefore became necessary for Germany to import 57,000 tons of sugar, as compared with the 29,000 tons imported during the preceding year. The only thing that saved Germany from a heavier importation during the 1919-20 period was the supply of 216,000 tons which became available from the stocks of the preceding year.

CONDITIONS PROPITIOUS FOR DEVELOPING CULTIVATION AND INCREASING PRODUCTION

At the beginning of the new sugar year Germany finds itself without available stocks of this commodity on hand. There is felt more than ever the pressing need of developing the sugar-beet cultivation and increasing production as far as possible. Conditions appear to be propitious for such a result. The cultivable acreage shows a slight increase—4 per cent—over that of the preceding year, and the fields are reported to be in good condition. The question remains as to whether the sugar mills will receive supplies of coal adequate to their needs and whether strikes among the farm laborers will disturb cultivation.



Safety Methods Applied in the Ryerson Steel-Service Plants

An Outline of the General Organization for Safety Promotion in the Plants and of the Results Leading to Better Relationship Between Management and Workers and to Ultimate Reduction of Plant Operating Costs and Higher Efficiency

THE prevention of accidents is an essential function of modern industrial management. Safety means not only a humanitarian movement, but goes far toward a better relationship between management and workers, and it has a direct influence on the cost of production.

Even though there were no material benefits to be derived from the prevention of accidents, it would still be desirable for industry to put forth a powerful effort in the elimination of hazards. But the practical results of a continuous, concentrated safety campaign are so evident that the work is also well warranted on a basis of dollars and cents.

The Joseph T. Ryerson & Son plants inaugurated intensive safety work six years ago because the management appreciated the opportunity to protect its workers, and the same impulse continues to keep the interest keen. These efforts have had ample reward.

Safety promotion means not merely the showing of bulletins and the soliciting of suggestions. To be really successful, it demands a more vital interest on the part of the entire working force.

ENTHUSIASM ESSENTIAL

The secret of success in safety promotion is the maintenance of eternal interest and enthusiasm. Enthusiasm cannot be instilled satisfactorily by merely forming an organization or by providing a system for handling suggestions. To be enthusiastic, a man first of all must believe in the thing heart and soul. If a workman does not really understand and sympathize with accident prevention, no amount of bulletin boards or "safety sermons" will have any effect on him. He must be sold just as thoroughly as must a purchasing agent when considering a new product. Furthermore, he has got to have the goods delivered to him in the style which he

can understand. This requires many different forms of activities and constant resourcefulness in treating with the individual.

Safety work without organization is as ineffective as in any project without a method of operating. Just as we need a production man to plan the routing of work through our shop, so also do we need a man to be responsible for accident prevention.

Committee meetings are excellent in promoting a general familiarity and team work among the men, but safety meetings that lack real interest are worse than useless.

Talking with each man individually every day is impossible in a large plant, but an efficient substitute can be gained by providing bulletin boards that carry a daily message to the workman. Bulletin boards to



THE FIRST-AID ROOM

talk to workmen must say something, and say it with a punch. No man will take time to pore over a bulletin which is ambiguous, or too lengthy. Snappy and clear cut items on a neat appearing bulletin board never fail to attract attention. The following is an example of such bulletins:

NOTICE

TO ALL MEN SEEKING EMPLOYMENT

If you are unwilling to

THINK "SAFETY"

WORK "SAFELY"

and

BOOST FOR

"SAFETY ALWAYS"

You Should Not Ask For Employment Here

WE HIRE SAFE MEN ONLY

— IF EMPLOYED —

be sure to get a Safety Rule Book at once. You should read it carefully, and in your work abide by all its regulations. You will be expected to read regularly the Safety Bulletins and to promote Safety-Always-Everywhere.

This sign is placed at the entrance of our employment department where all prospective employees are bound to read it.

COMPETITION EFFECTIVE

Among all these essential measures, however, none compares with the use of the competitive spirit. Why not utilize one of the best traits in human nature? It is what causes men to strive for higher goals in every kind of endeavor. In safety work it is just as strong an incentive. Many workmen have been known to treat lightly the consideration of safety when the only incentive was the prevention of accident to themselves. But place those same men in a contest with others, competing for the safety record, and you have a different story. They are eager and watchful. They themselves not only are careful but they are quick to discipline a fellow worker if he fails to play the game.

All the foregoing are intended for the most part to arouse interest, to maintain enthusiasm.

Most of the real constructive steps are taken through the system for receiving suggestions and for making periodical inspections.

A STRONG ORGANIZATION

The first step taken for the elimination of accidents was the creation of an organization that would be responsible for the carrying on of the work. Operating men who are busily engaged in directing the Ryerson steel-service plants have ex-officio positions on the committees, but are not held directly responsible for the carrying on of the campaign. Betterment department men, whose duties in other lines are entirely consulting, are chairman of the various committees and take the initiative in planning innovations and are responsible for the maintenance of continual interest in the work. Each plant has its own officers and full committee so that direct action can be taken on suggestions, and so that

local meetings can be held as frequently as desired. All are, however, co-ordinated by an inter-plant executive committee, the chairman of which is responsible to the vice-president of the company. This committee inaugurates inter-plant contests and makes it possible for the various local plants to make use of the ideas developed by the central committee, as well as by the other plants.

An interesting feature of the Ryerson safety organization is the provision for rotating the workman members of the plant committees. They are selected monthly, and the number of men on each plant committee is so calculated that every man in each plant has his turn at least once a year. Changing the committees once each month brings new energy and interest into the organization. Successful safety work requires inspiration and inspiration from plant men can best be gained by utilizing the greatest number possible.

BULLETIN BOARDS

A few fundamental rules govern the handling of the Ryerson bulletin boards:

1. They are placed in positions about the plant where men—because of necessity or habit—most frequently congregate. Very often the mistake is made of placing the board in an obscure corner of the factory, and then expecting the workman to go to it. Newspapers are sold because aggressive newsboys bring the papers to your very hand. If the daily papers expected their patrons to walk to a central point to secure the morning sheet their sales would fall off appreciably. Likewise with the safety bulletin board. We are selling the workman a daily news sheet on "safety," and we have got to bring it to his attention, and not expect him to take the initiative in hunting it up.

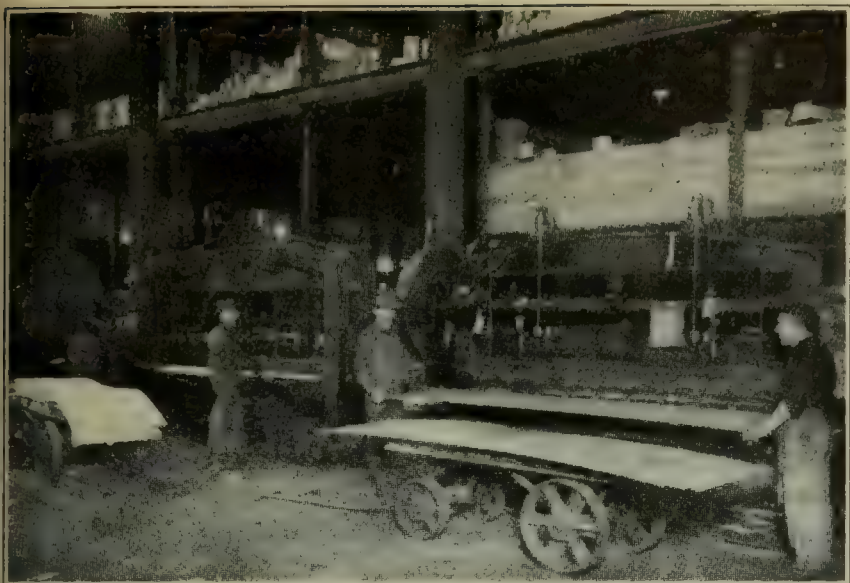
2. One person should be responsible for the placing of bulletins on the board. If there is no such rule in



AN APPEAL TO HOME INSTINCTS

the factory and any one feels free to post whatever seems to him appropriate, the result is the same as would be the appearance of a newspaper which was edited by its entire reportorial staff. The Ryerson bulletin boards are in charge of one individual in each plant, who alone can unlock them and who alone is responsible for their appearance.

3. Interest travels in cycles, and accordingly that which attracts a man one day palls on him the next. Bulletin boards are changed daily, so that every morning



BATTERY OF SHEET SHEARS SHOWING GEAR GUARDS

the worker entering upon his job has before him a fresh thought on safety. Sometimes a very good bulletin can be posted a second time after a lapse of several months. But to allow the bulletin board to remain unchanged for several succeeding days is likely to mar the whole safety program. A man finally concludes that there is nothing to interest him on the board and therefore decides not to bother looking at it again. He has then got to be sold all over again, as far as his interest in reading safety bulletins is concerned, before he becomes what is desired—a habitual daily reader of the safety bulletin board.

4. "What kinds of bulletins do the work?" is a frequent query. Every plant is different, of course, in the type of men employed and accordingly in the language which must be used in pointing out hazards. Years of experience have taught the Ryerson safety organization a few fundamental rules in the preparation of safety bulletins. They should not be long or ambiguous. They should have a definite point. Wherever possible they should be illustrated with a photograph, or a magazine clipping, or with an exhibit such as a broken goggle, a worn-out glove, etc. They should cover subjects which are recognized by the men as directly affecting their own working conditions as far as possible.

An interesting and very effective way of determining the relative value of different types of safety bulletins, as well as of stimulating general interest, is by holding a preference vote. The Ryerson plant safety committee men have posted before them different types of safety bulletins. Arguments for and against the different types are heard from the various members, and a vote is then taken as to the prize bulletin submitted.

SUGGESTIONS ADD INTEREST

One of the most effective ways of stimulating interest in safety work lies in the encouragement of suggestions from the workman. Men take a natural pride in seeing their own suggestions put into effect. The Ryerson safety organization makes it a point to welcome all suggestions and also to put them into effect, if they are at all practical. Many times the interest that is created through the approval of safety suggestions is of even more value than the actual result of the improvement itself.

It has been found that men hesitate to place the suggestion in a box such as is usually provided. Not being able to see whether there are any other suggestions therein or whether or not they are ever removed, their interest will naturally lag. Glass bowls with red lights

in the background have been provided for the receipt of safety suggestions from Ryerson workmen. These bowls are emptied daily, and it has been found that the sight of even one suggestion in the glass bowl has prompted others to present theirs, where otherwise they might have never given the matter a thought.

LIVE SAFETY MEETINGS

The holding of safety meetings is a good deal like the conduct of a political gathering or of any other congregation where it is the object to interest the audience in a specific issue. It is frequently found desirable to include on the program a number of features which, although entirely irrelevant to the subject at hand, have nevertheless an interest which holds the meeting together and arouses enthusiasm. That is why political campaigners like to visit state fairs. The crowd is there to hear and see what really interests them, and incidentally the campaigners get their opportunity.

The safety meeting is advertised in advance. Bulletins posted on the various boards announce perhaps the fact that a fellow workman is billed to talk on "How to Make the Assembling of Sheets Safer." It is suggested in the bulletin that every man ask his foreman for permission to attend the meeting. Of course, it is impossible for every man to be allowed to attend such a meeting, but the object is gained thereby of arousing indirectly an interest in safety by instilling a desire in every workman's mind.

Every man is probably surprised to learn that Bill Jones, his fellow workman, has agreed to stand before them and discuss "Safety." Their curiosity is aroused. They are anxious to know how Bill got the nerve and also whether he can "put it across." The idea of securing a lesson in safety probably never occurs to a single man, because each is far more interested in how Bill Jones is going to deliver.

Nevertheless, in the meeting there is going to be a lesson in safety. That will be assured in advance by those in charge of the meeting. And so, without hardly realizing it, all who attend the gathering will receive a bit of experience or an item of knowledge that will react toward the promotion of safety.

There is a general inclination among all men to dislike being preached to. They do not of their own free



HUGE PLATE SHEAR SHOWING GEAR GUARDS AND CAREFUL METHOD OF PILING STOCK



HIGH-SPEED FRICTION SAW OPERATED WITH SAFEGUARDS AND BY SAFETY RULES

will attend meetings where they suspect that they are going to be "talked to." However, a sermon can be presented indirectly sometimes in the form of a suggestion. And much easier than that can be the presentation of a thought on safety in an indirect manner. Give a man the nucleus of an idea, the foundation on which the thought is based, and he will make the proper decision himself. He likes to do that, and when a man believes he has made his own decision he is jealous of it, he champions it against all odds. That is the ideal condition in which to have the workman's mind in regard to safety.

A man who has made up his own mind that safety is a fine thing is worth ten who believe it simply because they think it is a good policy to do so.

PLANT COMMITTEE MEETINGS

At least once each month each plant committee holds a meeting at which it discusses reports, inspections, suggestions, accidents and other routine occurrences. These are called the routine committee meetings. Also once a month another meeting is held, such as we have described, to be attended by a considerable portion of the plant men and where no routine matter is taken up, where the sole object is inspiration for safety.

When we state that these meetings also result in cooperation, in good fellowship and in an excellent understanding, we merely express the obvious. The main purpose is the promotion of safety, but the byproducts are also very much worth while.

REGULAR AND FREQUENT INSPECTION

The backbone of accident prevention is regular and frequent inspection. Every stock room and piece of equipment in the Ryerson plants is inspected once each week by members of the plant committee. A detailed report on the condition of each item is submitted to the chairman of the committee. This chairman is responsible for seeing that dangerous conditions are remedied through the proper operating channels, and he also makes certain that the members of the committee are sufficiently thorough in their inspection.

PRIZES AND REWARDS

Contests to be successful must be both personal and collective. They must be personal in order to provide an incentive for each individual, and they must be collective in order to insure proper team work.

The plants, although scattered at widely different points, in Chicago, New York, St. Louis, Detroit and Buffalo, are nevertheless tied together by a closely knit organization, and a healthy and friendly rivalry in everything that makes for better service and working conditions. They compete with one another in safety with the same ardor that they show for greater steel tonnages and speed in shipment.

The plant which at the end of six months has the highest percentage standard is considered the prize winner, and every man in that plant, eligible through length of service, receives a reward in cash. Individual workmen in other plants are not neglected, however, if they themselves have a perfect score, even though their plant may fall down. Individuals maintaining perfect records for themselves throughout the contest period also receive a cash reward. It is a fact that a large majority in all plants earn their individual perfect record rewards.

Although the foremen should not be held entirely responsible for the conduct of the safety movement, nevertheless their influence in promoting the work should be clearly recognized. A foreman can be a hindrance to aggressive safety campaigning, even though not actively in opposition, by being merely passive in his enthusiasm. On the other hand, he can give a tremendous impetus to the prevention of accidents.

The foremen are encouraged to aid in every way in promoting safety, and are given a practical incentive for so doing. Every month the foreman whose department is leading in the contest receives a cash prize. Not alone is it the money reward which spurs the foreman to accomplishment in the safety campaign, but the natural desire to maintain his plant in the lead over other plants is an even greater incentive.

VARIOUS SAFEGUARDS

Various safeguards installed in the plants mutely testify to the low accident rate prevalent and to the ever lessening likelihood of workmen becoming injured.

Safeguards are not limited to any one class of machines or conditions. Sometimes the most dangerous appearing machines are the ones which do not require safeguarding as much as other conditions where danger is less obvious. For instance, the condition of floors, ramps and stairways is a common hazard which is very often overlooked, and accidents resulting from slipping and tripping or falling are taken as a matter of course. Safeguarding workmen from accidents of this kind is nevertheless just as important as protecting machinery, because the hazard in most cases is presented to a greater number of men. Safeguarded machines protect few men; safeguarded stairways protect the entire working force.

The Ryerson organization has met the situation by adopting the very best anti-slip material for stairways, ramps and slippery floors.

THE RESULT—SAFE PLANTS

The experience of an organization which for years has conducted an intensive promotion of safety means more perhaps to such a company than do the arguments of the safety campaigners.

It is difficult to determine the decrease in accidents in an organization which is growing and extending as fast as the Ryerson company; however, figuring conservatively from the yearly accident statistics, the accident rate has been reduced 80 per cent and even better is expected.

Legal Notes

BY WELLINGTON GUSTIN

Rights to Trade Mark Between Manufacturer and Distributor

A question of trade mark rights was decided by the Court of Appeals of Maryland in a suit brought by Corkran, Hill & Co., against the A. H. Kuhlemann Co. of Baltimore. The trade mark was known as the "Orange Brand" and had been used by the first-named company for many years covering meat products. In 1910 the company began to sell oleomargarine products, buying such from the Kuhlemann company. It furnished at its own expense the labels for such product, employing the words "Orange Brand," and stated thereon, in obedience to a requirement of the Government, the place where such article was manufactured. No oleomargarine product bearing this trade mark was sold by the Kuhlemann company to any one else. This course of dealing continued down to 1914. From 1914 to 1916 the plaintiff used the trade mark slightly changed, it being the same in design as that registered in the Patent Office in 1908. In 1916 the contract between the parties was more general, in which labels were used showing the Kuhlemann company manufacturer of the "Orange Brand" and Corkran, Hill & Co., as distributors. In this same year the Kuhlemann company, without the knowledge and consent of the other, had registered in its name the "Orange Brand" trade mark for manufacture and sale of oleomargarine. Upon discovery of this proceeding Corkran, Hill & Co. demanded surrender or abandonment of such trade mark, and instituted this suit. The trial court decided against Corkran, Hill & Co.'s claims and dismissed the case, but on appeal the Court of Appeals has reversed the lower court.

It was said to be unnecessary, to entitle the claimant to the use of a trade mark, that it should have been the manufacturer of the article. Neither was it necessary that the trade mark should have been registered to entitle plaintiff, the claimant, to use of trade mark, or to protect the company and its work against infringement.

The facts showed that Corkran, Hill & Co., or its predecessor, designed, adopted and used the "Orange Brand" trade mark, and thereby acquired exclusive right to its use. This right persists unless abandoned or acquiesced in its use by the defendant. The court said an abandonment is the voluntary and intentional disuse or non-use of the trade mark. Such intention may be inferred from circumstances necessarily pointing to an intention to abandon, but an actual intention to give up permanently the use of the trade mark is necessary to constitute an abandonment of it. Mere disuse, though for a considerable period, in the absence of intentional abandonment will not amount to an abandonment, nor will it destroy trade mark rights, unless the mark has ceased to be distinctive and the good will associated with it has passed away, or the mark has become identified with other goods.

Finally, it was said where the manufacturer was permitted to use the trade mark for goods put up for the

distributor, there was no abandonment of the mark by the distributor, nor was the right to use it lost by such distributor on account of its acquiescence in the use by the manufacturer for their mutual benefit.

A permanent injunction therefore was awarded to Corkran, Hill & Co.

Contract to Buy May Not Be Transferred Without Consent of Original Seller

Litigation between the Phosphate Mining Co. and the Atlanta Oil & Fertilizer Co. has occupied the courts for several years over a contract of the latter to accept and pay for phosphate rock mined by the former. The latest decision in the matter is that of the Court of Appeals of Georgia (103 S. E., 873) affirming the trial court. The two questions presented the jury were the "rule of avoidable consequences" and "whether the seller had in fact consented to the transfer of the contract."

It appears that the Atlanta company transferred its purchase contract to the Empire Cotton Oil Co. and contended that because of such transfer it was not liable under the contract.

The court instructed that if the transfer was made to the Empire company and the Phosphate Mining Co. accepted the transfer, the Atlanta company was relieved of further liability but the Empire company would assume such obligation that might arise out of the contract. The Atlanta company would be relieved either by express contract or by implication having notice of the transfer and accepting it. The jury found there was no notice and acceptance of the transfer of the contract by the seller, Phosphate Mining Co.

The action being one for damages for the buyer's breach of written contract to accept and pay for phosphate rock, a charge to the jury, on the issue of damages and the avoidance of consequences, that, if the buyer breached the contract, the seller might recover the difference between the market value and the contract price for the rock, was not erroneous as ignoring the defense by the buyer's transfer of the contract to another company and the seller's duty to minimize the damages after its acceptance of such transfer.

The contract provided:

"Buyers are at liberty to diminish the quantity called for in any year to the extent of not exceeding 10 per cent, provided that the quantity to be taken shall not be less than buyer's consumption, and provided further that notice of such diminished demand be given seller twelve months in advance of such change."

The seller was notified that the buyer had no demand for consumption and had no capacity for consumption after July 1, 1912, and had sold out its plant and transferred its contract to another consumer, the Empire Cotton Oil Co., the purchaser of its plant. The action of the purchaser, and its refusal to take any rock, operated at least to diminish the quantity specified in the contract to the amount of 10 per cent beginning one year after such date. The purchaser of the plant and transfer of the contract notified the seller, Phosphate Mining Co., in writing to decrease the quantity specified in the contract 10 per cent beginning one year from date of that notice, or one year from July 9, 1912.

The points having been determined in favor of the mining company, judgment for it was affirmed.

Polishing Motor for Metal Sections

By CHARLES Y. CLAYTON

While the microscopic study of metals is as a rule most interesting, the preparation of the specimen for study is generally an irksome task. Unless the polishing machines are carefully designed and arranged the task is usually a long one.

The common method now in vogue is to rough-polish

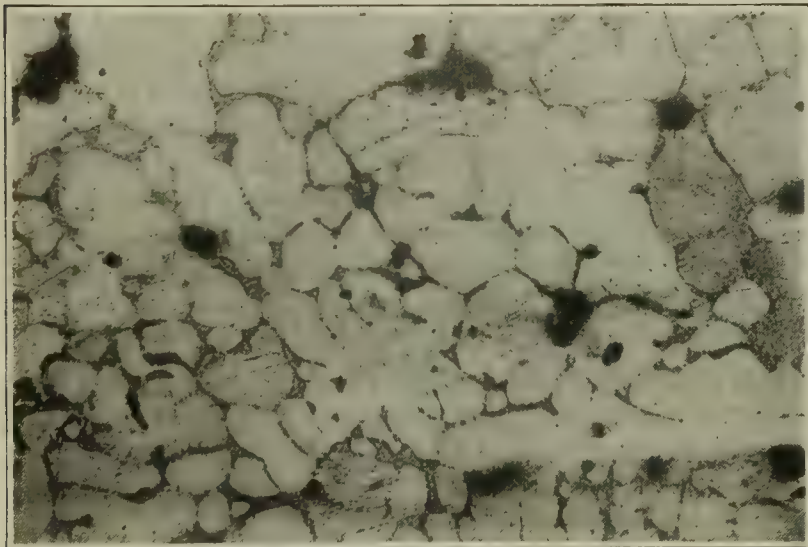


FIG. 1. CAST COPPER; ETCHED WITH $\text{NH}_4\text{OH} + \text{H}_2\text{O}_2$. $\times 100$

on a vertical wheel and to finish on horizontal disks covered with the proper media.

Having experienced considerable trouble with horizontal disks mounted on spindles driven by belts or friction clutches, the writer designed a vertical motor with a rotor shaft sufficiently long for a threaded end to permit affixing a bronze disk.

The motor was made by the Cincinnati Electrical Tool

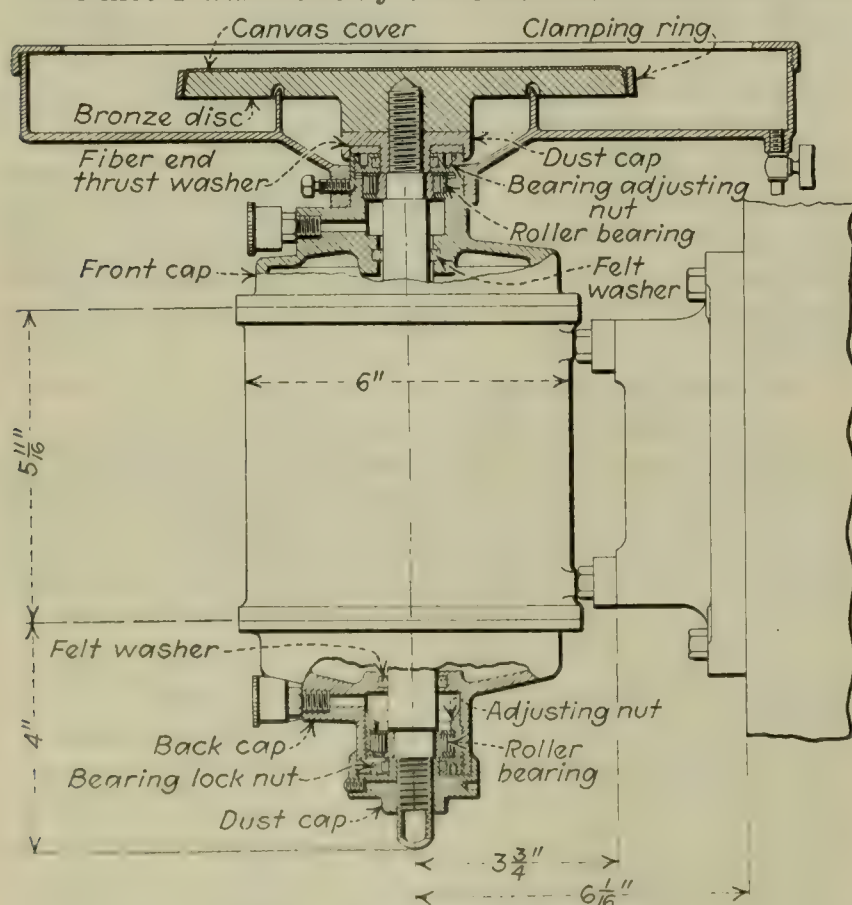


FIG. 2. DESIGN OF MOTOR

Co. It operates at 3,000 r.p.m. and gives complete satisfaction. Even soft metals can be polished with the proper care, as is shown by Fig. 1, a microphotograph of cast copper polished on this machine.

Fig. 2 shows the design of the motor, horizontal disk and water pan. Fig. 3 is a photograph of the assembled unit.

Rolla, Mo.

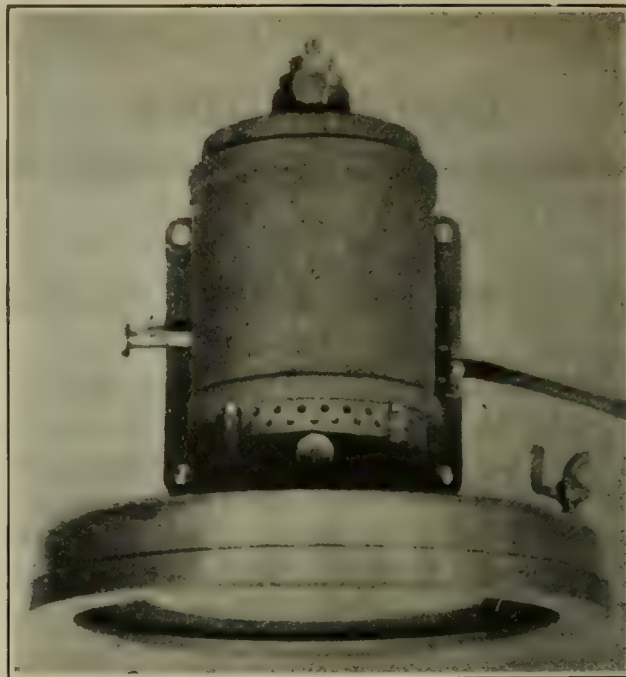


FIG. 3. ASSEMBLED POLISHING UNIT

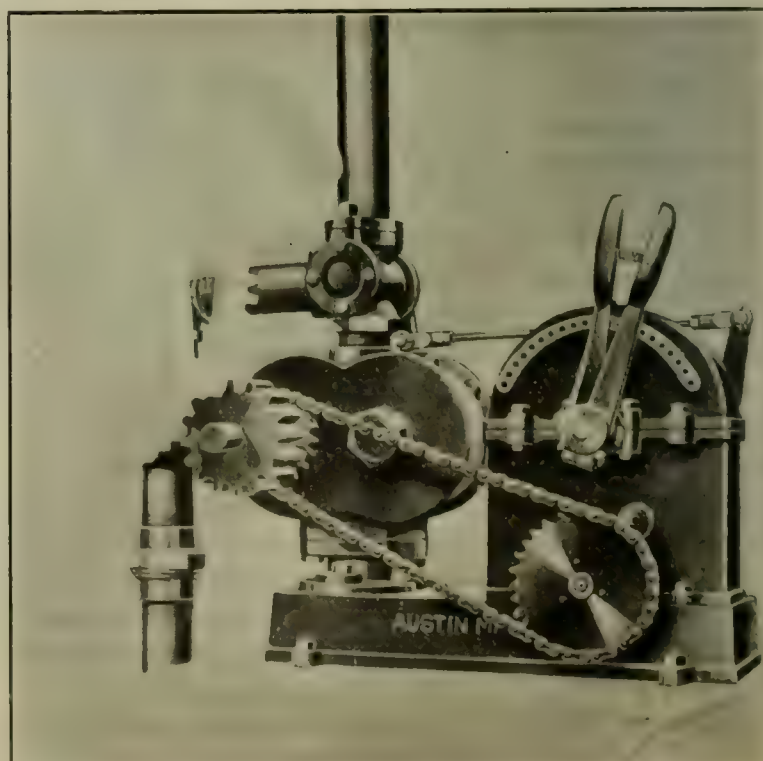
Automatic Motor Pump

This is a novel device developed by the Austin Machinery Corporation of Chicago, for pumping and measuring the water discharged into concrete mixers. The importance of proper quantities of water in each batch of concrete mixed is well known, and this device will be welcomed as solving this much discussed problem.

The apparatus consists of a pump, a valve, a timer and pipe with fittings. The pump is driven from the mixer shaft and works continuously. It has a lift of 12 ft. from dead water level to pump or can take water from a hydrant. The two-way valve is opened and closed by means of a cam on the timer, which is in turn controlled by the starting lever. With the valve open, water is discharged to the mixer. When it is closed, water circulates through the return loop in the piping.

The operator opens the valve by throwing the starting lever over to the timing pin. Then he forgets it until the next batch is ready for water. The valve closes itself automatically at the precise moment the predetermined quantity of water has been discharged. The amount required is a matter of indifference, since the device has a range of about 250 per cent from minimum to maximum discharge.

The total equipment weighs less than 200 lb.



AUTOMATIC MOTOR PUMP

Wallace Elected Secretary American Engineering Council

WHEN American Engineering Council of the Federated American Engineering Societies was organized in Washington last November the selection of an executive secretary was deferred until the field could be thoroughly canvassed to discover the man best suited for this important post. Practically three months later, at a meeting of the Executive Board of the Council at Syracuse, N. Y., Feb. 14, the board elected Lawrence Wilkerson Wallace to succeed L. P. Alford, who has been acting secretary since the formation of the Council.

Lawrence Wilkerson Wallace has been one of the most active figures in the Council and from the time it was organized has been its treasurer. As vice-chairman of the Council Mr. Wallace has been directing the work of the committee on elimination of waste in industry, one of the principal committees of the Council, whose scope, following the Syracuse meeting, will be greatly broadened.

Mr. Wallace was born in Austin, Tex., Aug. 5, 1881. He was graduated from the Agricultural and Mechanical College of Texas in 1903 with the degree of B.S. in mechanical engineering. In 1912 he received the degree of M.E. from Purdue University. From 1903 to 1906 he served a special apprenticeship with the Santa Fe Railway Co. at Cleburne, Tex., and was a member of the Purdue faculty during 1906-07, becoming head of the department of railway and industrial management in 1913.

As head of this department he was in charge of instruction pertaining to railway mechanical engineering and industrial engineering and of the research work carried on in the railway laboratories; made extensive research pertaining to locomotive performance through both laboratory and road tests and made an exhaustive study by road and laboratory tests on the possibility of fire from locomotive sparks, which information has been largely used in fire cases. His investigations have also covered tests of brake beams, truck side frames, truck bolsters and many other features of car and locomotive construction.

After leaving the university Mr. Wallace became assistant general manager of the Diamond Chain & Mfg. Co., Indianapolis, Ind. As assistant general manager he was in charge of the production during the war.

Upon leaving the Diamond Chain & Mfg. Co. he went to Baltimore, Md., and became director of the Red Cross Institute for the Blind, which was commissioned with the responsibility of giving vocational training to the blinded of the military forces. He left the Red

Cross Institute for the Blind on Jan. 1, 1921, to take charge of the investigation being conducted by the committee on elimination of waste in industry, appointed by Herbert Hoover.

He is author of a treatise on steel freight car design which is used by several universities as a text book; also prepared a number of instruction booklets for educational departments of railway companies; contributed various papers to railway and industrial engineering societies, papers covering varied topics pertaining to the activities of these two general groups.

Mr. Wallace is a member of the American Society of Mechanical Engineers and vice-chairman of the society's management section. He is now serving his third term as president of the Society of Industrial Engineers and is a past president of the Indiana Engineering Society. Mr. Wallace is a member of the International Railway

Fuel Association, Western Railway Club, Master Car Builders Association, Academy of Political and Social Science, and Western Efficiency Society. Mr. Wallace is prominent in Masonry, and is a past grand lecturer of the Grand Lodge of Indiana.

Mr. Wallace's social and commercial activities embrace a wide range. His work in New York as vice-chairman of the committee on elimination of waste in industry has been instrumental in bringing national attention to the purposes of the Council.

In an address before Engineering Council in Washington he summed up his idea of the function of the engineer as follows:

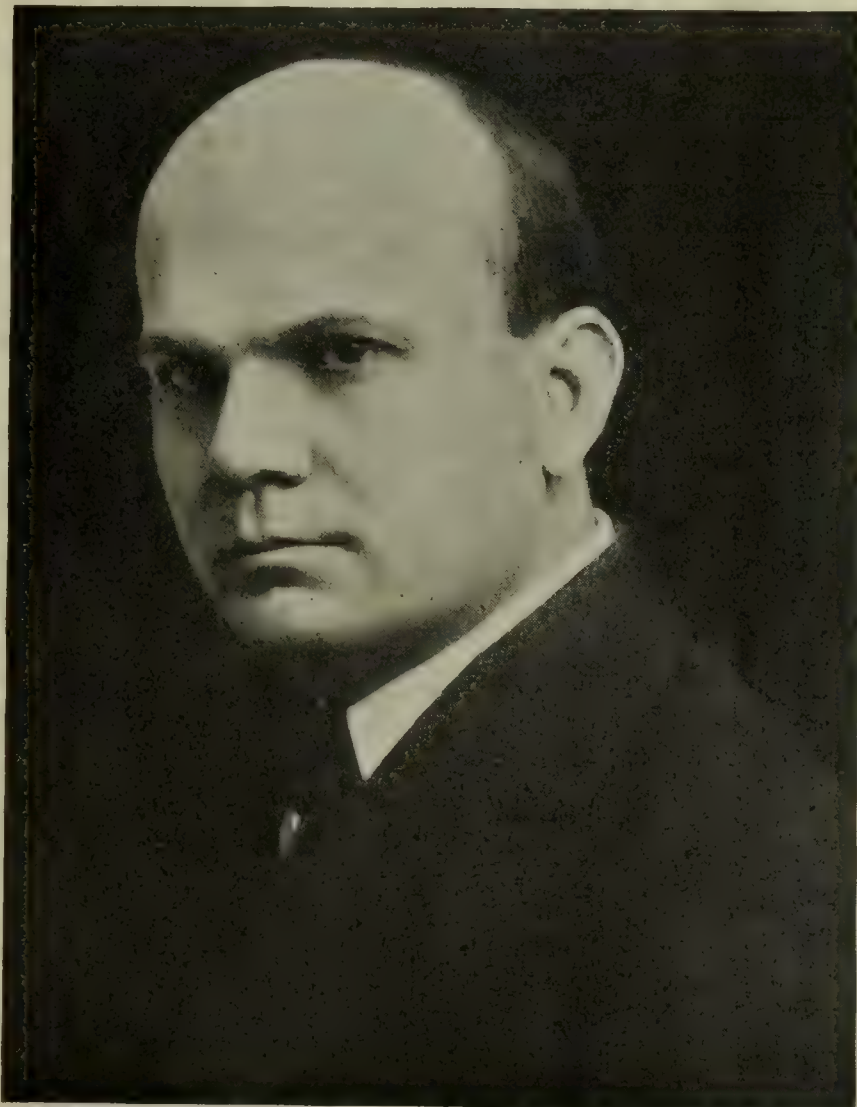
"It is the function and province of the engineer to make the correct analysis, to predict effect through known causes. It is purely the mission of the engineer of wide experience, of great foresight and of unselfish motive to see to it:

"First—That every action is based upon the principles of honesty, justice and fairness to the employee, the employer and the public.

"Second—To so formulate the plan of action as to eliminate all unfair privilege of employer and employee and to make it possible for each to fulfill its responsibilities to the community.

"Third—To so organize the plant or industry as to make it exceedingly difficult for an incompetent to hold a position of authority or to have autocratic control."

Mr. Wallace, now at the temporary headquarters of the Council in the Engineering Societies Building, New York City, will soon transfer his activities to Washington, where the Council has established permanent national headquarters in the McLachlen Building. The Employment Service Bureau will be continued in New York, with Walter V. Brown in charge.



LAWRENCE WILKERSON WALLACE
Executive Secretary, American Engineering Council

Current Events

in the Chemical and Metallurgical Industries

American Engineering Council Begins War on Waste in Industry

American Engineering Council of the Federated American Engineering Societies held a two-day session in Syracuse, N. Y., Feb. 14 and 15. At this meeting President Herbert Hoover announced the appointment of a committee on elimination of waste in industry as follows:

J. Parke Channing, Dr. Ira N. Hollis, L. W. Wallace, H. K. V. Scheel, L. P. Alford, George D. Babcock, F. G. Coburn, Morris L. Cooke, Harrington Emerson, E. E. Hunt, C. E. Knoeppel, Robert Linton, Fred J. Miller, J. H. Williams and Robert B. Wolf.

It was announced that the committee has already begun work and will study the nation as a single industrial organism to locate the weaknesses in the country's industrial system. An announcement by the Council says:

"The Federated American Engineering Societies, in which the national and local engineering societies of the nation are coalescing, is organized for public service. Unemployment, intermittent employment, strikes, lockouts and restrictions of output are waste. Disuse and misuse of machinery and equipments and losses of manufacturing materials are likewise waste. Stabilization of industry is a crying need, and also an engineering problem. Labor, capital, management and the consuming public stand to gain if common constructive action can be taken to lessen the idleness of men, idleness of productive equipment and the utilization of material."

The Council gave formal approval to the action of the committee on procedure requesting that President Harding put an engineer on the Interstate Commerce Commission. The procedure committee was authorized to name six qualified engineers when requested to do so. Activity in behalf of a National Department of Public Works will be continued by the Council through the public affairs committee. It was recommended that engineering efforts be extended to the whole question of Government reorganization planned under a special congressional committee.

The plan for the registration of engineers as presented in the Council's report was indorsed and the appointment of another committee was authorized.

An invitation from Philadelphia engineers to hold the April meeting in that city was accepted. The June meeting will be held in St. Louis.

The Council decided to recommend to President Harding that an engineer be appointed Assistant Secretary of War. No action was taken relative to the National Civic Federation, Fuel Conservation or Merchant Marine committee appointments.

Alloy Steel Patent Case Before Supreme Court

A case which may have a far-reaching affect on all chemical patents is now before the Supreme Court of the United States. The Churchward International Steel Co. has petitioned for a writ of certiorari in its case against the Bethlehem Steel Co. The Churchward company is the owner of certain patents covering alloy steel. It is alleged that the Bethlehem Steel Co. has infringed on these patents. The issue in the case, however, is the validity of the patents. The trial court found them to be valid and infringed. The Circuit Court of Appeals for the Third Circuit, however, reversed the lower court on the validity of the patents. The Circuit Court of Appeals' finding was based on an assumed inutility of the patent alloys and on an assumed lack of novelty in the alloy composition.

The Churchward company makes the point that if the patent alloys are of no special merit the Bethlehem company would be in the position of defrauding the Federal Government for selling such steel at a price of \$800 per ton. More-

over, it is pointed out that if the steel made by this formula had no special merit the safety of naval officers and sailors was menaced by the use of this steel in naval craft. The Churchward company also claims in its petition to the Supreme Court that if the decision of the Circuit Court of Appeals should be allowed to stand it would "result in the imposition of the burden of proof on inventors in the chemical arts, not imposed on any inventor in the mechanical arts, and a burden which has no statutory foundation, for Judge Woolley holds that to be patentable a chemical composition must be not only new, original and useful but must possess marked superiority. Such a doctrine is in conflict with the established precedence in the mechanical arts, where the similar test of patentability is one of utility and not of comparative utility."

The Churchward company states in its petition to the court that the Carnegie Steel Co. had infringed on these patents but that the matter had been settled out of court by payment of \$275,000.

Plan Symposium on Drying for Rochester Meeting, A.C.S.

The Division of Industrial and Engineering Chemistry will hold a symposium on drying at the Rochester meeting of the American Chemical Society during the week of April 25, giving particular attention to the six points of interest to the chemical engineer. These points have been selected as follows:

1. Transmission and distribution of heat in drying.
2. Temperature control of material in drying.
3. Effect of atmospheric conditions in drying.
4. Economy in drying.
5. Cost of drying.
6. Solvent recovery.

Thus far papers have been obtained from authorities on rotary driers, solvent recovery, compartment driers, vacuum drying and spray drying.

The chairman of the committee organizing this symposium is Charles O. Lavett, of the Buffalo Foundry & Machine Co., Buffalo, N. Y.

Industrial Survey Being Made at Old Hickory

As a part of its plan for industrial development at Old Hickory the Nashville Industrial Corporation is having a survey made of the whole powder plant. This investigation, which is being conducted by Meigs, Bassett & Slaughter, Inc., chemical engineers, of Philadelphia, will cover in detail possible uses for and means for disposing of the various units of the plant, which include:

Fifteen contact sulphuric acid plants, 7 nitric acid plants, 7 cotton purification plants, 7 cotton dry houses, 9 nitrating houses, 5 mix and weigh houses, 9 boiling tub houses, 9 pulping houses, 9 poacher houses, 16 solvent recovery houses, 1 diphenylamine plant, 1 causticizing plant, 4 box factories, 3 chemical laboratories, 3,500-ton refrigerating plant.

The diphenylamine plant is especially adaptable for a dye-making company, and is a separate and distinct unit in itself, having a 1,500-hp. steam plant, its own refrigerating system, independent warehouses, a hospital and a restaurant. It is located sufficiently distant from the village to protect the inhabitants from any fumes therefrom.

Some of the factors which are favorable to the establishment of manufacturing plants at Old Hickory may be summarized as follows: A power plant capable of supplying more steam and electricity than a community of 30,000 could use; a water reservoir and filtration plant which could meet the needs of a city the size of Boston; 1,138 six-room houses for which only a small rental is asked; excellent sanitary arrangements.

Duty on Potash Asked

A duty of 50c. a unit on imports of potash has been asked by the United States Potash Producers Association. Wilbur LaRoe, Jr., appeared for the domestic producers. He laid particular stress on a statement that the potash industry has a highly diversified ownership and that it is in no way controlled or influenced by the packing industry. Mr. LaRoe points out that the duty asked is only 20 per cent of the present price of potash. He stated that the industry was born under war conditions when potash was worth \$5 a unit. He said that the freight rate from the West to the East is 60c. a unit. In connection with his testimony, Mr. LaRoe submitted a number of tables, among which are the following:

POTASH PRODUCTION AND CAPITALIZATION, 1920

	Number of Producers	Production, Salts, Tons	Production, K ₂ O, Tons	Per Cent of Total	Capital Invested
Natural Brines:					
Nebraska lakes..	8	84,168	21,439	44.0	\$7,846,000
Other brines....	5	52,151	16,688	34.3	12,889,782
Alunite, silicates and kelp.....	5	4,562	2,282	4.7	4,070,000
Molasses distil- lery waste ...	4	9,882	3,433	7.1	717,861
Sugar mills.....	3	8,609	3,325	6.8	921,000
Blast-furnace dust.....	5	2,102	155	0.4	3,000
Cement-mill dust	5	12,071	1,035	2.1	2,021,000
Wood ashes.....	19	453	299	0.6	227,500
Total.....	53	173,998	48,656	100.0	\$28,696,143

POTASH PRODUCTION BY STATES

State	Number of Plants	Available Quantity, Short Tons	Content of Potash (K ₂ O) Percentage of Total
Nebraska.....	8	21,439	44.0
California.....	11	12,013	24.7
Utah.....	3	10,282	21.1
Pennsylvania.....	5	183	.4
New York, New Jersey and Maryland.....	4	1,739	3.6
Virginia, Ohio, Colorado, and Porto Rico...	4	2,733	5.6
Wisconsin.....	10	231	.5
Michigan.....	8	64	.1
Total.....	53	48,684	100.0

The American Fertilizer Industry

The present status and tendencies in the fertilizer industry were discussed from many points of view at a symposium of the Chemical Society of Washington on Feb. 10. At this meeting fertilizer use, phosphates, potash, nitrogen resources, fertilizer utilization and the future prospects of concentrated chemical fertilizers were all discussed by specialists in these fields.

TENDENCIES IN FERTILIZER INDUSTRY

William D. Hurd, director of the soil improvement committee of the National Fertilizer Association, summarized the present tendency of the industry. The relation of fertilizer use to the quality and quantity of crops produced was especially emphasized, and it was pointed out that this, the largest heavy chemical industry, is operating through 700 plants which produced in 1920 over 7,000,000 tons of product valued at over a quarter of a billion dollars. Some of the tendencies of the industry are particularly important. Those emphasized by Mr. Hurd were: A change from scavenger to chemical industry; the production of fewer brands; the use of higher percentages of plant foods in the fertilizers; the sale on the basis of pounds of plant food required per acre instead of pounds of fertilizer per acre; the use of domestic sources of raw materials previously imported; the adaptation of fertilizers to plant needs with particular attention to plant physiology; a clearer recognition of proper selling methods and an improved standard of ethics throughout the industry; the tendency to throw aside old long-held fallacies and emphasize the scientific business of farming.

PHOSPHATES AND PHOSPHORIC ACID

W. H. Waggaman of the Bureau of Soils discussed the present phosphate situation and certain suggestions for phosphoric acid production in relation to fertilizer development. He pointed out that America is independent of foreign sources of phosphate, a condition quite in contrast

to that found during the war period with respect to nitrogen and potash, the two other important fertilizer constituents. It is estimated by the Bureau of Soils that there is a reserve of phosphate materials of at least ten billion tons. These reserves are being drawn upon extensively in Florida, Tennessee and South Carolina and to a very much lesser degree elsewhere. These three states furnished approximately 2,500,000 tons, 500,000 tons and 50,000 tons respectively in 1920. The most serious aspect of the phosphate development is the large waste due to washing and screening of the product during preparation. It is estimated that only 15 per cent of the rock mined is saved and that more than twice as much phosphate goes on to the dump as to the market.

It was the effort to save these wastes of phosphate that led the Bureau of Soils several years ago to develop a pyrogenic method for phosphoric acid production which has been described (see *CHEMICAL & METALLURGICAL ENGINEERING*, p. 1057, Dec. 1, 1920). It is believed that the process described can be operated electrically to give phosphoric acid as cheaply as from the sulphuric acid method when power is available at \$25 per hp.-yr. When oil-firing is used the cost for fuel is only one-third. Hence under most circumstances it is believed that this will be a most economical system. The application of the phosphoric acid to phosphate rock produces the most concentrated phosphate fertilizer, perhaps best characterized as "treble" phosphate because it contains about three times the available P₂O₅ that is usual.

EFFECT OF BORAX

In a number of cases the problem of borax has been considered very serious. In fact during a single year the losses due to borax in the salt resulted in tremendous losses especially to Maine potato crops. A full discussion of this point at the meeting showed that it is no longer a problem to be feared, as salts well under one-half of 1 per cent borax are now supplied and in every case a guarantee not to exceed 1 per cent can be observed.

NITROGENOUS MATERIALS

Nitrogen resources and the possibilities and requirements of the country were discussed by Captain D. P. Gaillard of the Nitrate Division of the Ordnance Department. He pointed out the import situation, the relative importance of domestic nitrogen sources and the present status of nitrogen demand with prophecies for ten years to come. These phases of the subject have already been fully discussed in *CHEMICAL & METALLURGICAL ENGINEERING*, vol. 22, pp. 783 and 841.

CO-ORDINATION OF SOIL, PLANT AND FERTILIZER

Dr. Oswald Schreiner of the Bureau of Plant Industry pointed out in his discussion that fertilizer as applied to the soil is really a raw material of food production and agricultural manufacture. Viewed from this standpoint, it is necessary in fertilizer utilization to plan upon proper co-ordination of soil, plant and fertilizer. The work of the Bureau of Plant Industry on this subject was described by Dr. Schreiner particularly with reference to the proper selection of fertilizer types for different soil types.

POTASH SITUATION

The potash situation of today was discussed by F. W. Brown, secretary of the U. S. Potash Producers Association. Mr. Brown contrasted the present situation under which many potash producers of America have been compelled to suspend operations with the conditions which prevailed during the war period. He estimated that the production in 1920 amounted to 175,000 tons of potash salts, or 40,000 tons of K₂O. Of this the Nebraska lakes supplied 44 per cent, other brines 34 per cent. At the present time most of the small Nebraska plants are closed, but eight of the large companies are still operating. Whether they will continue successfully depends upon the measure of protection granted as a result of the present tariff legislation.

The 1920 potash operations demonstrated, according to Mr. Brown, one very important fact—namely, that these plants could operate on brines containing not over 3½ per cent of solids. The 1920 season was excessively rainy and

operation on these low percentage brines was therefore necessary, whereas previously a 7 per cent brine was considered the minimum which could be commercially worked. In Mr. Brown's opinion, this experience has demonstrated the almost indefinite extension possible in the potash brine development. The separation processes now are giving 45 per cent salt instead of 25 per cent salt formerly supplied and caustic and soda ash are becoming important sources of byproduct income.

CONCENTRATED FERTILIZERS

R. O. E. Davis of the Bureau of Soils discussed the subject "Concentrated Chemical Fertilizers, A Future Prospect." This discussion brought out the possibilities of using as fertilizers potassium and ammonium phosphates and potassium or ammonium nitrates. Two methods of application are available: First, by solution in water and sprinkling upon the land, and second, by mixing with soil on the farm to permit application by drilling into the soil as is now customary with mixer fertilizers.

The discussion of this subject brought out the possibility which is recognized by some that the use of chemical fertilizers may not answer the entire need of the plant any more than use of concentrated food without vitamins will answer the human need for food. However, it was pointed out that the soil as an active bacterial culture, which in effect it is, probably can care for these other needs without the artificial addition of these materials. The discussion also brought out the interrelation of many of the fertilizer problems with other industrial chemical problems of great importance, all of which emphasizes the importance to the chemical industry of this field of industrial activity.

Barrels and Cans for Petroleum Products

The manufacture of barrels and tin cans was explained and illustrated Monday evening, Feb. 7, before the Rochester Section of the American Chemical Society by Florus R. Baxter, chief chemist of the Vacuum Oil Co. Mr. Baxter told how years ago all barrels were made by hand and a man who could make ten or twelve barrels a day was a rapid worker. Now machinery has been invented and improved so that the greater part of the barrels are made by machinery. The present capacity of the Vacuum Oil Co.'s Rochester plant is about one million barrels a year.

To make these million barrels requires an enormous amount of materials—for instance, about eighteen million staves, one million pair of heads, and quantities of iron hoops, glue and paint. About four thousand acres of timber land is required for each year's supply. These timber lands are in Arkansas, Kansas, Kentucky, Tennessee, Alabama, Mississippi, Louisiana and Georgia.

First the lumber camp is established. The trees usually cut are those 50 ft. high and 2 ft. in diameter. No trees less than 14 in. in diameter 7 in. from the ground are cut. It takes about thirty years for the young trees to develop the required size. After the tree has been cut it is sawed into required length for staves or heads. The lengths for the staves are sawed on a cylinder so they are curved a little, and the staves are piled up in the air to dry. After the air-drying they are piled on edge and kiln-dried. The heads are cut out and piled in chimney form to air-dry for from three to six months. The staves and heads are shipped from the lumber camps to the factory.

The actual making of the barrel now begins. The staves are fitted inside a head hoop, and steamed to soften the staves so they may be bent. After bending the truss hoop is then put on and the moisture dried out. The bung hole is next put in. The iron hoops are next riveted together and flared on a machine and put on the barrel in place of the truss hoops. The ends of the staves are beveled and the groove cut to accommodate the heads.

The barrels are then inspected and all worm holes filled. The inside is covered with glue by putting glue inside the barrel and rolling it down an irregular incline so the glue is evenly distributed. Next the barrel is aged for ten or fifteen days, after which the hoops are again driven on. Another heavier coating of glue is put on the inside and allowed to dry. The barrel is then painted and dried, and

painted again and cured in a forced air drier. After inspection it is weighed and the weight stenciled on.

Now the barrels go to the filling room, where they are filled, automatic fillers being used. The bung holes are filled with a wooden plug and the oil is ready for shipment after being weighed and the gallons of oil computed. In the cars the filled barrels must be carefully wedged to keep them from rolling about.

TIN CANS

Mr. Baxter then took up the manufacture of the 1-gal. and 5-gal. tin cans. Most of the tin comes from Cornwall, England, although lesser amounts are found in other parts of the world. The tin is extracted from the ore by roasting. After several washings and smeltings the pure tin is recovered. Sheets of tin plate are formed, using a coating of palm oil, which is later removed by bran or sawdust. Then the sheets are decorated to suit the manufacturer. In this case they are enameled white and the trade mark is stenciled on.

The cans are made on machines which turn a hem on the sheet of tin and later close the seam. The tops and bottoms are put on and the seams soldered. The spout is then put on and after testing the cans go to the filling room. The cases in which the cans are packed are also made at the factory.

Throughout the factory and in the loading of cars, wherever possible, the barrels and cans are transported on conveyors.

Average Wages in New York Chemical Plants for November, 1920

A report issued recently by the New York State Industrial Commission gives the average weekly earnings in representative manufacturing industries in New York State for November, 1920. Figures for the corresponding month in 1914, 1916, 1918 and 1919 and the per cent increase of

AVERAGE WEEKLY EARNINGS IN NEW YORK STATE FACTORIES

Industry	Average Weekly Earnings in November					Per Cent Increase, 1920 Over 1914
	1914	1916	1918	1919	1920	
Stone, clay and glass products.	\$13.30	16.22	\$23.32	\$26.41	\$32.06	141.1
Miscellaneous stone and mineral products.....	14.60	18.85	23.67	27.82	34.43	135.8
Lime, cement and plaster...	13.18	16.58	25.47	29.55	34.37	160.8
Brick, tile and pottery.....	11.61	13.73	18.81	24.00	28.70	147.2
Glass.....	14.30	15.83	24.41	24.90	31.16	117.9
Metals:						
Gold, silver and precious stones.....	13.09	17.50	24.17	30.68	34.97	167.2
Brass, copper, aluminum, etc.	12.67	16.57	23.09	26.34	29.14	130.0
Pig iron and rolling mill products.....	16.79	21.85	35.34	35.10	40.78	142.9
Leather.....	11.12	15.28	20.40	24.52	26.68	139.9
Rubber and gutta-percha goods	11.41	13.31	17.27	23.57	26.49	132.2
Paper.....	13.28	15.96	23.91	26.71	32.36	143.7
Chemicals, oils, paints, etc....	12.80	15.37	20.96	25.20	28.71	124.3
Drugs and chemicals.....	12.36	15.01	17.90	25.05	27.71	124.2
Paints, dyes and colors.....	14.33	15.38	20.77	23.39	27.13	89.3
Animal and mineral oil products.....	12.93	15.67	23.49	25.76	28.98	124.1
Miscellaneous chemical products.....	12.30	15.94	19.81	24.91	29.61	140.7

1920 over 1914 are given for comparison. Employees in both office and shop are included, the effect of higher office salaries on the average being offset by the small number of office employees. Figures of interest to the chemical and metallurgical fields are given in the accompanying table.

New Tariff for Camphor Proposed

An attempt is being made to embody in the emergency tariff bill a duty of 50 per cent ad valorem on camphor. This step is taken in the interest of the synthetic camphor industry in the United States. The emergency tariff is being confined to agricultural products, but it is being argued that the income from turpentine recoveries forms an essential part of the revenue of farmers in the naval stores belt.

Among the articles added to the emergency tariff bill by the Senate is sugar. An additional duty of 1c. per lb. is provided.

Chicago Chemists' Club Smoker

The members of the Chicago Chemists' Club held an informal smoker at the quarters, 315 Plymouth Court, on Wednesday, Feb. 9. The address of the evening was delivered by Dr. Rollin B. Salisbury, dean of the Ogden Graduate School of Science, University of Chicago, who spoke on the origin of the earth. It seems that the earth is not a hot ball thrown off from the sun as is popularly supposed, but was developed by the accumulation of great numbers of smaller bodies revolving about the sun. The earth is still accumulating such material at the rate of about 50,000,000 meteorites per day. It is estimated that human life existed on the earth at least 1,500,000,000 years ago. He spoke of the work of English scientists in determining the age of rocks by use of radio-active substances. Without reference to religion the principal point of informal discussion centered around the origin of the original mass of matter or nucleus from which the solar system was developed.

The Drying of Paper

The regular February meeting of the Connecticut Valley Section of the Technical Association of the Pulp and Paper Industry was held in Holyoke Tuesday evening, Feb. 15, with an attendance of seventy-five members.

Mr. Farnsworth of the Farnsworth Engineering Co. of Conshohocken, Pa. spoke on "The Drying of Paper," with especial reference to the system developed by his company. He said that drying conditions had been the subject of investigation for years, for proper drying constitutes one of the fundamentals of paper manufacture. The introduction of any system to the industry as a whole is virtually impossible. In fact, he said that strictly speaking his own company had no real system, for each paper machine represented a different problem. The many grades of paper made and the many different types of machines in use rendered anything standard out of the question. It is possible to start out with one general outline of procedure and vary the details according to conditions.

The system which he has worked out depends for its efficiency on being entirely closed. By means of special valves it is possible to keep the condensate under pressure and return it to the boilers at a high temperature, thereby saving a large amount of heat. In such cases the volume of make-up water added to the system to replace losses is very small. The essential feature in the system consists in passing steam through a reducing valve set at any desired pressure and then to a number of drying rolls on the dry end. These driers are in parallel and the amount of steam entering each one is controlled by a throttle valve.

The exhaust steam from this set of driers is collected in a header, the condensed water trapped off and the balance of the steam passes directly into a set of driers at the wet end. The amount of condensate here is much greater than at the dry end and the number of driers in the set is adjusted so as to make the condensation cause sufficient reduction in pressure to pull the steam rapidly through the first series of driers and thereby prevent the accumulation of condensed water in the drying cylinders and at the same time to remove air from them.

Steam coming out of the driers at the wet end flows into a special apparatus where the make-up water is added as a spray, thereby condensing part of the steam and creating enough reduction in pressure to insure a rapid flow of steam through all the driers at the wet end.

All this condensed water is above the boiling point; its exact temperature depends on the conditions of operation of the paper machine and the pressure maintained. It is collected in special tanks and blown back to the boiler feed tank by high pressure steam let in at the top of the collecting tanks by an automatic valve arrangement which operates only when the tank is full.

For most paper machines the driers may be divided into two sets in series parallel arrangement, although more divisions may be necessary for certain types, especially of board machines.

The problem of proper drying, he said, consists in getting a gradual rise in temperature all the way along the driers

with the wet end at the lowest temperature. This must be done in such a way as to get the greatest economy in steam possible in order to meet modern industrial conditions.

Meeting of the New York Chapter of the American Society for Steel Treating

The New York Chapter of the American Society for Steel Treating held its meeting on Feb. 15, at the Machinery Club, New York City. Colonel A. E. White, the national president of the society, was the speaker of the evening. He outlined the present status of the society and said that during the short period of its existence the membership has grown to 2,959 and that since September, 1920, three new chapters have been instituted (Syracuse, N. Y., Charleston, W. Va., and Gary, Ind.) and that the next annual meeting would in all probability be held at Indianapolis, Ind. He then presented his paper on "Alloy Steel, Its Rise and Secrets."

Colonel White reviewed the great importance of iron in our present-day life and the history of the rapid growth of the steel industry in the United States. Electric steel, which was first manufactured here in 1908, reached a production of about 511,000 tons in 1918 and about 2,000,000 tons in 1920 and is steadily gaining in favor. The growing demands of the automobile industry and of armaments have influenced the development of the alloy steel industry. He then spoke on the theories proposed by Osmond and Edwards on the relations which exist between the elements and their influence in alloy steels. Osmond classified the main elements entering into alloy steels according to their

atomic volume $\left(\frac{\text{atomic weight}}{\text{specific gravity}} \right)$ and grouped them into two

classes according to whether the atomic volume is below or above 7.2 thus:

Class I		Class II	
Element	Atomic Volume	Element	Atomic Volume
C	3.6	Cr	7.7
B	4.1	W	9.6
Ni	6.7	Si	11.2
Mn	6.9	As	13.2
Cu	7.1	P	13.5
		S	13.7

Edwards uses the classification as given in Mendeleef's periodic table of elements. Colonel White also spoke of the laws of Léon Guillet on the influence of the variations of the carbon content, or of the special elements, or of both, on the constitution of the alloys. A series of equilibrium diagrams were shown to illustrate the theory of the coefficients of equivalence as applied to alloy steels. (Guillet's theory of the coefficient of equivalence as applied to ternary alloys was published in *CHEMICAL & METALLURGICAL ENGINEERING* of Jan. 26 and Feb. 9, 1921, pp. 177 and 261.)

In the discussion that followed it was brought out that zirconium steel does not present any special useful property at present known.

Alleged Gas Injuries Being Investigated

Manufacturing chemists are being asked by the Chemical Warfare Service for data in regard to the effects of gases on workers. It is believed that valuable information can be secured from chemical plants that have been manufacturing gases over a period of years.

More than 900,000 claims have been filed with the Government for compensation based on injuries received while in the military service. Of this number about 25 per cent are for alleged injuries due to gas. Studies that have been made by officials of the Chemical Warfare Service indicate that injuries from gas usually are as well defined as are wounds from projectiles. They do not take much stock in the claims that there are delayed effects arising from poison gas. They have not been able to trace a single case of tuberculosis which they are satisfied had its origin in gas. In the matter of compensation claims, however, the Government apparently must bear the burden of proof. In that connection General Fries expects to go minutely into the

records of industrial employees who have been handling gases.

The Chemical Warfare Service has undertaken to investigate some of the alleged after-effects of being gassed. In several of the cases it has been shown conclusively that the claimant was in error in his assumption that gas is responsible for his condition.

Paris-Havre Oil Pipe Line Delayed

Owing to the drop in the price of coal in France and the general business depression, work on the proposed oil-pipe line between Havre and Paris has been indefinitely suspended after nearly 20,000,000 f. has been expended on preliminary work. However, plans will be completed by the Stewart Construction Co. of New York with the hope of construction being resumed in ninety days.

The project, which is being financed by the Atlantic & Gulf Refining Co. through a French holding company, was designed to supply cheap fuel to industries in Paris.

Dye Industry Lags Pending Action on Dye Legislation

Hesitancy on the part of dye manufacturers to lay out a definite program of production for 1921 in the face of uncertain dye legislation is shown by their delay in placing contracts for sulphuric and nitric acids. This was brought out in an analysis of contract renewals made by several large acid manufacturers for the purpose of explaining an unexpected decrease in the amount of acid placed on contract.

Personal

Dr. GEORGE BORROWMAN, who for thirteen years was professor of industrial and engineering chemistry at the University of Nebraska, subsequently to which he did some research work with Dr. J. E. Teeple of New York, has recently entered independent practice in Chicago.

A. H. JONES has taken over the metallurgical laboratory and engineering business of Charles Butters & Co., Salt Lake City, Utah, under the name of the A. H. Jones Co.

WILLIAM B. LEACH, JR., has been discharged as Captain, C.W.S., in charge of the Experimental Division, and is now assistant manager at the Mathieson Alkali Works, Inc., Niagara Falls, N. Y.

Dr. JOHN A. MATHEWS has been elected president of the Crucible Steel Co. of America. Dr. Mathews has been identified with the company since 1902, and was vice-president for about a year.

Major J. E. MILLS, professor of chemistry at the University of South Carolina, has been chosen as an official consultant of the Chemical Warfare Service. Major Mills went to France with the first Chemical Warfare troops and was among the last officers of that service to leave that country.

Dr. R. B. MOORE, chief chemist of the Bureau of Mines, has delivered a number of lectures recently on helium, one of which he gave at the University of Illinois Section of the American Chemical Society on Feb. 16.

A. V. H. MORY, of the Procter & Gamble Co., Cincinnati, was in Chicago recently.

J. G. NEWTON, formerly with the Cerro de Pasco Copper Corporation, La Fundicion, Peru, is associated with the American Smelting & Refining Co., Maurer, N. J.

Dr. CHARLES WADSWORTH, 3d, who received the degree of Ph.D. in 1916 from Harvard University and who has recently been in charge of research and developments at the plant of Zinsser & Co., at Hastings-on-Hudson, N. Y., is now chemical engineer with the Grasselli Chemical Co. at East Chicago.

Book Reviews

TEXTBOOK OF CHEMISTRY FOR NURSES AND STUDENTS OF HOME ECONOMICS. By *Annie Louise Macleod*. New York: McGraw-Hill Book Co. 180 pages, illustrated. Price \$2.25.

In this textbook the author has presented the subject in a manner readily understood by a layman, giving in a practical way the chemical principles underlying nutrition, dietetics and cookery. Nurses of the present day customarily have at least a high school education, which gives them more than sufficient knowledge of chemistry to make the book readily understood and applied. The author has kept her work well within the scope indicated by the title, as a consequence of which it can be purchased by nurses and students of home economics with the assurance that it will meet their needs.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, Feb. 18, 1921.

A marked improvement has taken place in the demand for general chemicals during the past week. All signs point to better business in the very near future and prices are showing more stability in many directions. Resumption of operation is going on steadily among textile mills and tanneries as well as in other branches of the consuming trades. A gradual expansion is also noted in the call for export shipments and inquiries have reached the chemical market from various foreign countries on a fairly large scale. Resale stocks have been steadily decreasing, while the output among large producers has been sharply curtailed. Under this condition manufacturers seem to be in better control of the situation than at any time previously and it looks as though the time is ripe for the pendulum to swing back on price movement. Any large inquiries that have reached the market for spot material have been filled with difficulty, and in some instances it has been surprising to see how little actual stock is held by second hands. Liquidation in the past few months has been quite thorough and almost every item is in a position to respond to any permanent expansion in the extent of demand.

Among the large chemical items that merited interest was *soda ash*. Inquiries for this basic chemical reached the market from some of the leading foreign countries. The domestic inquiry was also more active and sales of 100-ton lots passed at 2c. per lb. in single bags f.o.b. N. Y. Japan has come into the market again and an inquiry was noted for a large tonnage over the year for ash and caustic soda. Interest on the part of Japan leads prominent factors to believe that the Orient might be one of the first sections to recover from the present industrial slump. *Bichromate of soda* attracted attention at prices ranging from 8½¢@8¾¢. lb. Spot material showed a firmer tendency during the week and there appeared to be relatively little stock offered among second-hand interests. Sales of late have been confined mostly to small lots and it is said to be doubtful if a round quantity could be purchased without advancing quotations. Resale lots of light *soda ash* were offered sparingly at prices ranging from \$2.10@2.20 per 100 lb. in single bags. Barrels were quoted firm at 2½¢. lb. with only an odd car available here and there. Producers' prices for contracts still remain unchanged at \$1.72½ per 100 lb., bases 48 per cent, f.o.b. works in single bags. Holders of resale *caustic soda* are asking \$3.90@\$4 per 100 lb. in most quarters. An odd car could probably be bought at \$3.85 or thereabout, but the general market shows a strong undertone with no apparent pressure of resale stock to record.

Trading continued along quiet lines and the condition was reflected in a slight irregularity of quotations. Small lot sales of solid caustic were reported as high as \$4.10 per 100 lb. Manufacturers' contract prices remained unchanged at \$3.60 per 100 lb., basis 60 per cent, f.o.b. works for prompt and future shipments.

Sellers of *aluminum sulphate*, iron free, are quoting the market at prices ranging from 3½@4c. per lb., depending upon the quantity of the inquiry. The movement of late has been along quiet lines. Moderate quantities of the commercial variety are offered at 2½@2¾c. per lb. Spot *formaldehyde* in the open market is offered at 17½c. per lb. and it is intimated that actual round lot business would shade this figure. The demand is fair, with competition rather keen to secure what business is passing. Dealers are quoting moderate quantities of *prussiate of soda* at 16½@16¾c. lb. on spot and in some directions 17c. is asked. Shipments from abroad that are due to arrive this month are offered at 15½c. lb. Domestic producers are holding contract prices firm at 18c. lb. Limited quantities of *yellow prussiate of potash* were offered at prices ranging from 29@32c. per lb. ex-store N. Y., depending on sellers. Supplies of this chemical are said to be low at the present time. Moderate quantities of imported *bleaching powder* were offered by dealers at 2½@2¾c. per lb. on spot. Some interests stated that only small quantities could be purchased at the inside figure and quoted the market as high as 3c. per lb. Small drums were quoted at 3½@3¾c. per lb. according to seller. A fair inquiry was in the market and the tendency was reported firm. Irregular quotations on *nitrite of soda* have been named throughout the entire week. Sellers have quoted as low as 6c. and as high as 9c. per lb. Demand has not shown very much activity and most of the business placed was said to be within the range of 6@6½c. per lb.

Trading in *alcohol* during the past week took on a little more activity both in domestic and foreign quarters. Prices are quoted by leading factors at unchanged levels, but in view of the strong competition it is quite possible to do business at lower figures. *Ethyl alcohol* ranges from \$5.25@ \$5.50 per gal. for domestic consumption, while for export 55@58c. per gal. is heard. *Denatured* ranges from 54@60c. per gal. Pure *methanol* is offered at \$1.50 per gal., although the regular market is quoted at \$1.60.

COAL-TAR PRODUCTS

The tone of the coal-tar products market has improved somewhat during the past week and reports from various quarters of the allied markets are very encouraging from the standpoint of a wider spread of operations and the handling of orders on a larger volume. There is still little talk along contract lines. In the crude products the tendency is steady and some of the items are moving freer. *Benzene* is firmly held in first hands at 30@36c. per gal. *Naphthalene* flakes, prime quality, holds at 9c. per lb. and in second hands at 8@8½c. Dealers' offerings of intermediates have been available in various quarters and sellers have shown little intention of naming any lower levels among their offerings. First hands are quite steady in their views with their prices listed somewhat higher, although firm orders on round lots might bring about shading.

Aniline oil seemed to be easy in some quarters while *para-nitraniline* is reported firm, with one manufacturer quoting \$1.05 per lb. on contract basis. Producers of *beta naphthol* are firm in their views on prices and quote on a basis of 42@45c. per lb. Offerings of cheap resale lots have been diminishing of late and the best quotation obtainable was 32c. per lb. The consuming element of *dimethylaniline* is still holding to a hand-to-mouth buying. Producers are firm in their views at 60@65c. per lb., while resale material ranges from 50@55c. Factors report the market for *meta-phenylenediamine* rather dull, with material available in fair volume and moving slowly in a routine manner on a basis of \$1.25@\$1.30 per lb. A fairly steady demand of a routine nature continues for *monochlorbenzene*. Producers report a regular output and quote prices steady at 14@16c.

per lb. Manufacturers of *para-phenylenediamine* seem to be in fair supply while the outside market has little to offer. Trading is picking up and prices are holding steady at \$1.90@\$2.20 per lb. A steady improvement in the fur industry will help bring about more stabilized prices for this commodity.

VEGETABLE OILS

The spot market for *chinawood oil* was irregular, with prices ranging from 9¼@10c. per lb. On the Pacific Coast prices were quotably unchanged at 8c. per lb. sellers' tanks and 8¼c. in cooperage. Trading in *coconut oil* was quiet, but prices showed very little change locally. *Ceylon oil* was held around 8½c. lb. sellers' tanks f.o.b. New York. There was a good call for spot *olive oil* and with supplies cleaned up the market at the close was more or less nominal. The uplift in exchange caused some operators to advance their prices for *palm oil* for shipment. *Lagos* closed at 7¾@7½c. per lb. c.i.f. New York. The market for crude *soya bean oil* was a dull affair among local dealers. Importers quote the market for shipment goods at 4¾@5c. per lb. sellers' tanks. For jobbing lots in barrels 7½@8c. per lb. seem to be the general quotations.

The Iron and Steel Market

PITTSBURGH, Feb. 18, 1921.

Last week's report noted that the steel market had suddenly begun to break. A week's experience with the "break" shows that it is a very tame affair indeed, altogether lacking in vitality. It is simply a case of the buying demand being so extremely light that it could not nurture a real break. This break is therefore altogether different from the various breaks in the steel market that have occurred in the past. The normal course in a break is for some mills to name cut prices and get some orders, whereupon other mills cut lower and get orders for themselves, other mills, or the first mills, then making fresh cuts, and so on. There must be some buying on the way down.

At the present writing many of the independent mills are naming cut prices from the Industrial Board or Steel Corporation prices, but a larger number are not, because they have not the opportunity. They are prepared to sell at reduced prices, but are awaiting bids by customers, or the expression of a willingness to buy.

Lowest prices actually done or quoted to date, as compared with the Steel Corporation prices, which represented the whole market after the independents reduced their prices to the corporation level late in 1920, are as follows: Bars, 2c., against 2.35c.; shapes, 2.25c., against 2.45c.; plates, 2.25c., against 2.65c.; plain wire, 3c., against 3.25c.; nails, \$3.10, against \$3.25; hoops, 2.85c., against 3.05c.; blue annealed sheets, 3.20c., against 3.55c.; black sheets, 4.15c., against 4.35c.; galvanized sheets, 5.35c., against 5.70c. Thus the declines range in general from \$4 to \$8 a ton.

In practically all the commodities mentioned there are mills willing to accept orders, if of reasonable size, at still lower prices. It is believed, for instance, that on a 5,000-ton order for plates 2c. could be done.

The trade generally attributes the starting of the break in the market to the Midvale Steel & Ordnance Co., which undoubtedly was the first interest to quote deep cuts to the trade at large. Inasmuch, however, as other independents within a few days decided also to make large concessions, even though they observed the Midvale company was not getting much business, the distinction is not an important one. It looks as though others would have taken the initiative within a short time if Midvale had not done so.

ATTITUDE OF INDEPENDENTS

The usual philosophy of steel makers, in a period of light demand, is that there is no use in reducing prices when buyers are not ready to take hold. Such a philosophy applied to the present situation would not countenance the price concessions that are so readily available. There is,

however, a difference, a situation that never before existed when the market was dull, the difference being that the Steel Corporation has been running at a high rate. From Dec. 1 to Jan. 15 the Steel Corporation produced at the rate of approximately 92 per cent of capacity, while the independents averaged a rate of scarcely more than 25 per cent, certainly not more than 30 per cent. In 1908 prices were maintained fairly well, but at that time the Steel Corporation's operations did not average as high as those of the independents. That was known at the time, and can be seen in the official statistics since compiled. Possibly the independents had no objection to the Steel Corporation running so well when they were almost idle, except for one circumstance, that consumers were getting the product. What the consumers were securing from the Steel Corporation they had no occasion to get from some other producer. Some independents felt that a redistribution, or a fresh start, was desirable from their viewpoint.

The Steel Corporation's operations were marked for a decline, but the break in independent steel prices is now causing the decline to be more rapid. The corporation operated at about 92 per cent of capacity in the fore part of January, and at somewhat under 90 per cent toward the close of the month. Its operations this week may be estimated at about 80 per cent, and the present outlook is that operations will decline at the rate of several per cent a week. Even at the beginning of the year some of the corporation customers were receiving more steel than they were currently consuming. With prices breaking, these buyers are unwilling to continue piling steel, and suspensions of shipment have become common. In some commodities the corporation's decrease in production in the next few weeks will not be fully equal to the decrease in shipping instructions, since the corporation can make stocks. This is quite feasible, as the corporation's production costs, while high, are not really excessive. The independents as a rule allowed their costs to mount so in 1920, when the money came in so easily, that it would be quite unbusinesslike now to make any stocks.

THE FUTURE

The first recasting of the steel market will require only a few weeks. Depending on the volume of buying, now too light to make a real market, the independents may develop something like a stable market. Then there is the Steel Corporation to be considered. It is not a question of whether the corporation will reduce its prices, but a question of when it will do so. The corporation may decide to reduce its prices when its operations get down to 60 per cent or 50 per cent or it may not reduce until it is operating at a lower rate than the independents.

As to demand, there will necessarily be an increase in the near future, for the present demand, in the open market, is almost nothing. The steel industry's capacity in finished rolled steel is in the neighborhood of 150,000 net tons per working day. The buying this week is not at a rate 10 per cent of that. The possibility of full operation again is such an indefinite one that it is not the subject of prediction or even conjecture. The nearby future presents a prospect of all mills striving to reduce their production costs, both for the purpose of being able to take orders without loss and for the purpose of broadening the demand for steel, which as a construction material must be at attractive prices. To illustrate, an estimate is made that of all the large skeleton steel or skyscraper office and hotel buildings in the country 85 per cent are built with steel contracted for when the steel market was at one of its low points.

PIG IRON

Since Jan. 1 the nominal market on bessemer iron has been \$32 valley, basic being nominally \$30. Of late it has been well known that steel interests, having surplus pig iron, would sell at much less, but actual quotations have been lacking. A large valley merchant interest has now voluntarily announced its asking prices at \$29 for bessemer and \$27.50 for basic, f.o.b. valley furnaces. There is no inquiry. Foundry iron remains nominally quotable at \$28 valley.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.		\$0.55 - \$0.60
Acetone.....lb.	\$0.13 - \$0.13	13½ - 14
Acid, acetic, 28 per cent.....100 lbs.	3.00 - 3.25	3.50 - 3.75
Acetic, 56 per cent.....100 lbs.	6.00 - 6.25	6.50 - 6.75
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.50 - 11.00	11.25 - 11.50
Boric, crystals.....lb.	14½ - 15	15½ - 16
Boric, powder.....lb.	15½ - 16½	17 - 18
Citric.....lb.		46 - 48
Hydrochloric.....100 lb.	1.60 - 1.75	1.85 - 2.25
Hydrofluoric, 52 per cent.....lb.	15 - 16	16½ - 18
Lactic, 44 per cent tech.....lb.	10 - 11	11½ - 12
Lactic, 22 per cent tech.....lb.	04½ - 05½	06 - 07
Molybdic, C. P.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.		
Nitric, 40 deg.....lb.	07 - 07½	08 - 08½
Nitric, 42 deg.....lb.	08½ - 09	09½ - 10
Oxalic, crystals.....lb.	18 - 18½	18½ - 19
Phosphoric, Ortho, 50 per cent solution, lb.	15 - 15½	16 - 16½
Picric.....lb.	30 - 32	35 - 40
Pyrogallie, resublimed.....lb.		2.30 - 2.40
Sulphuric, 60 deg., tank cars.....ton		14.00 - 15.00
Sulphuric, 60 deg., drums.....ton		
Sulphuric, 66 deg., tank cars.....ton	18.00 - 19.00	
Sulphuric, 66 deg., drums.....ton	21.00 - 22.00	22.50 - 23.00
Sulphuric, 66 deg., carboys.....ton		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 - 24.00	
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 - 35.00	40.00 -
Tannic, U. S. P.....lb.		1.15 - 1.25
Tannic (tech.).....lb.	45 - 47	48 - 50
Tartaric, crystals.....lb.		35 - 38
Tungstic, per lb. of WO.....lb.		1.00 - 1.20
Alcohol, Ethyl.....gal.		5.25 - 5.50
Alcohol, Methyl (see methanol).....gal.		
Alcohol, denatured, 188 proof.....gal.		54 - 57
Alcohol, denatured, 190 proof.....gal.		58 - 60
Alum, ammonia lump.....lb.	04½ - 04½	05 - 05½
Alum, potash lump.....lb.	05½ - 06	06½ - 07
Alum, chrome lump.....lb.	13 - 13½	14 - 14½
Aluminum sulphate, commercial.....lb.	02½ - 02½	02½ - 03
Aluminum sulphate, iron free.....lb.	03 - 03½	03½ - 03½
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	07 - 07½	07½ - 08
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	30 - 32	33 - 35
Ammonium carbonate, powder.....lb.	11½ - 11½	12 - 12½
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	07½ - 07½	08 - 08½
Ammonium chloride, granular (gray salamoniac).....lb.	09 - 09½	09½ - 10
Ammonium nitrate.....lb.	09 - 09½	10 - 10½
Ammonium sulphate.....100 lb.	3.25 - 3.35	3.40 - 3.60
Amylacetate.....gal.		4.25 - 4.50
Amylacetate tech.....gal.		3.50 - 3.75
Arsenic oxide, (white arsenic).....lb.	10½ - 10½	10½ - 11
Arsenic, sulphide, powdered (red arsenic).....lb.	14 - 14½	15 - 15½
Barium chloride.....ton	65.00 - 70.00	75.00 - 80.00
Barium dioxide (peroxide).....lb.	24 - 25	26 - 27
Barium nitrate.....lb.	10 - 10½	10½ - 11
Barium sulphate (precip.) (blanc fixe).....lb.	04½ - 05	05½ - 06
Bleaching powder (see calc. hypochlorite).....lb.		
Blue vitriol (see copper sulphate).....lb.		
Borax (see sodium borate).....lb.		
Brimstone (see sulphur, roll).....lb.		
Bromine.....lb.	50 - 52	54 - 56
Calcium acetate.....100 lbs.	2.00 - 2.05	
Calcium carbide.....lb.	04 - 04½	04½ - 05
Calcium chloride, fused, lump.....ton	27.00 - 29.00	30.00 - 32.00
Calcium chloride, granulated.....lb.	01½ - 02	02½ - 02½
Calcium hypochlorite (bleach'g powder).....lb.	02½ - 03	03½ - 03½
Calcium peroxide.....lb.		1.00 - 1.10
Calcium phosphate, monobasic.....lb.		15 - 16
Camphor.....lb.		75 - 80
Carbon bisulphide.....lb.	08 - 08½	09 - 09½
Carbon tetrachloride, drums.....lb.	11½ - 11½	12 - 12½
Carbonyl chloride (phosgene).....lb.		75 - 1.00
Caustic potash (see potassium hydroxide).....lb.		
Caustic soda (see sodium hydroxide).....lb.		
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	09 - 09½	10 - 10½
Chloroform.....lb.		38 - 40
Cobalt oxide.....lb.		3.00 - 3.10
Copper as (see iron sulphate).....lb.		
Copper carbonate, green precipitate.....lb.	22 - 22½	24 - 25
Copper cyanide.....lb.		50 - 60
Copper sulphate, crystals.....lb.	06 - 06½	06½ - 07
Cream of tartar (see potassium bitartrate).....lb.		
Epsom salt (see magnesium sulphate).....lb.		
Ethyl Acetate Com. 85%.....gal.		1.05 - 1.10
Ethyl Acetate pure (acetic ether 98% to 100%).....gal.		
Formaldehyde, 40 per cent.....lb.	17½ - 17½	18 - 18½
Fusel oil, ref.....gal.		3.50 - 3.60
Fusel oil, crude.....gal.		2.75 - 3.00
Glauber's salt (see sodium sulphate).....lb.		20 - 21
Glycerine, C. P. drums extra.....lb.		3.85 - 4.00
Iodine, resublimed.....lb.		10 - 20
Iron oxide, red.....lb.		17.50 - 20.00
Iron sulphate (copperas).....100 lb.	1.25 - 1.50	
Lead acetate, normal.....lb.		14½ - 16
Lead arsenate (paste).....lb.	11 - 12	12½ - 13
Lead nitrate.....lb.		15 - 20
Litharge.....lb.	08½ - 09	09½ - 10
Lithium carbonate.....lb.		1.25 -
Magnesium carbonate, technical.....lb.	10½ - 11	11½ - 12
Magnesium sulphate, U. S. P.....100 lb.	2.00 - 2.50	
Magnesium sulphate, commercial.....100 lb.		1.50 - 1.75
Methanol, 95%.....gal.		1.28 - 1.30
Methanol, pure.....gal.		1.60 - 1.65
Nickel salt, double.....lb.		12 - 12½
Nickel salt, single.....lb.		13 - 13½
Phosgene (see carbonyl chloride).....lb.		
Phosphorus, red.....lb.	45 - 46	47 - 50
Phosphorus, yellow.....lb.		35 - 37
Potassium bichromate.....lb.	14 - 14½	14½ - 15

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar) . . . lb.	\$. . . \$. . .	\$0.30 - \$0.35
Potassium bromide, granular . . . lb.		.20 - .40
Potassium carbonate, U. S. P. . . . lb.	.35 - .40	.45 - .50
Potassium carbonate, crude . . . lb.	.08 - .08½	.09 - .10
Potassium chlorate, crystals . . . lb.	.08 - .10	.11 - .18
Potassium cyanide . . . lb.		.65 - .70
Potassium hydroxide (caustic potash) . . . lb.	.12 - .12½	.13 - .13½
Potassium muriate . . . ton	70.00 - 75.00	
Potassium iodide . . . lb.		3.00 - 3.20
Potassium nitrate . . . lb.	.09½ - .09½	.10 - .12½
Potassium permanganate . . . lb.	.48 - .50	.52 - .60
Potassium prussiate, red . . . lb.	.50 - .52	.53 - .55
Potassium prussiate, yellow . . . lb.	.28 - .29	.30 - .32
Potassium sulphate (powdered) . . . per unit		 2.25
Rochelle salts (see sodium potas tartrate)		
Sal ammoniac (see ammonium chloride)		
Sal soda (see sodium carbonate)		
Salt cake . . . ton		32.00 - 33.00
Silver cyanide . . . oz.		1.25 - . . .
Silver nitrate . . . oz.		.43½ - .44
Soda ash, light . . . 100 lb.	2.10 - 2.20	2.25 - 2.40
Soda ash, dense . . . 100 lb.	2.20 - 2.30	2.40 - 2.60
Sodium acetate . . . lb.	.05½ - .05½	.06 - .06½
Sodium bicarbonate . . . 100 lb.	2.50 - 2.75	3.00 - 3.25
Sodium bichromate . . . lb.	.08½ - .08½	.08½ - .09
Sodium bisulphate (nitre cake) . . . ton	7.00 - 7.50	8.00 - 11.00
Sodium bisulphite powdered, U.S.P. . . lb.	.05½ - .05½	.06 - .06½
Sodium borate (borax) . . . lb.	.08½ - .08½	.08½ - .09
Sodium carbonate (sal soda) . . . 100 lb.	2.00 - 2.25	2.50 - 2.75
Sodium chl. rate . . . lb.	.10 - .10½	.10½ - .11
Sodium cyanide, 96-98 per cent . . . lb.	.20 - .21	.22 - .28
Sodium fluoride . . . lb.	.13½ - .14	.14½ - .15
Sodium hydroxide (caustic soda) . . . 100 lb.	3.85 - 3.90	3.95 - 4.25
Sodium hyposulphite . . . lb.		.03½ - .04
Sodium nitrate . . . 100 lb.	2.85 - . . .	3.00 - . . .
Sodium nitrite . . . lb.	.06 - .06½	.06½ - .07
Sodium peroxide, powdered . . . lb.	.30 - .31	.32 - .34
Sodium phosphate, dibasic . . . lb.	.03½ - .04½	.04½ - .05
Sodium potassium tartrate (Rochelle salts) lb.		.29 - .31
Sodium prussiate, yellow . . . lb.	.16½ - .16½	.16½ - .17
Sodium silicate, solution (40 deg.) . . . lb.	1.10 - 1.15	1.20 - 1.40
Sodium silicate, solution (60 deg.) . . . lb.	.02½ - .03	.03½ - .03½
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.75 - 2.00	2.25 - 2.50
Sodium sulphide, crystal, 60-62 per cent (conc.) lb.	.05 - .05½	.05½ - .06
Sodium sulphite, crystals . . . lb.	.04 - .04½	.04½ - .05
Strontium nitrate, powdered . . . lb.	.17½ - .18	.18½ - .18½
Sulphur chl. ride, red . . . lb.	.07 - .07½	.07½ - .08
Sulphur, crude . . . ton	16.00 - 20.00	
Sulphur dioxide, liquid, cylinders . . . lb.	.08 - .08½	.08½ - .09
Sulphur (sublimed), flour . . . 100 lb.		2.25 - 3.10
Sulphur, roll (brimstone) . . . 100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent . . . lb.	.18 - .19	
Tin oxide . . . lb.		.45 - .47
Zinc carbonate, precipitate . . . lb.	.16 - .18	.19 - .20
Zinc chloride, gran . . . lb.	.11 - .11½	.11½ - .12
Zinc cyanide . . . lb.	.45 - .49	.50 - .60
Zinc dust . . . lb.	.12 - .13	.13½ - .14
Zinc oxide, XX . . . lb.	.08½ - .09	.09½ - .11
Zinc sulphate . . . lb.	.03½ - .03½	.04 - .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude . . . lb.	\$1.10 - \$1.15
Alpha-naphthol, refined . . . lb.	1.45 - 1.50
Alpha-naphthylamine . . . lb.	.38 - .40
Aniline oil, drums extra . . . lb.	.21 - .27
Aniline salts . . . lb.	.27 - .30
Anthracene, 80% in drums (100 lb.) . . lb.	.75 - 1.00
Benzaldehyde U.S.P. . . lb.	1.00 - 1.50
Benzidine, base . . . lb.	.95 - 1.05
Benzidine sulphate . . . lb.	.80 - .90
Benzoic acid, U.S.P. . . lb.	.70 - .75
Benzoate of soda, U.S.P. . . lb.	.70 - .80
Benzene, pure, water-white, in drums (100 gal.) gal.	.30 - .35
Benzene, 90%, in drums (100 gal.) . . gal.	.28 - .32
Benzyl chloride, 95-97%, refined . . . lb.	.30 - .35
Benzyl chloride, tech . . . lb.	.25 - .30
Beta-naphthol benzoate . . . lb.	3.50 - 4.00
Beta-naphthol, sublimed . . . lb.	.70 - .75
Beta-naphthol, tech . . . lb.	.32 - .35
Beta-naphthylamine, sublimed . . . lb.	2.25 - 2.40
Cresol, U. S. P., in drums (100 lb.) . . lb.	.16 - .18
Ortho-cresol, in drums (100 lb.) . . lb.	.23 - .25
Cresylic acid, 97-99%, straw color, in drums . . gal.	.95 - 1.00
Cresylic acid, 95-97%, dark, in drums . . gal.	.90 - .95
Cresylic acid, 50%, first quality, drums . . gal.	.60 - .65
Dichlorobenzene . . . lb.	.06 - .09
Diethylaniline . . . lb.	1.20 - 1.30
Dimethylaniline . . . lb.	.55 - .65
Dinitrobenzene . . . lb.	.30 - .32
Dinitrochlorobenzene . . . lb.	.25 - .30
Dinitronaphthalene . . . lb.	.33 - .35
Dinitrophenol . . . lb.	.40 - .45
Dinitrotoluene . . . lb.	.25 - .30
Dip oil, 25%, tar acids, car lots, in drums . . gal.	.37½ - .40
Diphenylamine . . . lb.	.60 - .70
H-acid . . . lb.	1.30 - 1.50
Meta-phenylenediamine . . . lb.	1.25 - 1.30
Monochlorobenzene . . . lb.	.14 - .16
Monoethylaniline . . . lb.	1.75 - 2.00
Naphthalene crushed, in bbls. (250 lb.) . . lb.	.07 - .08
Naphthalene, flake . . . lb.	.08 - .08½
Naphthalene, balls . . . lb.	.08 - .08½
Naphthionic acid, crude . . . lb.	.70 - .75
Nitrobenzene . . . lb.	.12 - .15
Nitro-naphthalene . . . lb.	.30 - .35
Nitro-toluene . . . lb.	.18 - .25
Ortho-amidophenol . . . lb.	3.20 - 3.75
Ortho-dichlor-benzene . . . lb.	.15 - .20
Ortho-nitro-phenol . . . lb.	.75 - .80
Ortho-nitro-toluene . . . lb.	.20 - .24
Ortho-toluidine . . . lb.	.25 - .30
Para-amidophenol, base . . . lb.	1.90 - 2.00
Para-amidophenol, HCl . . . lb.	2.10 - 2.20

Para-dichlorobenzene . . . lb.	.15 - .25
Paranitroaniline . . . lb.	.90 - .95
Para-nitrotoluene . . . lb.	.90 - 1.05
Para-phenylenediamine . . . lb.	1.90 - 2.00
Para-toluidine . . . lb.	1.30 - 1.60
Phthalic anhydride . . . lb.	.55 - .60
Phenol, U. S. P., drums (dest.), (240 lb.) . . lb.	.10 - .12
Pyridine . . . gal.	2.00 - 3.50
Resorcinol, technical . . . lb.	1.85 - 2.00
Resorcinol, pure . . . lb.	2.30 - 2.50
Salicylic acid, tech., in bbls. (110 lb.) . . lb.	.23 - .25
Salicylic acid, U. S. P. . . lb.	.27 - .30
Salol . . . lb.	.85 - .95
Solvent naphtha, water-white, in drums, 100 gal. . . gal.	.28 - .32
Solvent naphtha, crude, heavy, in drums, 100 gal. . gal.	.16 - .18
Sulphanilic acid, crude . . . lb.	.30 - .35
Tolidine . . . lb.	1.35 - 1.45
Toluidine, mixed . . . lb.	.40 - .45
Toluene, in tank cars . . . gal.	.28 - .32
Toluene, in drums . . . gal.	.30 - .35
Xylidines, drums, 100 gal. . . lb.	.40 - .45
Xylene, pure, in drums . . . gal.	.42 - .45
Xylene, pure, in tank cars . . . gal.	.45 - . . .
Xylene, commercial, in drums, 100 gal. . . gal.	.33 - .35
Xylene, commercial, in tank cars . . . gal.	.30 - . . .

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark . . . lb.	\$0.24 - \$0.26
Beeswax, refined, light . . . lb.	.27 - .28
Beeswax, white pure . . . lb.	.40 - .45
Carnauba, Flora . . . lb.	.71 - .72
Carnauba, No. 2, North Country . . . lb.	.30 - .32
Carnauba, No. 3, North Country . . . lb.	.18 - .19
Japan . . . lb.	.19 - .20
Montan, crude . . . lb.	.07 - .08
Paraffine waxes, crude match wax (white) 105-110 m.p. . . lb.	.04½ - .04½
Paraffine waxes, crude, scale 124-126 m.p. . . lb.	.04 - .04½
Paraffine waxes, refined, 118-120 m.p. . . lb.	.04½ - .05½
Paraffine waxes, refined, 125 m.p. . . lb.	.05½ - . . .
Paraffine waxes, refined, 128-130 m.p. . . lb.	.06½ - . . .
Paraffine waxes, refined, 133-135 m.p. . . lb.	.07½ - .07½
Paraffine waxes, refined, 135-137 m.p. . . lb.	.09 - .09½
Stearic acid, single pressed . . . lb.	.12 - . . .
Stearic acid, double pressed . . . lb.	.12½ - . . .
Stearic acid, triple pressed . . . lb.	.13½ - . . .

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940 . . . gal.	\$1.70
Pine oil, pure, dest. dist. . . gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035 . . . gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla. . . gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990 . . gal.	.75
Pine tar, ref., thin, sp.gr. 1.080-1.960 . . . gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970 . . . gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990 . gal.	.37
Pinewood creosote, ref. . . gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B- , bbl. . . 280 lb.	\$7.25 - . . .
Rosin E-I . . . 280 lb.	7.25 - . . .
Rosin K-N . . . 280 lb.	7.25 - . . .
Rosin W. G.-W. W . . 280 lb.	7.50 - . . .
Wood rosin, bbl. . . 280 lb.	7.75 - . . .
Spirits of turpentine . . . gal.	.58 - . . .
Wood turpentine steam dist . . . gal.	.56 - . . .
Wood turpentine, dest. dist. . . gal.	.55 - . . .
Pine tar pitch, bbl. . . 200 lb.	. . . - 8.50
Tar, kiln burned, bbl. (500 lb.) . . . bbl.	. . . - 15.00
Retort tar, bbl. . . 500 lb.	15.00 - 15.50
Rosin oil, first run . . . gal.	.50 - . . .
Rosin oil, second run . . . gal.	.52 - . . .
Rosin oil, third run . . . gal.	.60 - . . .

Solvents

73-76 deg., steel bbls. (85 lb.) . . . gal.	\$0.41
70-72 deg., steel bbls. (85 lb.) . . . gal.	.39
68-70 deg., steel bbls. (85 lb.) . . . gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.) . . gal.	.30

Crude Rubber

Para-Upriver fine . . . lb.	\$0.17 - \$0.18
Upriver coarse . . . lb.	.13 - .14
Upriver caucho ball . . . lb.	.14 - .14½
Plantation—First latex crepe . . . lb.	.19½ - . . .
Ribbed smoked sheets . . . lb.	.18½ - . . .
Brown crepe, thin, clean . . . lb.	.18 - . . .
Amber crepe No. 1 . . . lb.	.20 - . . .

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls. . . lb.	\$0.09½ - \$0.09½
Castor oil, AA, in bbls. . . lb.	.10½ - .11
China wood oil, in bbls. (f.o.b. Pac. coast) . . lb.	.08 - .08½
Cocoonut oil, Ceylon grade, in bbls. . . lb.	.11½ - .12
Cocoonut oil, Cochinchina grade, in bbls. . . lb.	.12 - .12½
Corn oil, crude, in bbls. . . lb.	.08½ - .09
Cottonseed oil, crude (f. o. b. mill) . . . lb.	.05½ - .06
Cottonseed oil, summer yellow . . . lb.	.08½ - .08½
Cottonseed oil, winter yellow . . . lb.	.09 - .09½
Linseed oil, raw, car lots (domestic) . . . gal.	.70 - .71
Linseed oil, raw, tank cars (domestic) . . . gal.	.63 - . . .
Linseed oil, boiled, car lots (domestic) . . gal.	.72 - .73

Olive oil, commercial.....	gal	\$2 40	\$2 60
Palm, Lagos.....	lb.	.07	.07 ¹ / ₂
Palm, Niger.....	lb.	.06 ¹ / ₂	.06 ¹ / ₄
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.06 ¹ / ₂	.07
Peanut oil, refined, in bbls.....	lb.	.12 ¹ / ₂	.13
Rapeseed oil, refined in bbls.....	gal.	1.05	1.10
Rapeseed oil, blown, in bbls.....	gal.	1.15	1.20
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07 ¹ / ₂	.08
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.04 ¹ / ₄	.....

FISH

Light pressed menhaden.....	gal.	\$0 46	\$0 48
Yellow bleached menhaden.....	gal.	.48	.50
White bleached menhaden.....	gal.	.50	.52
Blown menhaden.....	gal.	.85	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	.....
Blanc fixe, dry.....	lb.	.05	.05 ¹ / ₂
Blanc fixe, pulp.....	net ton	50.00	60.00
Casein.....	lb.	.14	.18
Chalk, domestic, extra light.....	lb.	.05	.06
Chalk, domestic, light.....	lb.	.04 ¹ / ₂	.05 ¹ / ₂
Chalk, domestic, heavy.....	lb.	.04	.05
Chalk, English, extra light.....	lb.	.05	.07
Chalk, English, light.....	lb.	.05	.06
Chalk, English, dense.....	lb.	.04 ¹ / ₂	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	17.00
Fullers earth, granular, f.o.b. Fla.....	net ton	25.00	.....
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	.....
Fullers earth, imported, powdered.....	net ton	35.00	40.00
Graphite, crucible, 90% carbon, Ashland, Ala.....	lb.	.....	.09
Graphite, crucible, 85% carbon, Ashland, Ala.....	lb.	.07	.09
Graphite, higher lubricating grades.....	lb.	.11	.40
Pumice stone, imported, lump.....	lb.	.04	.50
Pumice stone, domestic lump.....	lb.	.05	.05 ¹ / ₂
Pumice stone, ground.....	lb.	.06	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	10.00
Quartz (acid tower) 1 ¹ / ₂ @ 2 in., f.o.b. Baltimore.....	net ton	.....	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	7.50
Shellac, orange fine.....	lb.	.65	.....
Shellac, orange superfine.....	lb.	.70	.....
Shellac, A. C. garnet.....	lb.	.57	.....
Shellac, T. N.....	lb.	.55	.....
Soapstone.....	ton	12.00	15.00
Sodium chloride.....	long ton	.....	17.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	15.00
Talc, imported.....	ton	40.00	50.00
Talc, California talcum powder grade.....	ton	20.00	45.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160
Chrome brick, f.o.b. Eastern shipping points.....	net ton	80-100
Chrome cement, 40-45% Cr ₂ O ₃	net ton	45-50
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	-55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50
Magnesite brick, 9-in. straight.....	net ton	100
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105
Magnesite brick, soaps and splits.....	net ton	120
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65-70
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56-61
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	50-60

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	16	.....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	16	17
Ferromanganese, 76-80% Mn, domestic.....	gross ton	95.00	100.00
Ferromanganese, 76-80% Mn, English.....	gross ton	95.00	100.00
Spiegeleisen, 18-22% Mn.....	gross ton	38.00	40.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.00	2.50
Ferrosilicon, 10-15%.....	gross ton	50.00	55.00
Ferrosilicon, 50%.....	gross ton	80.00	85.00
Ferrosilicon, 75%.....	gross ton	150.00	155.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.55	.60
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	7.00	.....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00	5.25

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content, less than 2% Fe ₂ O ₃ , up to 20% silica, not more than H 4% moisture.....	gross ton	\$10.00	\$11.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.55	.60
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.50	.55
Coke, foundry, f.o.b. ovens.....	net ton	6.00	6.50
Coke, furnace, f.o.b. ovens.....	net ton	4.50	5.00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	11.50	12.00
Fluorspar, lump, f.o.b. Heathden, New Mexico.....	net ton	17.50	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	25.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 ¹ / ₂	.01 ¹ / ₄
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.35	.40
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	.60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00	.....
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.16	.....
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.16 ¹ / ₂	.....
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	.14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	3.25
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	.....
Zircon, washed, iron free.....	lb.	.03	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	13.00
Aluminum, 98 to 99 per cent.....	28.3@28.5
Antimony, wholesale lots, Chinese and Japanese.....	5.25
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	.35
Monel metal, ingots.....	.38
Monel metal, sheet bars.....	.40
Tin, 5-ton lots.....	31.50
Lead, New York, spot.....	4.50
Lead, E. St. Louis, spot.....	4.10
Zinc, spot, New York.....	6.00
Zinc, spot, E. St. Louis.....	4.90@5.00

OTHER METALS

Silver (commercial).....	oz.	\$0.66 ¹ / ₂
Cadmium.....	lb.	1.40@1.50
Bismuth (500 lb. lots).....	lb.	2.25@2.35
Cobalt.....	lb.	4.50
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	70.00
Iridium.....	oz.	325.00
Palladium.....	oz.	65.00@70.00
Mercury.....	75 lb.	50.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	21.00
Copper bottoms.....	33.00
Copper rods.....	28.00
High brass wire and sheets.....	18.75
High brass rods.....	16.75
Low brass wire and sheets.....	27.50
Low brass rods.....	18.50
Brazed brass tubing.....	35.25
Brazed bronze tubing.....	40.50
Seamless copper tubing.....	25.00
Seamless high brass tubing.....	24.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	11.50	18.50	10.00	10.50
Copper, heavy and wire.....	11.00	16.50	9.50	9.50
Copper, light and bottoms.....	9.00	14.50	9.00	8.50
Lead, heavy.....	4.00	7.25	4.00	4.00
Lead, tea.....	3.00	5.25	3.00	3.00
Brass, heavy.....	7.00	9.50	7.00	10.00
Brass, light.....	5.50	8.00	5.00	5.50
No. 1 yellow brass turnings.....	6.00	9.50	5.50	6.00
Zinc.....	4.00	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	*Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes.....	\$3.73	\$3.80	\$3.47	\$3.58	\$3.37	\$3.58	\$3.47
Soft steel bars.....	3.93	3.70	3.52	3.34	3.27	3.48	3.52
Soft steel bar shapes.....	3.93	3.70	3.52	3.48	3.27	3.48	3.52
Soft steel bands.....	4.33	4.65	4.22	6.25	.....	.....	.....
Plates, 1/2 to 1 in. thick.....	3.93	4.00	3.67	3.78	3.57	3.78	3.67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

FORDYCE—The Magnolia Petroleum Co. has awarded a contract to Schneider & Camp, Pine Bluff, Ark., for the rebuilding of the portion of its plant, recently damaged by fire with loss reported in excess of \$75,000.

California

PITTSBURG—The Pioneer Rubber Co., San Francisco, has awarded a contract to the Cahill & Vensano Co., 110 Sutter Street, San Francisco, for the erection of a new 1-story, reinforced-concrete plant at Pittsburg, to cost about \$50,500. Construction will be placed under way at once.

Connecticut

NEW HAVEN—The Seamless Rubber Co., Hallock Ave., manufacturer of rubber goods, has filed plans for the erection of an addition to its plant, including improvements to present works to cost about \$400,000, including machinery.

Florida

FERNANDINA—The Seminole Fertilizer & Oil Co. has tentative plans under way for the rebuilding of the portion of its plant recently destroyed by fire.

JACKSONVILLE—The Florida Paint & Cement Co., recently organized, has leased a local building for the establishment of a factory for the manufacture of technical paints. Local offices have been arranged at 302 Hill Bldg. H. A. Wheeler is president.

Georgia

SAVANNAH—The Southern Cotton Oil Co., 120 Broadway, has commenced the erection of its proposed new plant at Savannah for the manufacture of paint products. The factory with machinery is estimated to cost in excess of \$300,000.

Illinois

ALTON—The Consolidated Chemical Products Co. is planning for the erection of an addition to its local plant to be used for the production of muriatic acid and kindred specialties.

Iowa

HAMPTON—The Hampton Brick & Tile Co. is having plans prepared for the erection of a new brick and tile manufacturing plant with main building, 1-story, 40x200 ft., and a number of smaller structures, estimated to cost about \$250,000, including machinery. Claude Smith, Sheffield, Ia., is architect. J. C. Powers is secretary.

Louisiana

LAKE CHARLES—The Builders' Products Co. has plans under way for the erection of a new plant for the manufacture of hollow tile, paving brick and other burned clay products. Samuel Cummings is president.

Maryland

BALTIMORE—The Davison Chemical Co., Garrett Bldg., has arranged for a bond issue of \$2,000,000, the proceeds to be used for financing, operation and expansion. The company specializes in the manufacture of sulphuric acid, acid phosphate and other heavy chemicals. C. Wilbur Miller is president.

BALTIMORE—The Rasin - Monumental Co., National Marine Bank Bldg., a subsidiary of the Virginia-Carolina Chemical Co., Richmond, Va., specializing in the manufacture of fertilizers, has completed plans for the erection of its proposed new plant on the Patapsco River, and will take bids at an early date. The plant will be equipped for an annual production of 125,000 tons, and is estimated to cost about \$1,000,000, including machinery.

BALTIMORE—The Central Chemical Co., Pennington Ave., manufacturer of fertil-

izer products, has preliminary plans under way for the construction of a new building at its works. The company recently increased its capital from \$600,000 to \$1,000,000. M. H. Landers is head.

Massachusetts

MARBLEHEAD—The United States Upper Leather Co. has awarded a contract to the E. H. Porter Co., 15 Wallis St., Peabody, Mass., for the erection of a new 1-story building, 50x150 ft., at 278 B'way, Wyoma, to be equipped as a leather buffing department. Ernest Day is general manager.

RANDOLPH—The Randolph Foundry Co. has commenced the construction of a new 1-story foundry on Pleasant St., 50x75 ft., to cost about \$15,000. John Ferris is head.

Mississippi

NITTA YUMA—The Anguilla Cotton Oil Co. is planning for the rebuilding of the section of its plant destroyed by fire on Feb. 1, with loss estimated at about \$150,000.

Missouri

GERALD—The General Chemical Co., 25 Broad St., New York, is planning to open up a new mine at its local clay properties early in the spring, making the fourth such mine in operation by the company here. Equipment will be installed.

JEFFERSON CITY—John C. Dyott and associates are forming a company to construct and operate a local cement mill. Details of the new plant are being arranged.

Montana

MILES CITY—G. S. Bowser and B. C. Duggan are organizing a company to construct and operate a brick manufacturing plant on the Tongue River, near Fort Keogh, Mont. The plant will have an initial capacity of about 20,000 bricks daily.

New York

MASPETH—The United States Industrial Alcohol Co., 27 William St., New York, has awarded a contract to the George A. Fuller Industrial Eng. Co., 949 B'way, for the erection of its proposed new plant at Maspeth, on site at Grand St. and Harrison Ave. The works will comprise two brick and stone buildings, estimated to cost about \$500,000 with machinery.

NEW YORK—The Tide Water Oil Co., 11 B'way, operating an oil refinery at Bayonne, N. J., has arranged for a bond issue of \$12,000,000, the proceeds to be used for general financing operations and extensions. R. D. Benson is president.

BROOKLYN—The Botts Marking Ink Co., 330 Pearl St., New York, has leased the factory at 68-76 Third St., Brooklyn, for the establishment of a new plant.

BROOKLYN—Constant A. Benoit, Jerome Ave., manufacturer of chemicals, has filed plans for the erection of a new 3-story plant, 151x161 ft., on Ave. Y, near E. 17th St., to cost about \$225,000 with machinery.

North Carolina

GLENDON—The Tale Products Co. is planning for the erection of a new grinding plant with initial capacity of about 50 tons per day.

WITAKERS—The Woodard & Whitley Oil Co. is planning for the rebuilding of the portion of its plant, destroyed by fire on Jan. 22, with loss reported in excess of \$35,000.

WILMINGTON—The Fisheries Products Co. has preliminary plans under way for the construction of a new fertilizer plant on the Cape Fear River. A site has been selected. It is proposed to develop a capacity of about 40 cars of material per day.

Oregon

PORTLAND—The Portland Vegetable Oil Mills Co. has awarded a contract to the Hurley-Mason Co. for the erection of its proposed new plant on the site of the former shipyard of the Foundation Co., estimated to cost \$450,000.

New Jersey

TRENTON—The Trenton Zinc & Chemical Co., Broad St. Bank Bldg., manufacturer of zinc oxide, with plant at Fall and Fair Sts., has arranged for a stock issue of \$650,000. A portion of the proceeds will be used for plant expansion and it is proposed to increase the output from 2,000,000 lb. per year to 12,000,000. Considerable machinery will be installed for this purpose. Max Movshovitz, formerly president of the M. M. & S. Metal Co., manufacturer of similar products, is president of the Trenton Zinc & Chemical Co.

NEWARK—The Martin Chemical Co., 204-206 New Jersey Railroad Ave., heretofore occupying a portion of the building at this location, has purchased the entire property for increased operations. Alterations and improvements will be made, and additional equipment installed.

METUCHEN—The General Ceramics Co., 50 Church St., New York, will call for bids early in April for the erection of the proposed addition to its local plant, to be used for the manufacture of sanitary porcelain ware. The extension will be 1- and 2-story, 165x785 ft., and is estimated to cost about \$400,000, including equipment. Dietrich Wortmann, 116 Lexington Ave., New York, is architect.

TRENTON—The Bergougan Tire Co., Whitehead Rd., has resumed production at its automobile tire manufacturing plant, and plans to place a new addition in service at an early date. The structure is nearing completion, including machinery installation, and will provide considerable increased production.

Pennsylvania

PITTSBURGH—The Standard Sanitary Mfg. Co., manufacturer of sanitary ware, has acquired property in the Northside district, in the vicinity of its plant, near Ontario St. The site totals about 80,000 sq. ft., and was secured for a consideration of about \$135,000. It will be used for the erection of an addition, and existing structures on the land will be razed at an early date. The company is reported to be planning for the establishment of a branch at Baltimore, Md., and negotiations are under way for the acquisition of an existing factory here. The capital was recently increased from \$12,000,000 to \$20,000,000 for expansion.

READING—The Atlas Mineral Products Co., recently organized with a capital of \$100,000, is planning for the operation of mining properties in the vicinity of Mertz-town for the production of mineral paints, colors, compounds, etc.

Texas

PORT ARTHUR—The Gulf Oil Co., operating a large local refinery, has arranged for a bond issue of \$35,000,000 for general operation, financing and extensions. The company's present plant is now averaging 22,000,000 bbl. of crude oil per year. W. L. Mellon, Mellon Natl. Bank, Pittsburgh, Pa., is president.

CORSICANA—The Corsicana Oil & Refining Co. has perfected plans for the immediate construction of its proposed new oil refinery, comprising the first unit, estimated to cost about \$200,000, with machinery.

FORT BEND—The Fort Bend Cotton Oil Co. has disposed of its local plant to the state, and in the future it will be operated by convict labor. The Prison Department is reported to be arranging plans for extensions to give employment to an increased number of men.

DALLAS—The Gulf Refining Co., 315 Sherman St., has awarded a contract to the Bowden Construction Co., C St., Galveston, Tex., for the erection of an addition to its local refining plant to cost about \$160,000.

DALLAS—The Trinity Paper Mills is completing the erection of a new plant at Commerce, Tex., and plans to install machinery and place the mill in service at an early date. It will have an initial capacity of about 20 tons of pulp per day.

DALLAS—The Magnolia Petroleum Co. has preliminary plans under way for the construction of a new oil refinery at Port Neches, Tex. The company has a 500-acre site here for the proposed plant, which is estimated to cost in excess of \$300,000.

West Virginia

HUNTINGTON—The West Virginia Glass Mfg. Co. is planning for extensive additions in its plant for large increased capacity. Six additional blowing machines and considerable other machinery will be

installed. It is planned to triple, approximately, the initial output of the works. This is a new industry in the city.

LUMBERPORT—The Mound City Glass Co. is planning for extensions in its plant with the installation of considerable new machinery. It is planned to double the present output.

New Companies

THE D-K CHEMICAL Co., Nutley, N. J., has been incorporated with a capital of \$100,000 to manufacture chemical products. The incorporators are Ernest Keller, Howard M. Gensel and Gustave Kay-sch, Nutley.

THE CONSOLIDATED PAPER & TWINE Co., New York, has been incorporated with a capital of \$100,000 to manufacture paper and cordage products. The incorporators are D. B. Tolins, J. G. Cohen and B. Waxenberg, 291 Broadway.

THE ATLANTIC LEATHER CORP., Boston, Mass., has been incorporated with a capital of \$200,000 to manufacture leather products. The incorporators are F. H. Nesmith, H. P. Mason and J. Sidney Stone, 84 State Street.

THE S. G. PARKER Co., Brookline, Mass., has been incorporated with a capital of \$62,500 to manufacture chemicals and by-products. The incorporators are Patrick J. and Donald D. Flynn, and O. A. Atkins, Brookline.

THE COTTON STATES RUBBER Co., Atlanta, Ga., has been incorporated with a capital of \$500,000 to manufacture rubber goods. The incorporators are R. W. Ragin, G. J. Reuter and J. B. Anchors, Atlanta.

THE CENTRAL STATES PAINT & VARNISH Co., 38 South Dearborn St., Chicago, Ill., has been incorporated with a capital of \$20,000 to manufacture paints, varnish, oils, etc. The incorporators are Charles Kramer, H. Kloth and Herman H. Sorem.

THE BURTOID Co., Paterson, N. J., has been incorporated with a capital of \$100,000 to manufacture chemicals and affiliated products. The incorporators are A. Lam-wers, Benjamin J. and Meyer W. Stein, 126 Market Street.

THE SYNTHOID Co., Inc., Boston, Mass., has been incorporated with a capital of \$50,000 to manufacture rubber products. The incorporators are Franklin W. Smith, Boston; Thomas L. Bronkhorst, Cambridge, Mass.; and Arthur V. Grimes, Brookline.

THE IBEX RUBBER CORP., Bound Brook, N. J., has been incorporated with a capital of \$125,000 to manufacture rubber goods. The incorporators are George O. Smalley, Bound Brook; William F. Jennings, Plainfield, N. J.; and Harry J. Lindsley, Detroit, Mich.

THE BEACON SMELTING & REFINING Co., Newark, N. J., has filed notice of organization to operate a plant at 3-5 Beacon St. Charles Friedman and Abraham M. Hein-owitz head the company.

THE CHASE OIL ASSN., INC., Boston, Mass., has been incorporated with a capital of \$100,000 to manufacture petroleum products. The incorporators are John M. Chase, George A. Fisher, and Joseph Schmanska, 51 Allston Street.

THE EDWARD E. ALLEN MFG. Co., Room 1016, 29 South La Salle St., Chicago, Ill., has been incorporated with a capital of \$50,000 to manufacture varnishes, enamels, paints, etc. The incorporators are Edward E. Allen and Louis A. Helle.

THE SOUTHERN INK MFG. Co., Houston, Tex., has been incorporated with a capital of \$25,000 to manufacture ink and chemical specialties. The incorporators are R. T. McDonald, J. C. Lemons and J. C. Kegans, Houston.

THE SYNTHETIC CHEMICAL CORPORATION, Landsdowne, Baltimore Co., Md., has been incorporated with a capital of 500 shares of stock without par value to manufacture chemical products. The incorporators are D. List Warner, John S. Short and Leslie E. Mahn.

THE H-W CHEMICAL Co., Columbia, S. C., has been incorporated with a capital of \$10,000 to manufacture chemicals and by-products. The incorporators are J. S. Hammack and J. W. Wilson.

THE JOLIET CARBONIC Co., 411 East Marion St., Joliet, Ill., has been incorporated with a capital of \$15,000 to manufacture acids, gases and byproducts. The incorporators are Walter F. and M. L. Pitcher, and Guy L. Meaker.

THE HALOGEN PRODUCTS Co., New Bedford, Mass., has been incorporated with a

capital of \$10,000 to manufacture chemicals, drugs, etc. The incorporators are George Mazel, Peter Cairns and Thomas N. Roche, 279 County St.

THE MAGNALOY METAL CORPORATION of America, 324 Bloomfield Ave., Montclair, N. J., has been incorporated with a capital of \$125,000 to manufacture metal alloys. The incorporators are Walter Lohry, Julius Kumpa and L. Friedmann.

THE PENN DISTRIBUTING Co., Camden, N. J., has been incorporated with a capital of 2,000 shares of stock of no par value to manufacture and deal in alcohol and kindred products. The incorporators are Joseph P. Murray, Frank S. Muzzey and F. Stanley Saurman. The Corporation Trust Co., 328 Market St., is representative for the company.

THE LA-LO CHEMICAL Co., Providence, R. I., has been incorporated with a capital of \$200,000 to manufacture chemicals and byproducts. The incorporators are E. J. Tetlow, C. E. Waterman and R. M. Green-law, Providence.

THE FRANKLIN DEVELOPMENT Co., Benton, Ill., has been incorporated with a capital of \$35,000 to operate an oil refining plant. The incorporators are James Austin, Hosea Rea and A. G. Sisk, Benton.

THE COLUMBIA PAINT Co., Columbia, S. C., has been incorporated with a capital of \$50,000 to manufacture paints, varnishes and affiliated products. The incorporators are W. J. Murray and A. S. Tompkins.

THE SOUTH KENTUCKY OIL & GAS Co., Burkesville, Ky., has been incorporated with a capital of \$50,000 to manufacture petroleum products and operate a refining plant. The incorporators are James A. McGartlin, Burkesville; H. A. Walton and Olaf A. Urseth, both of St. Louis, Mo.

THE UNITED SHALE BRICK Co., Ephrata, Pa., has been incorporated with a capital of \$100,000 to manufacture brick and other burned clay products. George W. Kinzer, Ephrata, is treasurer.

THE RAJET Co., Boston, Mass., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture chemicals and byproducts. The incorporators are John K. Howard, Warren Matley and Dunbar F. Carpenter, 55 Congress St.

THE WILLIAM H. SCHUTTE Co., INC., 419-21 South Wells St., Chicago, Ill., has been incorporated with a nominal capital of \$5,000 to manufacture oils, waxes, industrial alcohol and kindred products. The incorporators are William H. and B. I. Schutte, and John J. Kelly.

THE NATIONAL CHEMICAL CORP., Stamford, Conn., has been incorporated with a capital of \$10,000 to manufacture chemicals and byproducts. The incorporators are P. J. Bowes, J. J. Roreck and A. S. Sorgi, 544 Main St.

THE REFRACTORY PRODUCTS Co., Fredricksburg, Va., has been incorporated with a capital of \$900,000 to manufacture refractory specialties and insulation products. The incorporators are W. S. Quigley, L. E. Turk and T. M. Calvin. The company is affiliated with the Quigley Furnace Specialties Co., 26 Cortlandt St., New York.

THE NATIONAL AGRICULTURAL CHEMICAL Co., Jersey City, N. J., has been incorporated with a capital of \$100,000 to manufacture fertilizer products, chemical derivatives, etc. The incorporators are Henry G. Feinberg, Benjamin Altman and P. C. Wilke. Charles H. Blohm, 286 Central Ave., is representative.

THE ST. JOHN'S CHEMICAL Co., New York, has been incorporated with a capital of \$50,000 to manufacture chemicals and byproducts. The incorporators are A. E. and E. H. Post, and C. J. Hyland, 457 Third Ave., Brooklyn, N. Y.

THE NORRIDGEWOCK LIMF Co., Norridge-wock, Me., has been incorporated with a capital of \$200,000 to manufacture lime, operate limestone properties, etc. The incorporators are Charles H. Hussey, F. R. Folsom and Eben S. Miller.

HAMMILL & GILLESPIE, INC., 240-42 Front St., New York, has been incorporated under Delaware laws with a capital of \$500,000 to operate clay properties, mine clay, etc. The incorporators are Hilliard M. Gillespie, William D. Hart and Frederick H. Stokes.

THE DISSOWAY CHEMICAL Co., Brooklyn, N. Y., has been incorporated with a capital of \$60,000 to manufacture chemicals and kindred products. The incorporators are E. J. Fenning, G. G. Dallan and T. N. Dissoway, 412 E. 7th St.

THE CHICAGO PORCELAIN Co., 1313 West Harrison St., Chicago, Ill., has been incor-

porated with a capital of \$10,000 to manufacture porcelain products. The incorporators are George T. Jennings, Gerald C. O'Brien and Leo N. Appgar.

THE RUMFORD PULP REDUCTION Co., Rumford, Me., has been incorporated with a capital of \$100,000 to manufacture pulp and paper products. The incorporators are Paul B. Hudson and George H. Murphy.

THE BUR-MAC CHEMICAL CORP., New York, has been incorporated with a capital of \$50,000 to manufacture chemical and byproducts. The incorporators are W. R. and W. C. Burrows, and M. E. McGovern, 1 Liberty St.

SAVELL & FROST, INC., Niagara Falls, N. Y., has been incorporated with a capital of \$150,000 to manufacture chemical products. The incorporators are A. Killian, J. G. G. Frost and W. L. Savell, Niagara Falls.

GEORGE E. MIGNON, INC., New York, has been incorporated with a capital of \$50,000 to manufacture chemicals and byproducts. The incorporators are George E. Mignon, J. R. Clarke and R. T. Tyner, 49 Liberty St.

THE CAZ CHEMICAL CORP., Atlanta, Ga., has been incorporated with a capital of \$100,000 to manufacture chemicals and by-products. The incorporators are E. Saperstein, Frederick Darbonnier and Leon M. Shimoff, Atlanta.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY, CHICAGO SECTION, plans to hold a joint meeting with the Illinois Clay Manufacturers Association of Chicago about March 8.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 and 17.

AMERICAN PAPER & PULP ASSOCIATION will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

CANADIAN INSTITUTE OF MINING AND METALLURGY will hold its annual general meeting in the Chateau Laurier, Ottawa, Ont., on March 2, 3 and 4.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

NATIONAL PETROLEUM CONGRESS will meet at the Hotel Baltimore, Kansas City, Mo., March 22 to 25.

NATIONAL SAFETY COUNCIL, ENGINEERING SECTION, will hold its midwinter meeting in Philadelphia Feb. 28.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 342 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27, 28 and 29.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: March 11, American Chemical Society; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

CHEMICAL & METALLURGICAL ENGINEERING

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Volume 24

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Number 9

Sorts and Conditions of Men

WHEN we speak of all sorts and conditions of men we are likely to think more of their conditions than we do of their sorts—and we make a mistake in the lead. We can't gage the worth of a man by what he makes any more than we can gage the worth of an article by what it brings.

Let's cite an example on exposition of the latter statement. Imagine the affluent Mr. P. LUNJER walking into the establishment of a leading antiquarian on Fifth Avenue in New York. P. LUNJER is a patron of the arts, he is a collector, known as an amateur—in the true sense of the word—and his gallery is famous. He has lately returned from Italy and Spain, where he has been traveling and "picking things up."

The dealer in antiques has returned still more recently from abroad, where he has been over the same route. Two weeks after Mr. P. LUNJER visited Seville the dealer was also there, and he found in a second hand furniture store a picture that looked like a genuine Ribera. He bought it for ten dollars after finding out where it had come from. Then he spent a couple of days getting attests from notaries, and set sail for New York.

Mr. P. LUNJER is entering the Fifth Avenue door in response to a special invitation to be the first one to look at the dealer's great find. It is evidently designed to represent St. BONIFACE the Hospitable, and is a genuine Ribera without doubt. The curators of a number of museums recognize it as such and so does Mr. DAUBLESS, the eminent art critic. The dealer hates to let it go, but if Mr. LUNJER will permit him to exhibit it for six months he will let him have it for twenty thousand dollars. Mr. LUNJER does not want to wait so long: he wants it for his gallery immediately, and although it upsets the dealer's plans and he never meant to do it, he is finally persuaded to let Mr. P. LUNJER take it home with him in his automobile for twenty-five thousand dollars.

There we have a canvas that sold twice within three months, once for ten dollars, and once for twenty-five thousand. Whatever the value may be, the selling price does not indicate it.

It is very much the same way with men. We know individuals drawing ten, fifteen, twenty, and twenty-five thousand dollars a year that are not worth it at all outside their present jobs, and the only reason they get their pay is that somebody is an easy buyer; thinks himself a rare judge of men, mistakes boasts for performance, and—of such are our Feeble-Minded Heavy-Weights. On the other hand we know still more men who are pegging away at tasks that it would be flattery to call mechanical, and yet there are potentialities within them to do great things. They are ready, willing, and

anxious to serve with all their hearts, but the purchaser of their work does not see their value. He can't recognize their capacity. He has never even put them into a frame and looked at them.

Of course every one of us who would succeed must "hump himself" and look around occasionally. It is very well to preach the gospel of obedience, but obedience is merely an incident in the great art of getting along. Every man of affairs knows the misery of learning that he is to blame if things go wrong, from assistants who can't see the greater importance of keeping the whole establishment going right. If a lamp is upset and the house is afire it is more important to put out the fire than to learn who upset the lamp—and yet a great many persons can't understand this.

Every year there are hundreds of thousands of boys who leave school and go to work. The first desire of course is to work like a man and to get a man's pay. If he can feed a printing press or operate a passenger elevator he must first prove himself by being able to stick at it. Then comes the subtle gift to see that the work, no matter how well it pays, does not require intelligence; that it does not call for head work, and that if we spend our lives with our heads in idleness, our heads will not work when we want them to, either for us or for anybody else. So the mentally inert and those who lack the gift of faith in themselves stay along with those of feeble wit in the elevators or at feeding presses while the ambitious boys look for jobs where they can grow.

In the great ranks of labor these two sorts of men are bunched together by employers as well as by labor unions. This is a great mistake. The man with too much intelligence for a stupid job should not be kept at it. He may be able to leave it, but this is not always possible and the fault is just as likely due to the employer as to the employee, especially if work is scarce. One great reason why the man who outclasses his job should not be kept at it is because he is bound to become unhappy and discontented, and discontent is catching.

Let us take a well-known example of intelligence tests to illustrate our meaning. A pharmaceutical establishment employed young women to pack up boxes of pills. It was a steady job. They subjected applicants to intelligence tests, and graded them in classes from 1 to 10, one representing the lowest, ten the most intelligent. The efficiency of the workers was plotted on another curve, which rose quite rapidly up to grade 5, but fell off sharply and even declined for the high grades. Labor turnover also was chiefly in grades 7 to 10. The work was too dull for intelligent girls, and if they stayed on the job they lost heart and did not work well, while the best of them left as soon as they could afford to do so.

This rule holds among men as well as among women. We have intelligence and capacity with us in the shop

and in the office. If we do not recognize it, it will probably leave us. Then when we want talent we must go out and bid for it; bid high.

Now let us recall the journey of Mr. P. LUNJER through Seville bent on "picking up" art treasures and finding nothing, and the later journey of Mr. DEALER to the same place and his purchase of a dingy old canvas for ten dollars, and its subsequent resale for twenty-five thousand dollars. Having that in mind, let us recall that we are in the market for talent; that the progress of our business, whatever it may be, is largely a matter of talent.

Do we buy this talent like a man who knows it when he sees it? Or are we such easy marks that we can't see it until somebody else bids high for it or until we can see a sheet of past performances, often truly passed and not repeated?

Demonstrated Improvement—

The Best Argument for Protection

POTASH producers have appeared before the Ways and Means Committee urging a tariff of fifty cents a unit on imported salt, arguing that with this protection they will be enabled to continue the development of American potash to the point where it can meet fair foreign competition. Fortunately this industry has made a sufficient advance within recent years, or one might better say months, to make such a plea convincingly. Any infant industry which can demonstrate continuous improvement in plant processes and efficiencies can appear before Congress asking for temporary tariff protection with assurance of at least a respectful hearing from both parties.

Even its most vigorous advocates, however, do not claim that it has done all which it could have done in the way of technical improvement. Chemical control of brine plants and the application of sound physical and chemical principles have been conspicuously absent in many plants. Nevertheless certain parts of the industry have been advancing, demonstrating most effectively the value of pure science and applied scientific research.

In another way, too, this industry has, like many others, failed to do all that might have been asked of it. It is not essentially a competitive business, for the American demand far exceeds the domestic production, and will for years to come. All potash producers, therefore, will profit by active co-operation and exchange of technical information. However, instead of active co-operation, there has even been vigorous competition which has absorbed energies which might better have gone into development. This, fortunately, is rather aside from the main issue. The industry has advanced and on this basis deserves more careful consideration by our legislators than the many other mendicants now flocking to the feast.

Whether Congress will deem "national self-sufficiency" in potash important or not, one can but guess in the light of its performances toward other key industries. Since potash is a commodity made by few and used by many, and that many farmers, a cynical one might venture the prediction that a duty on potash will not be decided on its merits however great or small, but the question will particularly appeal to the free trade arguments tucked away in every legislator's equipment for use when it may increase the number of his votes.

Information on

Fatigue Failures

WÖHLER'S tests, published 50 years ago, confirmed the suspicion then held by constructors that beams or rods would fail under a relatively low stress if only repeated often enough. His research has since been the model for later investigators, who have sought to extend his conclusions regarding the relationship between range of stress and repetitions necessary for failure; evidently most important "practical" information. Most of the work was done with relatively heavy stresses, however, and did not disprove WÖHLER'S conclusion that each material possessed a "limiting stress" within which the number of repetitions necessary for rupture become infinite.

Infinity of course cannot be approached, but whereas the life of a bridge member, a rail, or even a car wheel might be compassed by the 20 millions of reversals attained by WÖHLER and his followers, the development of high-speed engines, turbines and electrical machinery raised anew the question of whether a recurring load, however small, might cause rupture, if only applied often enough. The Joint Investigation of Fatigue of Metals, under the able direction of Professor H. F. MOORE, has been able to show by means of dozens of tests that if the stress is not enough to cause failure in much less than 10 million alternations, it will not cause failure in 100 million. In other words, this investigation, still actively under way, has definitely confirmed the very important fact that each metal tested has a definite "endurance limit," a stress which may be applied to their test bars at least 100 million times without harm.

It is more than curiosity which impels metallurgists to inquire into the real mechanism of fatigue failure. An understanding of its nature is evidently precedent to accurate interpretation of present test data, correlation of other test results, development of short-time tests, and rational attempts toward provision of safer structures, either by more resistant materials or more skilled design.

At first it was thought that the fibrous tough elements comprising metallic articles were changed into growing crystalline particles, and these crystals then split open on their cleavage planes at the moment of fracture. However, microscopic examination has long since established the fact that metals and alloys are essentially crystalline aggregates, and there has never been any proof adduced that crystals increase in size under any circumstance of work or rest at atmospheric temperatures. Distortion under stress is known to be accompanied by crystalline disintegration rather than growth, and we even suspect that crystals are more ductile than that material which cements them together.

Secondly, BAUSCHINGER found that the elastic limit of mild steel, for instance, depended to a certain extent on its method of fabrication and heat treatment, and the figure ordinarily obtained was therefore dubbed the "primitive" elastic limit. When a specimen is subjected to stress reversals of growing amplitude, new or "natural" elastic limits in tension and compression appeared, within which the material would not fail by fatigue. This experimental conclusion suggests the hypothesis that some commanding portion of the material changes its elastic limit under alternating stresses.

However, recent studies into the ultimate structure of crystals have led to the proposal of the idea that fatigue failure is due to the spread of damage from

overstrained portions, microscopic in size. Stress concentrations at re-entrant angles and internal cavities have been shown mathematically to rise sometimes to six times the average. This fits in well with the latest hypothesis, which recognizes that metal is a complex and heterogeneous aggregate and accounts for the extreme sensitivity of the test to inclusions and surface finish, an experimental fact which finds striking support in the success one of our leading railroads has had in reducing axle failures by polishing the ends. In fact many things indicate that a fatigue break may be a property of a crystal rather than of a material; that is to say, ductile crystals are strong against fatigue, while unyielding amorphous metal has little resistance. Alternate stress therefore promotes rupture in all materials by changing ductile crystals into amorphous substance not so much by those internal earthquakes evidenced by slip planes as by tearing individual atoms from their regular locations. Under this supposition a high modulus of elasticity means a high endurance limit because the atomic motion for a given stress is correspondingly low and less liable to transgress the safe boundary; thus rubber or glass is poor, iron or steel good to resist alternating stress. For the same reason a stress between zero and $+40,000$ is much more dangerous than another ranging from $+20,000$ to $-20,000$.

No simple relationship between the fatigue endurance limit and any of the static properties has yet been discovered—in fact, Professor MOORE has found that ingot iron will withstand successfully 100 million repetitions of a stress equal to 160 per cent of its proportional limit, as determined from the usual tension test, yet a popular chromium-nickel analysis can be safely stressed no more than 60 per cent of its proportional limit. Other steels tested lie between these extremes, seemingly at random. Evidently further studies into the inner nature of fatigue, static and impact failure will be necessary before these tests can be correlated or a short-time fatigue test devised which will quickly indicate the reliability of new or doubtful material.

Most automobile users are sure that springs break under comparatively small shocks as compared to some of the bumps which left them whole; but is it really true that in general a few larger stresses greatly impair fatigue resistance? Does occasional annealing help or harm the resistance to repeated stress? Will a steel endure as long at a moderate temperature? Is there a relationship between endurance limit and amount of work absorbed by inelastic action? Does sudden application of load cause different results than the same total load applied in a harmonic manner? If so, what is the critical rate at which stresses may be built up? What is the result of loads which do not reverse from tension to compression, but simply range from a high pull to a low pull? What is the fatigue effect of alternate compression applied by direct longitudinal forces, in distinction to an equal stress at the outer fiber induced by flexure?

Machines have been devised for studying the last two problems, largely through a grant from the General Electric Company. Yet it may easily be recognized that the work now financed will only serve as a reconnaissance in the field of ferrous metals. It has been the experience of makers of springs, automobiles, and aeroplane-engines that ordinary static tensile results have comparatively little meaning to one anxious to pre-

dict performance of moving parts, lacking actual service tests. Since nearly all the high strength steels now being produced are subjected to recurring forces, the progressive concerns which absorb this expensive material simply cannot afford to allow this research to stop short of its goal. It is costing about \$15,000 a year. If it establishes data which will allow a saving of no more than one cent for every ton of alloy steel made in the United States, its annual cost is returned to industry.

Fluoresceine and Industrial Alcohol

SOME months ago when deaths from accidental poisoning by drinking methanol, or so-called wood alcohol, were a matter of almost daily occurrence we received an interesting communication from A. E. OUTERBRIDGE, Jr., a prominent metallurgist in Philadelphia, calling our attention to a simple method of deterring men from drinking denatured alcohol of known or unknown origin and thereby running the risk of methanol poisoning. Mr. OUTERBRIDGE explained that the addition of a small amount of fluoresceine to denatured alcohol, practically invisible in the concentrated solution, gave, on dilution with water to potable proof, a yellowish green fluorescence that would immediately attract the eye and cause the intending consumer to forego his drink. It was Mr. OUTERBRIDGE'S thought that if industrial alcohol could be thus treated men would think twice before drinking it, and that accidental poisoning from methanol would be greatly reduced. He brought this matter to the attention of the Prohibition Commissioner and subsequently sent us a small quantity of denatured alcohol to which had been added 7 milligrams of fluoresceine per 100 c.c. This we transmitted to the Prohibition Commissioner with the inquiry as to the possibility of obtaining his formal approval of the method and official adoption of the formula. His reply is printed elsewhere in this issue and we are glad to note that although he considers it inexpedient to require the addition of fluoresceine, because the coloring departed on dilution might be objectionable in some manufacturing processes, nevertheless he regards "the voluntary addition of fluoresceine to a factory stock of completely denatured alcohol or specially denatured alcohol . . . to be highly desirable."

If our readers desire to observe an interesting phenomenon let them repeat Mr. OUTERBRIDGE'S experiment and add a drop or two of alcoholic solution of fluoresceine to water. The fluorescent property of the chemical is magnified to an astounding degree and renders the alcohol repulsive in appearance for beverage purposes. We are assured by Mr. OUTERBRIDGE that in his personal experience this simple method of guarding against the consumption of industrial alcohol in the factory has been very effective, and we recommend its wider adoption.

Sir or Prince

IN a recent issue of *Chemical News* of London Mr. E. TOMLINSON writes from Barrow-in-Furness in regard to theories of the color of water propounded by Sir W. D. BANCROFT.

Sir WILDER sounds very well, but it hardly reaches. If titles were adjusted to personality and achievement one should be more disposed to regard him as Prince.

Readers' Views and Comments

Library and Research Work

To the Editor of Chemical & Metallurgical Engineering

SIR:—The New York Times of Sunday, Jan. 9, 1921, in its Editorial Section had a very interesting article on "Engineers Join in Research Work," with a sub-head "Agencies Co-operate in Effort to Salvage Knowledge Gained in War."

While the aim of this article is to make known the co-operation of the several large engineering societies of this country in linking together their members into a vast potential force for the solution of the various problems confronting the manufacturer and scientist, it has left out a very important link in this chain of research. I refer to the library link.

We all know that today, as never before scientists and manufacturers are depending more and more upon records of others as found in the printed word. Witness the growth of the service of the United Engineering Society, the generous response to the Chemists' Club for increased funds, the expansion of the technology room of the New York Public Library and, most important of all, the tremendous increase in special libraries organized since 1917 to aid large and small industries in the solutions of their problems. Now then, with the linking up of this vast reservoir of salvaged knowledge gained from the war together with knowledge that has been made available throughout past years, what greater ally to industrial research could be found?

To go back to March 25, 1915, the *Engineering Record* published an article the text of which was: "There are today in this country a large group of engineering libraries of great value collectively but not suitably co-ordinated." This article finishes by saying that: "To do the work would necessarily require considerable expenditure, but it would be time and money well spent."

It is not altogether unlikely that the following circumstance will be repeated many times, and to avoid it we should make a national effort to harness it. I refer to a happening in a large industrial city where a large manufacturing concern had been experimenting on a special process, resulting finally in failure. One of the men working on this process was talking with the librarian of the city about it. A smile crept over the librarian's face as he told the man that "that very experiment had been tried out before and found a failure. We have a record of that failure right here in one of our books." So because this concern went ahead blindly it lost thousands of dollars and was no further ahead.

So it goes and so it will continue to go—wasting thousands of dollars annually simply by failing first to find out whether or not the proposed process, operation or whatever it may be has ever been done before and if so what is the best way.

There are two ways that this "library link" can aid materially.

The first is by publishing weekly an index of abstracts of articles in current technical papers.

The second is the founding of a large central catalog

of all technical books, pamphlets, trade catalogs and translations, carefully analyzed for every item of value in them.

This proposed catalog would be a large undertaking but by no means unpracticable. A long start has been made in the Library of the United Engineering Societies, in the Library of Congress and John Crerar Library of Chicago. This proposed library has its prototype in the International Institute of Bibliography at Brussels, which fortunately escaped the ruthlessness of the Germans and recently filed its twelve-millionth card.

Additional co-operation could be gained by linking up the several hundred special libraries devoted to special industries by making them sponsors for picking out all items of pertinent value in their collections and sending copies of cards indexing these items to the proposed central catalog.

These two schemes for increasing research work of the future have been but briefly outlined. To some these two allies of research may seem remote and unpracticable. The fact that the International Institute of Bibliography has existed even through war-ridden days of Belgium long enough to file its twelve-millionth card is indicative of the commercial possibilities of a similar scheme in this country where the machinery for its accomplishment is greater.

Let us then make a determined stand to harness these forces and set them to work.

LIBRARIAN.

Advantages of Cadmium Lithopone

To the Editor of Chemical & Metallurgical Engineering

SIR:—Having been closely connected with the manufacture of lithopone and engaged in the designing of plants for the purpose for a number of years, the comprehensive article by H. R. Hanley on the production of electrolytic cadmium in a recent issue of your magazine was of particular interest to me in view of his reference to the use of cadmium for the manufacture of cadmium lithopone.

Some results from an investigation made into the commercial possibilities of producing that pigment and deductions therefrom may be of interest and value.

Cadmium lithopone in which the zinc of standard commercial lithopone is replaced by cadmium shows good covering properties and a high tinting strength—an admixture of only 5 per cent cadmium lithopone with 95 per cent standard lithopone, giving a pleasing and distinct cream yellow when rubbed out in oil.

The manufacture of cadmium lithopone follows in general the procedure for zinc lithopone, though certain precautions not required when zinc is used are necessary, and under control of the operator considerable variation in the shade and depth of the yellow color of the product may be obtained.

The use of metallic cadmium as a raw material is to be avoided, however; technically, because of the difficulties in getting it into solution as pure sulphate; commercially, because of its high cost, and Mr. Hanley's article seems to point the way to escape therefrom.

In the process of separation of the associated elements

he obtains a combined solution of zinc and cadmium sulphate apparently of approximately equal parts from which cadmium sponge is made for re-solution as sulphate relatively free from zinc.

The presence of thallium in small quantity has not been found detrimental and its removal would probably be found unnecessary.

The cost of the cadmium in the sulphate solution is, in the absence of cost figures, difficult to determine, but analysis of the methods, apparatus and man-hour figures, and with allowance for overhead and profit in the quoted prices, indicates that not more than 40 per cent, or less, of the present selling price of the metal, \$1.40@ \$1.50, or, say, 60c., is a liberal figure at which the charge for cadmium should appear in the lithopone product. At the present prices for acid, barytes, coal, etc., and labor, and taking cadmium at 60c., the cost figure for cadmium lithopone works out at 29c. per lb., including a 20 per cent profit. This figure is on the basis of using the sponge cadmium.

On account of the high strength of cadmium lithopone and because in most commercial uses it probably would be mixed with a large proportion of zinc lithopone or other white pigment, lithopone made from the equal part sulphate solution would have color and other values probably sufficient for many purposes.

Where cadmium lithopone is thus made in combination with zinc lithopone and by reason of lower cost chargeable to cadmium than the above 60c. figure and by reason of greater bulk, the product should cost appreciably less per pound than the above 29c. figure for the cost of cadmium lithopone content of the combined zinc and cadmium lithopone.

Given a source of cadmium from which the sulphate may be made at a cost comparable with the above example, the profitable manufacture of cadmium lithopone is indicated, especially when carried out in connection with other allied manufacture, as would probably be the case.

PAUL W. WEBSTER.

Perry & Webster, Inc.,
New York City.

The Metric System and Religion

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with profound wonder, mixed with something else, the reprints of certain articles on the chemistry of embalming which you printed some time ago. Now I pick up the latest issue of CHEMICAL & METALLURGICAL ENGINEERING and note the story entitled "Easy Money From Peat." It is certainly a modern miracle. My boyhood was spent up in the State of Maine, where the original demonstration (for public consumption) of easy money by the economical separation of gold from sea water was staged. But this was as nothing compared with these up-to-date superscientific wonders.

These things prompt me to send you the following letter on the dangers of our country adopting officially the metric system. It was written to the editor of one of our metropolitan daily papers and printed on the editorial page.

Your correspondent suggests as a topic of conversation the metric system and informs your readers that Congressman Britten has introduced a bill into Congress for the general use of the metric system by this country ten years after passage.

An attempt was made several years ago to introduce the metric system in this country, but it was not successful. The American engineers rejected it.

Aside from the fact that the metric system is based upon an unscientific premise and that in addition there

is a miscalculation in the length of the meter itself, this system is foreign to the Anglo-Saxon race, being Roman (French) in its origin. It was an element in the French attempt to eradicate religion from the earth and to introduce a system of atheism. It is an infraction of the Mosaic system of measurement, which is definitely correlated to and preserved in the Anglo-Saxon inch. It is not recognized either in America or in Britain.

It would seem that there are other methods besides physical occupation of territory in this hemisphere of attempting to attack and to violate the Monroe Doctrine, and the effort to introduce the metric system in this nation (America) is one of these "other" methods. It will not succeed, since God is keeping watch over His own. The eyes of all Americans should be wide open to these insidious attacks upon our institutions.

"In God We Trust."

Its reading has made me sad. I have an inherited religious tendency and was brought up to have a feeling of reverence for sacred things. In fact I am actually a member of that Church now most vigorously urging the passage of more of our well-known "blue laws."

But now my conscience troubles me. Every time I have sat down before my chemical balance with its set of metric weights I have committed a sin in comparison with which kneeling before a heathen idol in a Chinese joss house would be a mere peccadillo. I must make a change in my manner of living. Instead of weighing out one gram of potassium iodide I shall hereafter

weigh out $\frac{1000}{28350}$ of an ounce. I write this in fractional form for fear that perhaps even the mere use of the decimal point itself might be an infraction of the Monroe Doctrine, and I have reformed.

Little Falls, N. J.

R. R. HENDERSON.

To Prevent Use of Industrial Alcohol as Intoxicating Beverage

To the Editor of Chemical & Metallurgical Engineering

SIR:—This office is very much interested in the matter of the use of denaturants or repellent substances which may be added to completely or specially denatured alcohol in order to guard against the accidental or willful use of such alcohols for intoxicating beverage purposes, particularly in shops and factories.

There are a number of reasons why it would be inexpedient to require the addition of the particular substance which you call attention to—that is fluoresceine—for this purpose. The color imparted on dilution of an alcoholic solution of this substance might be objectionable to a number of manufacturers who use completely denatured alcohol or some of the widely used special formulas, such as specially denatured alcohol formula 1 or formula 2-B.

The voluntary addition of fluoresceine to a factory stock of completely denatured alcohol or specially denatured alcohol where the fluoresceine itself is in nowise objectionable as an added ingredient would seem to be highly desirable. The dilution with water of the neutral or slightly alkaline solution of fluoresceine produces an intense yellowish-green fluorescence which is practically transparent with transmitted light but markedly opalescent with reflected light. When this solution is slightly acid, however, the dilution with water produces very little change.

The addition of any substance to a denatured alcohol that would cause, upon dilution to potable proof, a condition repellent to the eye is of considerable value in protecting the alcohol from possible beverage use.

Bureau of Internal Revenue,
Washington, D. C.

JOHN F. KRAMER,
Prohibition Commissioner.

Western Chemical & Metallurgical Field

Southern California Edison Co. Granted Permit for Colorado River Power Development

The Federal Power Commission has granted the application of the Southern California Edison Co. for a preliminary permit to develop 2,500,000 hp. from the waters of the Colorado River. This is one of the largest developments that have been contemplated under the new water-power bill.

Some of the possibilities of the project may be gathered from the fact that the area that may be served with power includes the entire states of Arizona, Nevada and Utah, more than half of Colorado and New Mexico and three-quarters of California, with additional areas in Idaho, Wyoming and Mexico. The total power that may be developed is estimated at 4,350,000 hp.; about three and a quarter million acres of land can be irrigated and over 400 miles of the river will be made navigable. The Colorado River is the second in the United States in size, having a drainage area of 250,000 square miles and an annual run-off of sixteen million acre-feet. It is proposed to build a storage basin holding about forty million acre-feet which will impound 93 per cent of the run-off. About 35 per cent of the power will be used for railroad electrification; the remainder will be available for agricultural and industrial uses.

Production of Metallic Tungsten at Keeler, Cal.

During the war the several tungsten mines near Bishop, Inyo Co., Cal., were comparatively heavy producers of scheelite, but the mines have been idle since the armistice. An estimate of the capital invested for mine development and milling machinery is \$600,000. Some of those financially interested in the tungsten mines also have an interest in a soda ash plant on Owens Lake, about seventy-five miles from the mines at Bishop, and it was decided to experiment with the production of metallic tungsten, using soda ash and scheelite concentrates as the raw materials. A method has been developed by Cooper Shapley, general manager of the Round Valley tungsten mines, that produces a high-grade product at a very reasonable cost. An analysis of the metallic tungsten produced is:

	Per Cent		Per Cent
W	98.00	P	Trace
C	0.30	Cu	None
Fe	0.29	S	None
SiO ₂	0.03	WO ₃	None
Mo	1.25		

An experimental plant treating 25 lb. at a charge was built and an outline of the operation follows: The correct amount of trona, a crude soda gathered from the shores of Owens Lake at a cost of \$3 per ton, is mixed with the scheelite concentrate in a ball mill, the batch transferred to a firebrick crucible and melted with crude oil fuel, the flame striking directly on the charge. When the melt is quiet, the charge is tapped, the molten material flowing directly into a small Pachuca tank nearly filled with water. The water is agitated violently by compressed air during the pouring of the charge and for an hour in addition. The action of the water on the molten sodium tungstate shatters this material so that it will all pass a 20-mesh screen and the sodium

tungstate is easily and completely dissolved. The charge from the Pachuca is transferred to a redwood filter tank having a filtering medium of coco matting and canvas. The filtrate runs to storage tanks through a small filter press having filter paper between the plates. An absolutely clear solution results and, as the amount of insoluble matter is small, the press is cleaned only at rare intervals. The material in the filter tank is washed several times and the wash water returned to the Pachuca tank to be used for the next melt.

To precipitate an easily filterable tungstic oxide the solution is brought to boiling by means of steam coils placed directly in the solution and the boiling solution is transferred to stoneware crocks. The crocks are jacketed for hot water and contain enough hydrochloric acid to precipitate the tungsten as oxide. (About 3 per cent of nitric acid is used with the hydrochloric.) If the solution is kept nearly at the boiling point the precipitate will be comparatively coarse grained and easily filtered.

The precipitated material is allowed to stand for an hour at a temperature close to 100 deg. C., and the clear, weak acid solution decanted and replaced with distilled water obtained from the heating coils. The precipitate is run into a flat-bottomed filter tank having a filtering medium of coco mat and canvas (protected with shoveling strips) and is washed repeatedly with distilled water. An acid-free product results containing about 45 per cent water, as determined by heating a sample to 500 deg. C.

The batch is then transferred to a wooden mixer similar to a butter churn, and the correct amount of gas-house carbon is added to reduce the tungsten oxide to the metal. After kneading for half an hour the mixture is transferred to fireclay crucibles and allowed to dry slowly, waste heat from the reduction furnace being used to dry the product completely. Any reduction in volume due to shrinkage during drying is made up with more dry material, and the crucibles are covered with a graphite lid, ground to fit.

Reduction is done in a special furnace which is operated continuously and reduces a charge in about four hours' heating at 1,250 deg. C. Fuel oil is used for heating the furnace.

The metallic tungsten is a lumpy gray mass that must be ground and screened, and packed in 100-lb. tins.

Alunite Deposits of Utah

Increasing interest is being taken by Eastern capital in the alunite deposits of Utah. Several large concerns are doing important work in the state, while others are planning activity. One of the most recent important occurrences in Utah alunite history is the incorporation of the Utah Alunite Refining Co.

The company's holdings of eight claims are located in Sevier County, about 150 miles south of Salt Lake City and about one mile from Vaca station, on the Marysvale Branch of the Denver & Rio Grande R.R. Four products are obtained—potash alum, potassium sulphate, aluminum oxide and aluminum sulphate. It is stated that there is abundant water for milling purposes.

Iron:Nickel Alloys

Brief Description of the Properties of Nickel Steels and High-Nickel:Iron Alloys, the Former One of the Earliest Alloy Steels and Now of Widest Consumption, the Latter of Remarkable Thermal and Electrical Characteristics

BY PAUL D. MERICA

Superintendent of Research, International Nickel Co.

ALLOYS of nickel with iron, including nickel steels, are commercially by far the most important alloys of this metal, and the range of compositions used is a very wide one—from the alloys of low nickel content, the nickel steels, to those containing 30 per cent and more nickel. These alloys were first discovered in meteorites and have never ceased to interest and puzzle investigators because of the unusual properties of the alloys containing from 5 to 40 per cent nickel.

Binary alloys of all compositions solidify as solid solutions which upon cooling suffer both phase and magnetic transformations of great scientific interest and technical importance. The constitutional diagram¹ of the nickel:iron alloys is given in Fig. 1. Without entering upon a detailed discussion of the constitution of these alloys, for which further references² should be consulted, it is observed that the addition of nickel to iron and steel immediately depresses the temperature of both the A_1 and the A_2 transformation and in addition increases the temperature difference or lag between A_{c2} and A_{r2} —i.e., the temperatures at which iron loses its magnetism upon heating and regains it upon cooling respectively. This temperature range between A_{c2} and A_{r2} , within which the alloy may be either magnetic or non-magnetic depending on whether it has been heated or cooled to that range, is widened from practically zero for pure iron to about 500 deg. C. for an alloy containing 25 per cent of nickel; at the same time the

magnetic transformation range is lowered to ordinary temperatures and below. With increasing nickel content the temperature range of magnetic transformation again rises and becomes quite narrow—i.e., there is little lag in the transformation on heating and cooling. Steels of the former group, containing from 3 to about 30 per cent nickel, have become known as irreversible steels, whereas those of higher nickel content are called reversible steels. Accompanying these magnetic changes which characterize reversible and irreversible steels are corresponding ones in other properties, such as thermal expansivity, elasticity, electrical resistivity, the thermal alterations of which are also reversible or irreversible depending on the composition.

The presence of carbon causes further complications in the properties and behavior of these alloys and will be considered only in connection with nickel steels of low nickel content.

NICKEL STEELS

Nickel steel was the fourth alloy steel to be introduced and was first described in some detail by James Riley.³ The general subject of nickel steels is too broad for anything but the merest sketch in this place and references should be consulted for further details.

The principal effects of the addition of nickel to steel are the following:

1. Nickel depresses the critical temperature ranges of steel, and according to the degree of such depression we may consider three groups of nickel steels—namely, pearlitic steels, which have normal transformation and heat-treatment or critical ranges and are similar to ordinary carbon steels in a general sense; martensitic steels, self-hardening but too brittle to be of any importance commercially; and austenitic steels, which are not susceptible to hardening by thermal treatment and may perhaps more properly be considered as ferronickel alloys containing carbon. The nickel and carbon content of the steel determines its inclusion in any one of the above groups; Fig. 2, according to Guillet, gives a classification of different compositions of nickel steels.

2. Nickel dissolves in the ferrite of steel and increases the hardness and strength without a corresponding loss of ductility. Thus Bullens⁴ states that the addition of each 1 per cent (up to 5 per cent) of nickel to steel of forging grades will, without loss of ductility, increase the tensile strength and yield point from 4,000 to 6,000 lb. per sq.in., in the natural (not heat-treated) condition. But it is in the heat-treated condition that the superiority of nickel-containing steels is most evident and of most commercial importance. This is illustrated from the following data collected by the Society of Autom-

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¹Compt. rend., 1899, vol. 128, p. 304, and Gulliver, "Metallic Alloys," p. 331.

²Guertler, "Handbuch der Metallographie," Arnold and Read, Proc., Inst. Mech. Eng., 1914, p. 223. Mars, "Die Spezialstähle."

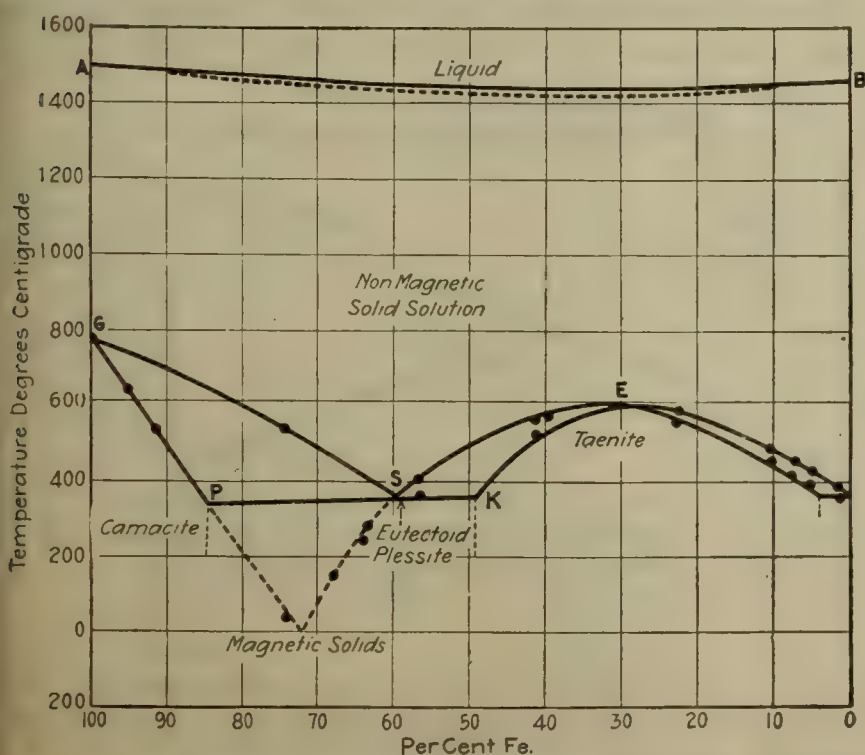


FIG. 1. EQUILIBRIUM DIAGRAM OF IRON: NICKEL ALLOYS

³J. Iron Steel Inst., vol. 1, p. 45.

⁴"Steel and Its Heat Treatment."

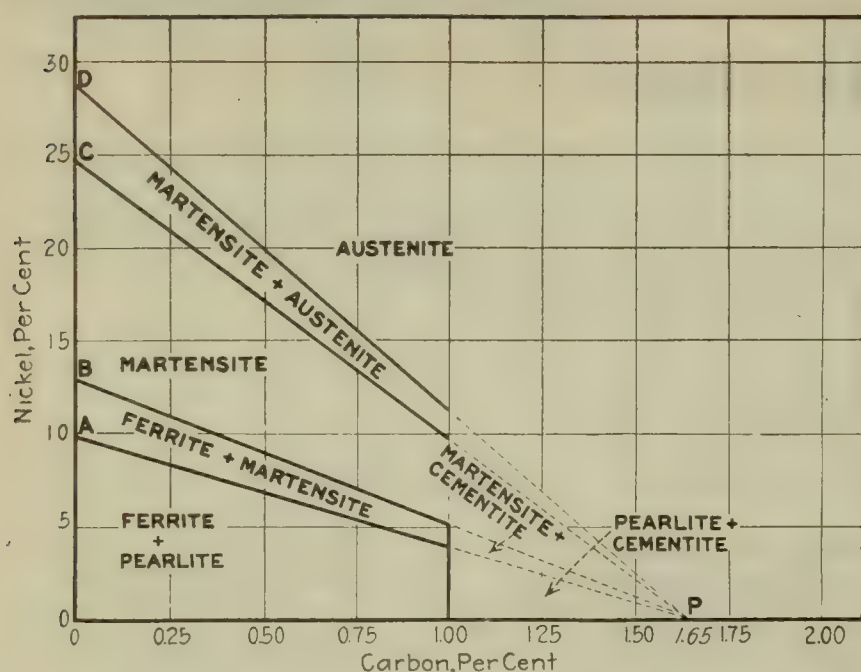


FIG. 2. CONSTITUTION OF SLOWLY-COOLED NICKEL STEELS (GUILLET)

tive Engineers showing a comparison between the tensile properties of a 0.40 per cent carbon steel without nickel and the same with 3.5 per cent of nickel in the heat-treated condition:

Analysis	Yield Point, Lb. per Sq. In.	Tensile Strength, Lb. per Sq. In.	Elongation in 2 In.	Reduction of Area
0.40 per cent carbon...	53,000	90,000	25	62.5
0.40 per cent carbon, 3.5 per cent nickel...	83,000	108,000	25	66

3. Nickel exerts an influence on the grain size of ferrite and pearlite, tending to produce a finer grain structure and finer pearlite, shading into sorbite. In the same sense it diminishes the rate of grain growth within the temperature ranges for heat-treatment, and thus minimizes the danger of overheating.

4. The structural effects of nickel noted above make a nickel steel (2 to 3½ per cent Ni, 0.10 to 0.20 per cent C) invaluable for case-hardening and superior to carbon steels in uniformity of zone of carburization and in mechanical properties of the core after heat-treatment.

The beneficial effects of nickel upon steel are intensified by the presence of other elements, particularly chromium; and chromium:nickel steels are perhaps more widely used today for heat-treated forgings for automobiles and other construction than are the straight nickel steels.

The following grades of steel are in most common commercial use:

(a) *Structural Steel With 3½ Per Cent Nickel:*

This is the oldest and best-known composition and constitutes the bulk of commercial nickel steel produced today. Its composition will average nickel, 3.0 to 3.5 per cent; carbon, 0.20 to 0.40 per cent. It is usually made in the open-hearth furnace and is used both in the rolled or forged condition and after heat-treatment.

It is much used for rolled structural shapes in construction of bridges and similar structures. It has also been used in the form of rails, although its economy for this purpose has not been satisfactorily demonstrated. In the heat-treated condition it is used for gun, engine and locomotive forgings, as well as for many automobile parts in too severe service for ordinary carbon steels. The average mechanical properties of this composition of steel after quenching in water from 1,400 deg. F.

(760 deg. C.) and drawing at various temperatures are shown in Fig. 3.

(b) *Nickel:Chromium Steels for Heat-Treated Automobile and Other Forgings:*

These compositions constitute the most prominent group of "automobile" steels and are used for a great variety of parts and construction where high strength, toughness and ductility are required. Typical ranges of composition are given below:

	Chromium, per Cent	Nickel, per Cent	Carbon, per Cent
Low.....	0.5	1.5	0.20 to 0.50
Medium.....	0.5 to 1.5	1.5 to 3.5	0.20 to 0.50
High.....	1.5	3.5	0.40 to 0.50

The "low" and "medium" nickel:chromium steels are used primarily in the automobile industry for crankshafts, axles, driving shafts, spindles, bolts, etc., and for case-hardened pivot pins and cam rollers. The "high" nickel:chromium steels are used in the manufacture of heat-treated gears. The latter compositions are also the principal ones used in the manufacture of both armor plate and of armor-piercing projectiles. The mechanical properties of typical steels in the heat-treated condition are given in Figs. 4 and 5.

(c) *Nickel Steel for Case-Hardening:*

The principal properties of nickel steel which make it invaluable for case-hardening have been noted above; in addition there exists the possibility for high-nickel steels (nickel 5 to 7 per cent) of obtaining air-hardening or self-hardening case-hardened surface layers together with a tough pearlitic core. Typical compositions used for case-hardening are given below:

Low nickel:	Per Cent
Nickel.....	1.5 to 3.5
Carbon.....	0.10 to 0.20
High nickel:	
Nickel.....	5 to 7
Carbon.....	0.10 to 0.15

(d) *Mayari Steel From Cuban Ores:*

This is a natural alloy produced in the blast furnace and open-hearth furnace; it has been used principally in the form of rails and track bolts. Its composition averages nickel, 1.0 to 1.5 per cent; chromium, 0.20 to 0.70 per cent.

(e) *High-Nickel Steels:*

Such compositions as the following are termed perhaps more properly "ferronickel alloys": nickel, 25 to

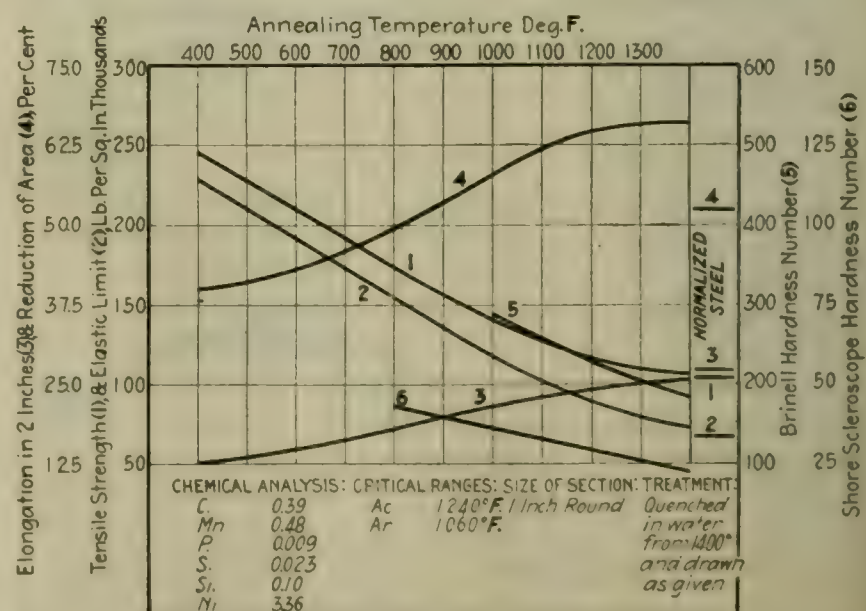
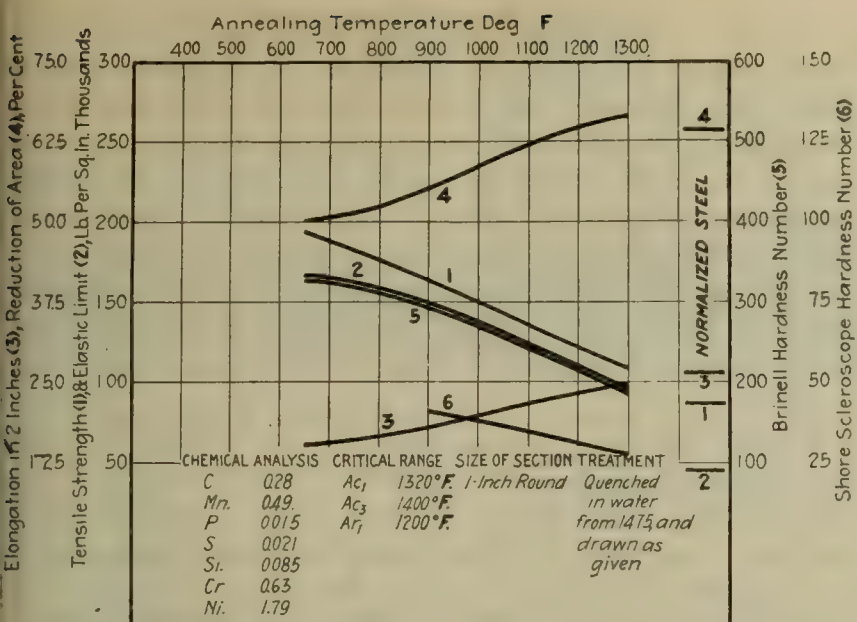


FIG. 3. PHYSICAL PROPERTIES OF 3½ PER CENT NICKEL STEEL FOR STRUCTURAL PURPOSES AFTER VARIOUS HEAT-TREATMENTS



10 per cent; carbon, 0.3 to 0.5 per cent. They are austenitic and do not respond to usual heat-treatments; they are, however, naturally quite tough and strong, have a low thermal expansivity and are very resistant to corrosion in air, fresh or sea water. They are much used for gas engines, valves and spindles, for ignition and boiler tubes, for valve stems on sea-water pumps. The alloys may be rolled and forged, but are not so readily machined as ordinary steel. They will have the following average tensile properties in the natural state:

	25 to 28 per Cent Nickel, 0.3 to 0.5 per Cent Carbon	30 to 35 per Cent Nickel	35 to 38 per Cent Nickel
Tensile strength.....	85,000 to 92,000	85,000 to 95,000	100,000 to 115,000
Yield point.....	35,000 to 50,000	40,000 to 50,000	64,000 to 78,000
Elongation in 2 in....	30 to 35 per cent	30 to 40 per cent	25 to 35 per cent
Reduction of area....	50 to 60 per cent	40 to 60 per cent	50 per cent

The alloys containing about 25 per cent of nickel are much used for electrical resistance wire, in the construction of rheostats and electrical heaters. Table I gives values of the electrical resistivity⁵ and its temperature coefficient⁶ for binary alloys of nickel and iron.

The section given below on "Alloys for Electrical Purposes" contains further information on this application of the ferronickel alloys.

⁵Burgess and Aston, MET. & CHEM. ENG., vol. 8, p. 23 (1910).

⁶Guillaume, "Les applications des aciers au nickel."

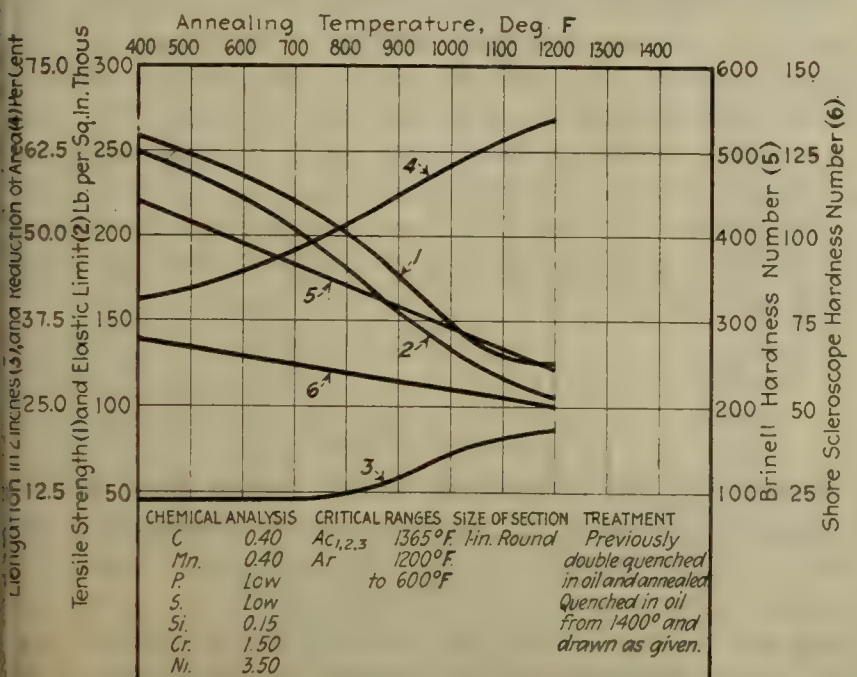


FIG. 5. PHYSICAL PROPERTIES OF A HIGH NICKEL: CHROMIUM STEEL AFTER VARIOUS HEAT-TREATMENTS

TABLE I. ELECTRICAL RESISTIVITY OF NICKEL-IRON ALLOYS

Per Cent Nickel	Electrical Resistivity in Microhm-Cm.	Mean Coefficient of Resistivity Between 0 and t Deg. C.
0	12.1	.....
0.27	13.1	.....
0.56	15.4	.....
1.07	16.9	.....
1.93	16.4	.....
7.05	26.9	.....
8.17	26.7	.....
10.20	28.6	.....
11.29	29.4	.....
12.07	30.3	.....
13.11*	34.8	.....
19.21	36.2	.....
22.0+	38.7	(784-0.13) 10 ⁻⁶
22.11	63.2	.....
25.20	65.5	(844+0.01) 10 ⁻⁶
26.2	82.0	.....
26.40	82.0	.....
28.42	82.0	.....
28.7	.....	(700-0.20) 10 ⁻⁶
30.4	.....	(897-0.43) 10 ⁻⁶
35.0	.....	(1,561-1.69) 10 ⁻⁶
35.09	81.1	.....
35.7	81.1	.....
47.08	44.7	(1,161-1.68) 10 ⁻⁶
75.06	22.1	.....
100.00	12.4	.....

* Contains 0.89 per cent C.

Within the range of compositions from 20 to 30 per cent nickel the ferronickel alloys may readily be obtained in a non-magnetic condition by cooling at normal

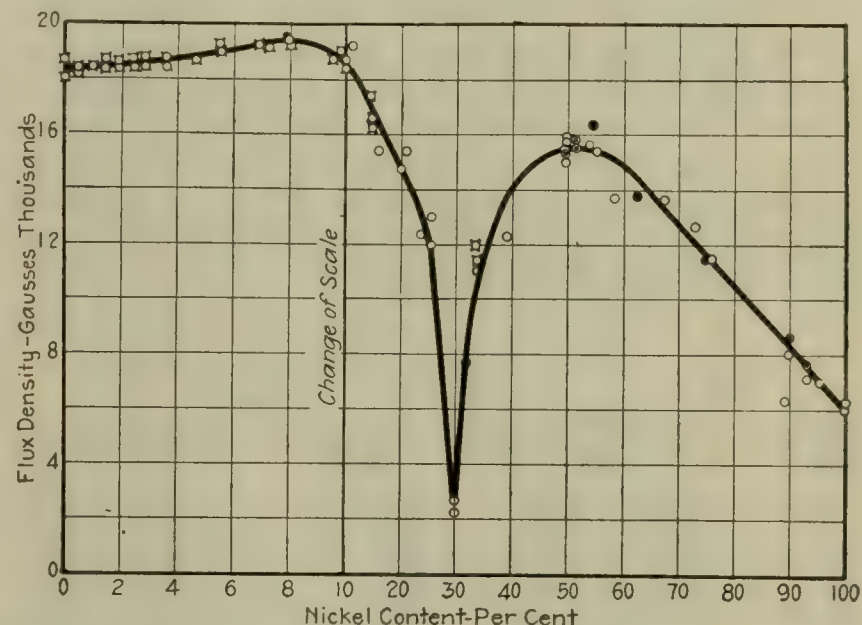


FIG. 6. MAGNETISM OF IRON: NICKEL ALLOYS (YENSEN)

rates from rolling or forging temperatures. They are used in this condition for the production of non-magnetic parts requiring strength and toughness. Table II shows the magnetic properties of ferronickel alloys.

TABLE II. THE MAGNETIC PROPERTIES OF NICKEL-IRON ALLOYS

Per Cent Nickel	Density D in G. per c.c.	Hegg 1910 (364)		Saturation Values at 0 Deg. Absolute; Magnetic Moment per Unit Mass (B-H)		Curie Constants (Weiss & Foex 1911)
		Transformation Temperatures, Centigrade (Curie Points)	Heating Deg.	σ ₀	4πσ ₀ D	
0	7.875	758	.....	223.2	22,090	0.072
10	7.89	730	532	221.0	21,910	0.0577
20	8.02	625	218	210.8	21,340	0.0460
30	8.06	533	127	203.6	20,620	0.0315
40	7.63	365	.....	184.2	17,660	0.0251
50	8.05	527	.....	169.2	17,120	0.0227
60	8.29	599	.....	146.8	15,290	0.0185
70	8.39	613	.....	127.1	13,400	0.0157
80	8.52	562	.....	103.1	11,040	0.0126
90	8.60	480	.....	80.6	8,710	0.0100
100	8.86	374	.....	58.8	6,550	0.0056

More recently Yensen⁷ has made a thorough study of the electrical and magnetic properties of iron: nickel alloys prepared by melting *in vacuo*. In Figs. 6 and 7 are reproduced some of his typical results.

Beginning at about 25 per cent nickel, the thermal

⁷Trans., Am. Inst. Mining Eng. (1920).

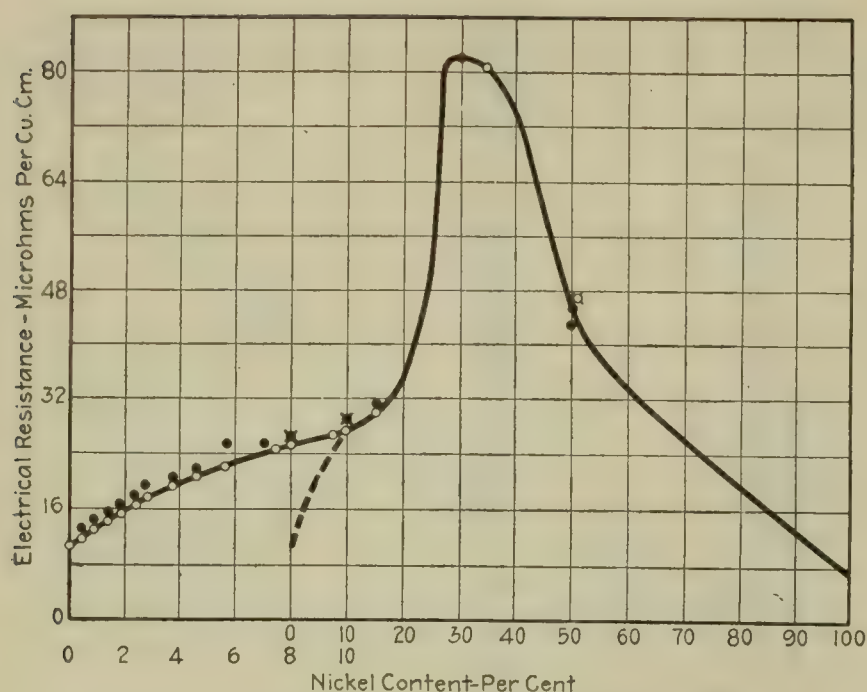


FIG. 7. ELECTRICAL RESISTANCE OF IRON:NICKEL ALLOYS (YENSEN)

expansivity of the ferronickel alloys at 20 deg. C. diminishes rapidly with increasing nickel content up to about 34 per cent; thereafter again increasing first rapidly and then more slowly to that of pure nickel. These curious changes are utilized in the manufacture of three patented alloys—invar, dilver and platinite—having respectively a thermal expansivity very low at ordinary temperature, nearly equal to that of glass and of platinum. Table III gives values of the thermal expansivity of ferronickel alloys.⁹

TABLE III. THERMAL EXPANSIVITY OF IRON:NICKEL ALLOYS

Per Cent Nickel	Mean Coefficients of Linear Expansion $\times 10^6$	Per Cent Nickel	Mean Coefficients of Linear Expansions $\times 10^6$
0	10.354 + 0.00523t	44.4	8.508 - 0.00251t
5.0	10.529 + 0.00580t	48.7	9.901 - 0.00067t
19.0	11.427 + 0.00362t	50.7	9.824 + 0.00243t
26.2	13.103 + 0.02123t	53.2	10.045 + 0.00031t
27.9	11.288 + 0.02889t	70.3	11.890 + 0.00387t
28.7	10.387 + 0.03004t	100.0	12.661 + 0.00550t
30.4	4.570 + 0.01194t	12.2 + 1 Cr	11.714 + 0.00508t
31.4	3.395 + 0.00885t	16.8 + 1 Cr	11.436 + 0.00170t
34.6	1.373 + 0.00237t	16.2 + 2.5 Cr	19.496 + 0.00432t
35.6	0.877 + 0.00127t	21.3 + 3 Cr	18.180 + 0.00426t
37.3	3.457 - 0.00647t	34.8 + 1.5 Cr	3.580 - 0.00132t
39.4	5.357 - 0.00448t	35.7 + 1.7 Cr	3.373 + 0.00165t
43.6	7.992 - 0.00273t	36.4 + 0.9 Cr	4.433 - 0.00392t

Invar contains about 36 per cent of nickel and has a mean linear thermal expansivity of approximately 0.000,001 per deg. C. between 0 and 40 deg. C. It melts at 1,425 deg. C., has a density of 8.0 g. per c.c. and an electrical resistivity of about 80 microhm-cm. It is very resistant to corrosion in water and may be immersed in it for days without the appearance of rust spots. Platinite is quite similar except that it has a thermal expansivity equal to that of platinum (approximately 0.00,000,9 per deg. C.) and contains about 46 per cent of nickel. Dilver has a thermal expansivity coefficient of 0.00,000,8 per deg. C. Invar, as well as the other alloys of similar character and composition, may be rolled, drawn and machined and is used for the manufacture of measuring tapes, length standards, instruments and chronometers of high accuracy for which temperature-length changes must be almost wholly eliminated. These and similar alloys are produced now in this country. For further information concerning invar, circular 58 of the Bureau of Standards should be consulted. Perhaps the principal present use for platinite is for the sealing in wire of electric lights.

German Potash Production

According to figures furnished by the German Potash Syndicate the sales of potash salts in 1919 reached a total of 4,159,227 metric tons, with 812,002 tons of potash. In 1918 the sales of the Potash Syndicate amounted to 4,840,934 tons of potash salts, with 1,001,664 tons of potash, showing a falling off in 1919 of 681,707 tons of potash salts and 189,661 tons of potash. In 1919 the sales of potash were less by 192,279 tons than those of 1917 and 298,367 tons less than the sales in 1913.

Among the various potash salts only carnallite, 30 per cent manure salts and sulphate of potash show a fair increase in sales for 1919, the last named going to foreign countries for fertilizing tobacco, cane sugar, fruit trees and potatoes. All the other salts showed decreased sales.

The first post-war shipments to Great Britain, United States and other overseas countries began in July, 1919. From this date on the foreign sales showed an increase. The sales of potash in 1919 were marked by a falling off in the following countries and in the following amounts as compared with 1918: Austria-Hungary 34,307 tons, Belgium 21,204 tons, Russia and Poland 5,171 tons, Switzerland 5,074 tons and Luxemburg 1,357 tons. On the other hand, increases for the same years are shown in the cases of Holland and the Scandinavian countries. Furthermore there appear as purchasers for the first time after the war the following countries: The United States with 70,128 tons, Great Britain with 10,278 tons, Spain with 358 tons and the remaining American countries with 1,648 tons.

As a result of the renewal of trade relations between Germany and the former enemy countries the sales of German potash increased from 141,947 tons in 1918 to 174,968 tons in 1919, an increase of 33,022 tons. This increase would have been greater had not the purchases of countries like Austria-Hungary, Russia and Poland fallen heavily behind preceding years. A further handicap to increased sales in 1919 is traceable to the difficulties experienced during that year in effecting shipments overseas due to the scarcity of shipping space.

The most noticeable decrease in the sales of German potash is found in Germany itself with a decline of 222,683 tons, of which the amount of 212,917 was classed as for agricultural purposes. However, as Germany in 1913 took 536,102 tons of potash for agricultural purposes, as against 608,766 in 1919, the year 1919 still shows a gain over 1913 in this direction of 72,664 tons or around 15 per cent.

The following table is a general report of the Potash Syndicate's import and export business for the years 1913 and 1919:

	1913 Tons	1919 Tons
Inland	604,282	637,032
Export	506,076	174,962
Total	1,110,358	812,001

Coconut-Oil Mill Situation in the Dutch East Indies

In an analysis of the coconut-oil mill situation in the Dutch East Indies, Trade Commissioner John A. Fowler points to the advisability of American manufacturers of oil-milling machinery developing the market which arises from the growth of the industry in these islands. For full information request file FE-210, Bureau of Foreign and Domestic Commerce, Washington, D. C.



Armour Fertilizer Works—II

Svenska Den System of Acid Phosphate Manufacture—Acid Pumping and Storage—Phosphate Rock Mill—Mixing Raw Materials to Produce Fertilizers for Various Soils—Mechanical Operations and Apparatus Employed in the Complete Modern Fertilizer Plant*

BY CHESTER H. JONES

FERTILIZER manufacture is carried on in the large building shown on the right in the above photograph and in the plan view Fig. 13. All raw materials except the acid are delivered from cars by way of the long platforms.

The operations consist of crushing and grinding phosphate rock, mixing ground rock with sulphuric acid to make acid phosphate, curing acid phosphate, removing hydrofluoric acid gas from the acid phosphate operation, accurately mixing and bagging other raw fertilizer materials. Electric current is distributed at 440 volts to the various motors in the plant through a large panel board located in the corner of the grinding room and so arranged as to meter the current consumed in the operation of each department. Trackage space for sixty cars is available, the tracks paralleling the shipping platform on both sides of the building.

The list of raw materials used in fertilizer blending

*For Part I see CHEM. & MET. ENG., vol. 24, No. 8, p. 333, Feb. 23, 1921.

are almost innumerable, but some of the more important ones are as follows:

Kainit from Europe. Potash content, 13 per cent.

Tobacco stems of high grade. Ammonia 3 per cent and potash 8.6 per cent.

Chilean nitrate.

Phosphate rock from the Columbia, Tenn., district with total P_2O_5 equivalent to bone phosphate of lime 72 per cent, iron oxide 2.8 per cent and Al_2O_3 2.8 per cent.

Sulphuric acid 53 deg. Bé.

Nebraska potash. K_2O content runs 20 to 30 per cent.

Muriate of potash from Europe. K_2O content is 50 per cent.

Tankage from the packing houses. Total P_2O_5 content is 9 per cent and ammonia runs 7 to 10 per cent.

Sulphate of ammonia. Ammonia 25 per cent.

Bone meal from Armour Glue Works. That known as 3-24 has 3 per cent ammonia and 24 per cent phosphoric acid; that called 2-27 has 2 per cent ammonia,

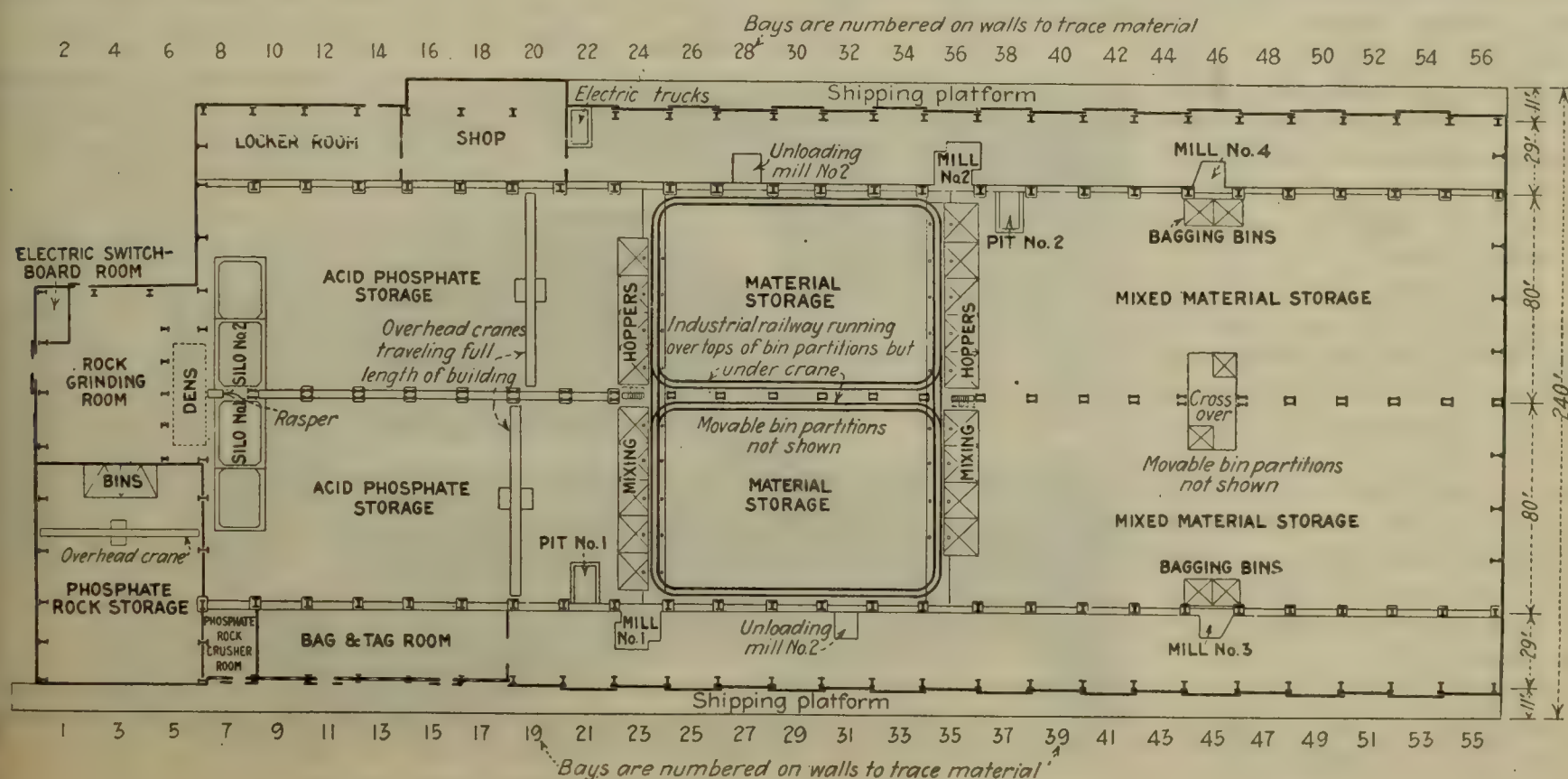


FIG. 13. PLAN OF FERTILIZER PLANT

27 per cent P_2O_5 . Raw bone meal ammonia 4.5 per cent, total P_2O_5 22 per cent. Manure salt. K_2O 20 per cent. Cottonseed meal. Ammonia 7 per cent, available P_2O_5 2.5 per cent and K_2O 1.5 per cent. Dried blood from Armour packing houses. In considering the successful outcome of a fertilizer - manufacturing enterprise it is well to remember that packing concerns have a distinct advantage in that they have an assured source of organic and animal ammonia.

ACID STORAGE AND HANDLING AT MILL

The 2-in. pipe line from the acid plant runs across the yard to the corner of the rock-grinding room, where acid is distributed by two Chemical Equipment Co. pumps shown in Fig. 14. These pumps are so connected that acid may be delivered to the mill storage tank for acid phosphate manufacture either directly from the acid plant, from the storage tanks, shown in Fig. 15, or directly from tank cars. Acid may also be delivered from storage tanks to tank cars or *vice versa* or it may be pumped from acid plant to outside storage tanks.

These tanks have no bottom outlet, but are emptied and filled through piping at the top. The centrifugal acid pumps accomplish the drawing up of the liquid from either tank cars or storage by means of the auxiliary priming tank shown in Fig. 14. The complete piping connections for this arrangement are shown in Fig. 16.

Engineers will realize that the lifting of liquids directly upward for a distance of 16 ft. where the pump intake

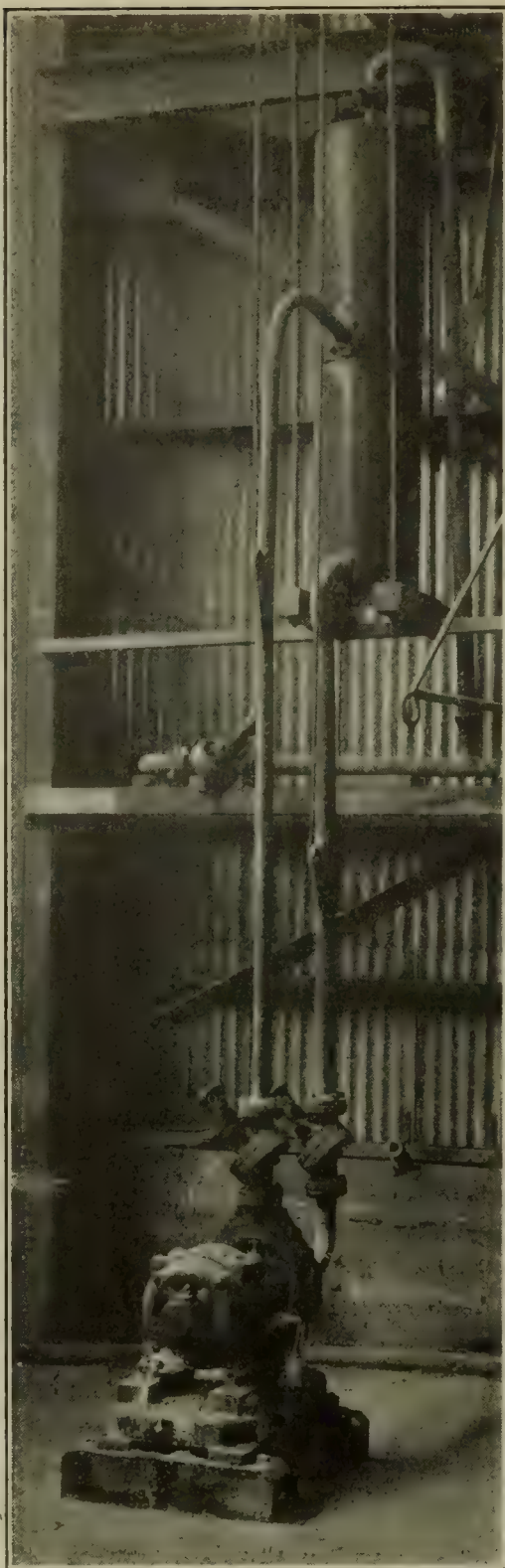


FIG. 14. ACID PUMPS AT FERTILIZER BUILDING

is not flooded directly from the source of supply is an innovation in centrifugal pumping practice.

ROCK GRINDING

The phosphate rock is delivered from box cars to the crusher room shown near the lower left hand, Fig. 13, where it passes through a Valke & Murdock crusher system to produce $\frac{3}{4}$ -in. size material and is delivered to the rock storage room. Storage capacity is about 3,500 tons.

The traveling crane delivers rock to overhead bins, which in turn feed to the grinding and pulverizing plant in the rock-grinding room. This department is equipped with one Raymond pulverizer and two Kent mills, all driven from a line shaft by a 200-hp. Allis-Chalmers motor. The rock is ground for 95 per cent to pass a 100-mesh screen and is delivered by elevators to the bins above the acid phosphate machinery. The material is handled through the mill system by screw conveyors and steel elevators made by the Weller Mfg. Co. Between 125 and 150 tons of rock are ground every twenty-four hours.

ACID PHOSPHATE MANUFACTURE

The Svenska Den system for making acid phosphate was brought over from Sweden in 1911, the Armour company purchasing both patents and machinery from the original owners. It has been in operation in a great many of the Armour plants since that time. While the methods of handling the material, particularly the operation involving the pushing of a den full of the newly mixed phosphate against the cutting apparatus, may seem unwieldy, nevertheless the system is efficient in actual operation. It is necessary for the green phosphate to cure over a considerable period and the action in the dens has a certain beneficial effect toward this process.

A glance at Fig. 13 will locate the machinery adjacent to the rock-grinding room with the two dens in dotted outline and the four silos adjoining. Fig. 17, a side elevation taken from the rock-grinding room, gives an excellent idea of the arrangement of the duplicate system of machinery, and Fig. 18 is an elevation of the left end of Fig. 17.

The pulverized rock elevator appears in the center of Fig. 17, delivering the product through a butterfly



FIG. 15. ACID STORAGE AND PIPING

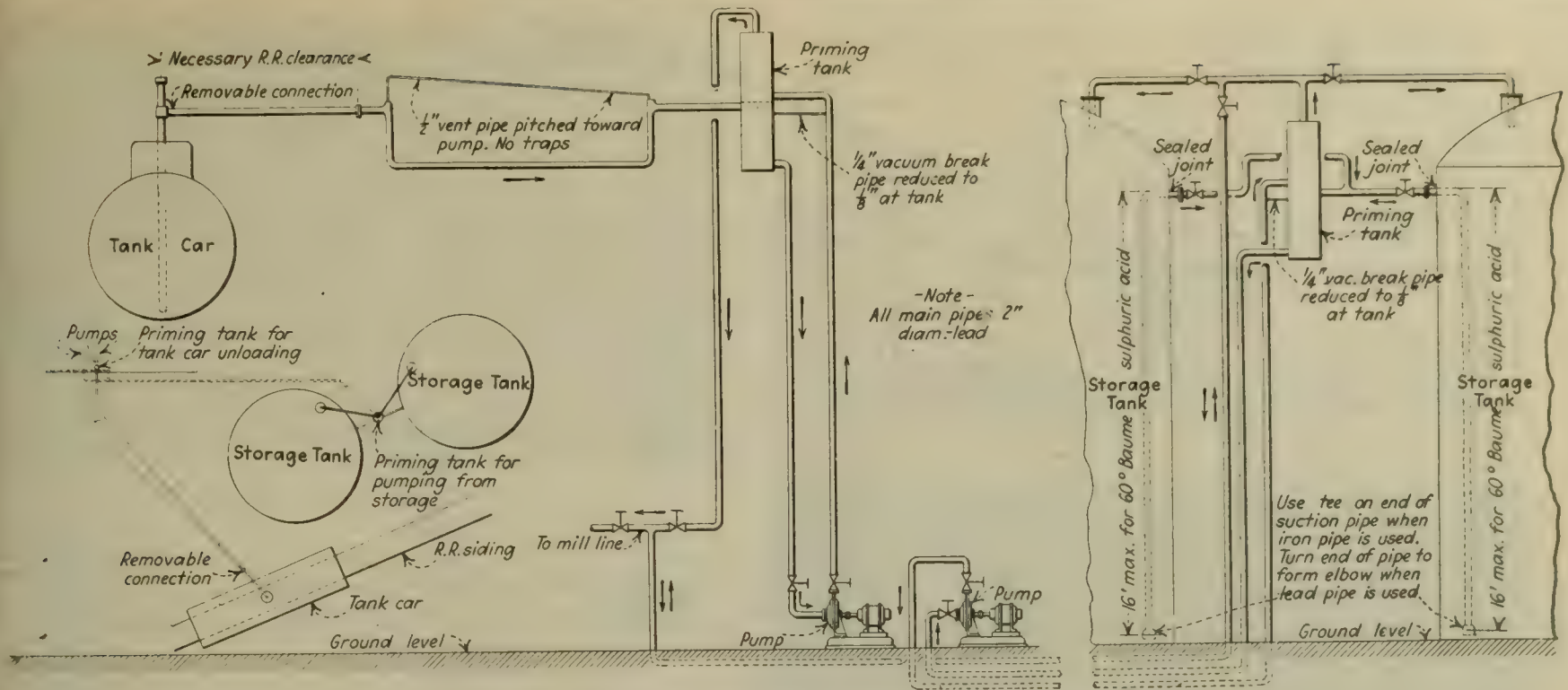


FIG. 16. PLAN AND ELEVATION OF ACID-HANDLING CONNECTIONS

valve on the third floor to the screw conveyors of either unit, whence it is carried to the dust weigh hopper over the mixers on the second floor. The acid 53 deg. Bé. sulphuric acid is simultaneously drawn to the acid-measuring hopper from the tank on the third floor.

Each charge for the Steadman pan mixer consists of about 1,625 lb. of acid, basis of 50 deg. Bé., and a like

quantity of ground rock, or about $1\frac{1}{2}$ tons total charge to the batch. Considerable quantities of fume are developed in the mixing and subsequent operations which is principally produced from the action of the sulphuric acid upon the fluorspar in the rock giving off hydrofluoric acid and silicon fluoride. This is conducted through tarred wooden flues to a wood stave tower

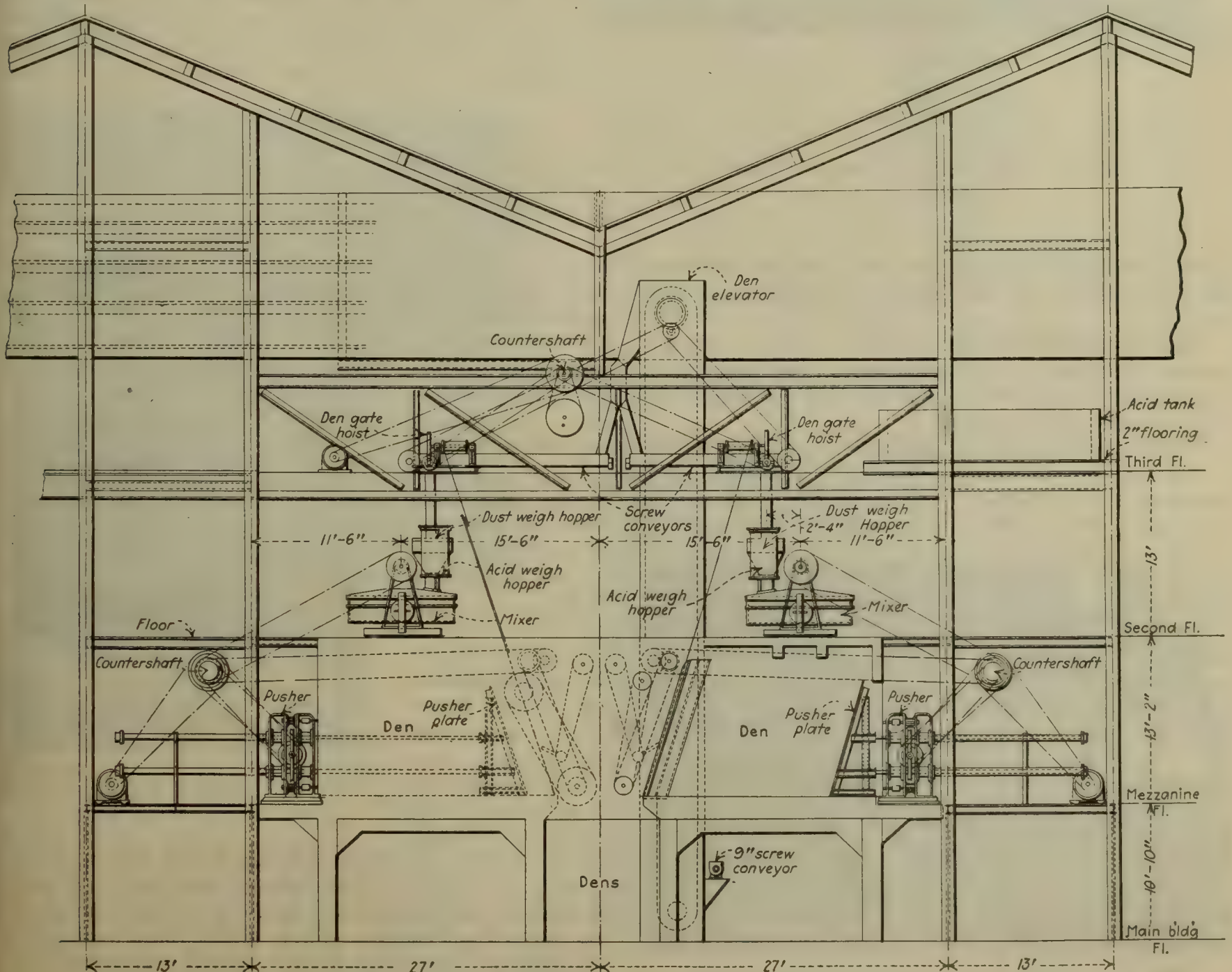


FIG. 17. SIDE ELEVATION, ACID PHOSPHATE PLANT

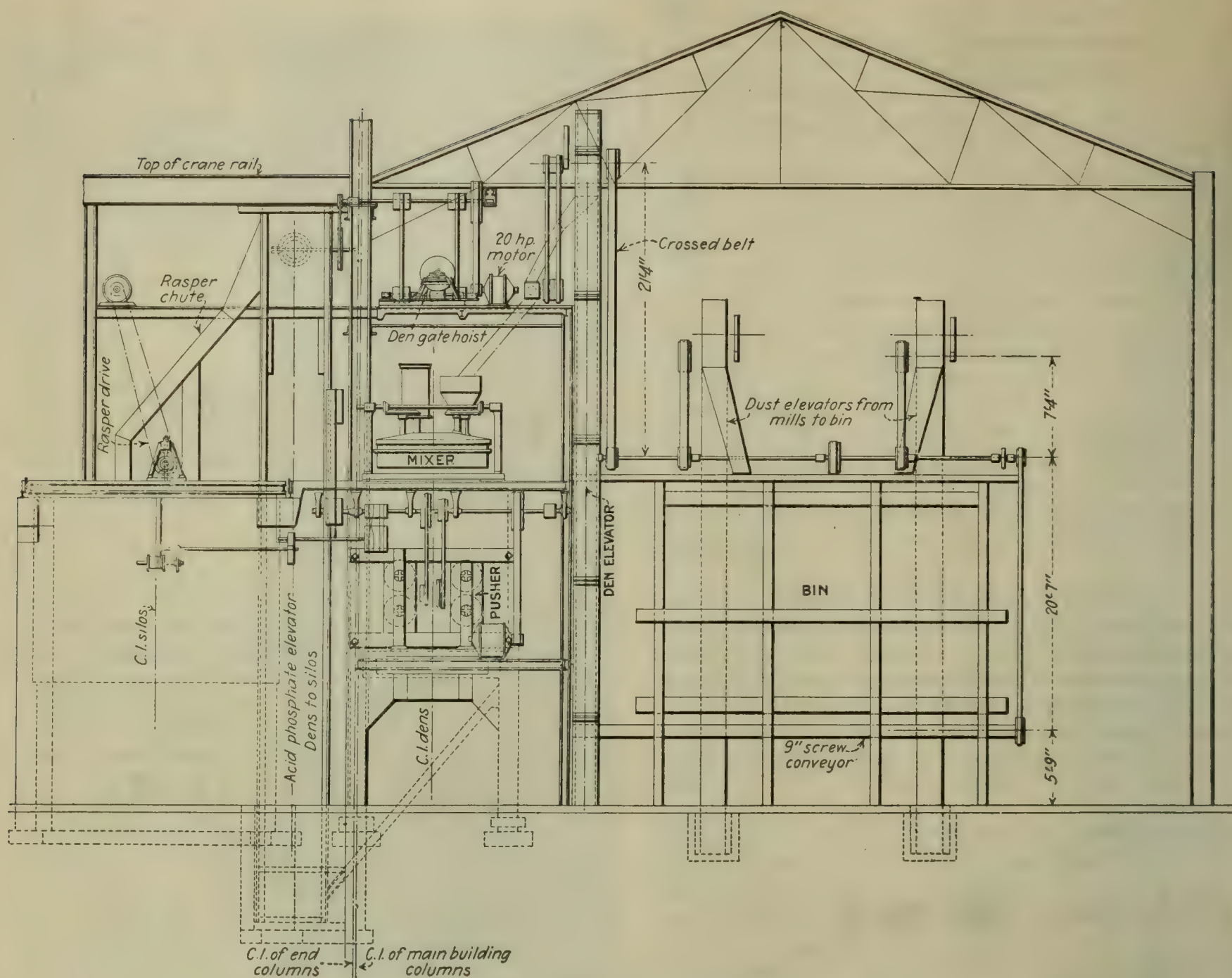


FIG. 18. LEFT END ELEVATION, ACID PHOSPHATE PLANT

system outside of the building and absorbed in water. The exhaustor on the end of the line is also made from wood.

Figs. 19 and 20 show the Steadman mixers and connections for feed and fume removal. The floor in the foreground of Fig. 20 is the movable platform over silo 1, as will be later noted.

When the batch is finished the mixer is discharged to the den directly below. One den is charged while the other is discharging.

The dens are constructed of heavily reinforced con-

crete on the side walls and bottom and will hold about 40 tons of acid phosphate. On the rear end wall of each den is located the pusher plate, actuated by the pusher mechanism. The position of pusher plate shown on the right hand of Fig. 17, mezzanine floor, is maintained while the den is being filled from the mixer above. The front end wall consists of a movable steel plate set at an angle, as also shown, on the same den, completely closing the opening during the charging.

As soon as the den is completely filled this steel door is elevated out of the way by the drum gate hoist on the third floor and the den is ready for discharging. The cutting mechanism is next thrown into operation. This consists of steel link belts equipped with large cut-



FIG. 19. STEADMAN MIXER, SHOWING WOODEN FUME LINE



FIG. 20. MIXER IN OPERATION, SHOWING DRIVE



FIG. 21. RASPER AND DRIVE

ting wires, the whole covering the face of the material as exposed by the raising of the steel gate. This mechanism is indicated in dotted outline as belts running at approximately the same angle as the gates.

Simultaneously with the starting of the cutters, the pusher motors are thrown in and the pusher plate slowly moves forward, forcing the whole mass of material against the cutters as fast as they can operate to shave it away at the surface.

Left-hand den, Fig. 17, shows position of pusher plate when den is nearly discharged. The machinery which operates the pusher plate consists of four large threaded bars with driving nuts working on the order of a screw-jack. A rear view of the plate mechanism is shown in Fig. 18.

As the cutters shave away the wet packed material to a powder it falls into the boot of the acid phosphate



FIG. 22. CRANE HANDLING ACID PHOSPHATE TO STORAGE PILE

elevator, Fig. 18, whence it is delivered to the rasper chute.

RASPING AND AIRING

The rasper receives the damp phosphate and puts it through a further intimate mixing operation in much the same manner as the den cutters. The chute and rasper drive are shown in Fig. 21. The rasper is located between silos 1 and 2 as indicated in Fig. 13, and may be discharged to either silo. It will be noted on the left of drawing, Fig. 18, that each silo is covered by a movable platform while being filled. This forms a closed compartment from which the fumes and dust

are drawn to outside atmosphere by a Sturtevant exhaustor during the operation. The platform appears in the foreground, Fig. 21, one of the supporting car wheels showing on the left. When a silo has been filled the platform is moved away by motor drive and the material is removed to the curing piles in acid phosphate storage by overhead crane. Here it remains at least six weeks before shipment. About 50,000 tons is produced annually at the present time.

Fig. 22 is a view down one side of the fertilizer mixing plant from the silo platform with one of the two Champion 10-ton cranes delivering phosphate to the curing piles in storage. Fig. 23 shows a closer view in the

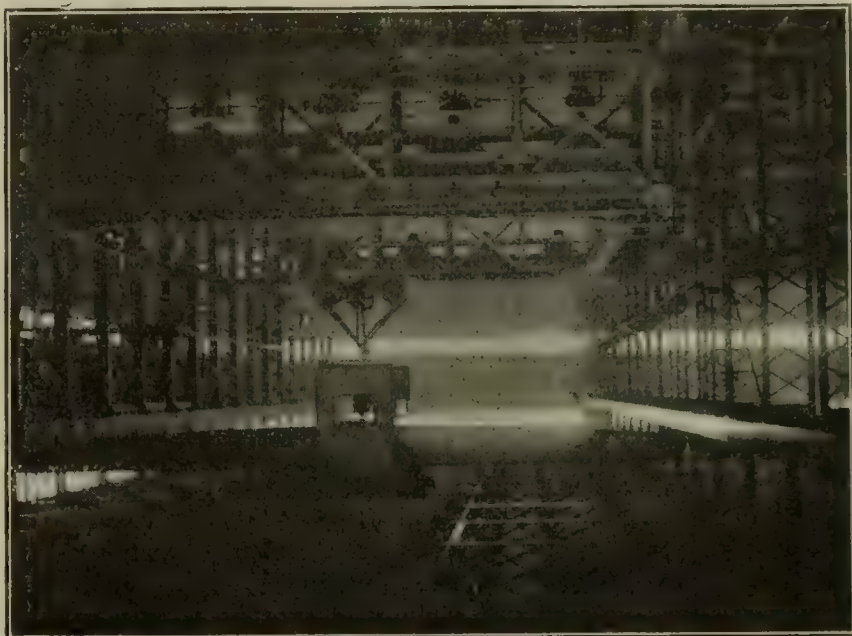


FIG. 23. MIXING PLANT

same direction with the crane in position to discharge a load to the mixing bins. Note industrial railway running along tops of bins and the two cars, Fig. 22.

MIXING FERTILIZER

The general layout of operations here differs from the usual principle of having the straight line flow of materials through the plant in that the work is carried out in three dimensions.

The crane is the key to the situation in that it both fills and empties stock piles from the top. The partitions or bulkheads for separating the various stock piles are

made up from 2 x 10-in. timbers laid flat and spaced with 2 x 4's on edge. (See Fig. 24.) This new system of bulkheading secures better ventilation of the piles and allows ready alteration in partition arrangements to suit changing conditions and quantities of materials. When it is desired to mix up a certain fertilizer the crane man is handed an approximate weight formula and proceeds to gather the ma-

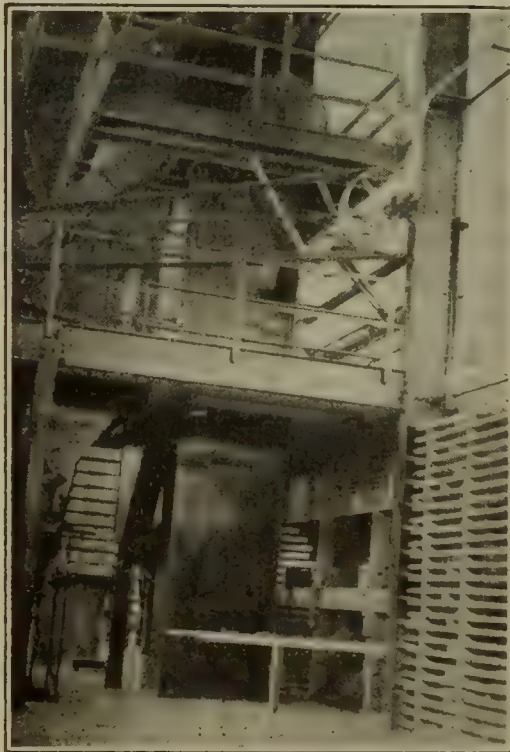


FIG. 24. BAGGING MILL 3

materials from the stock piles in the material storage area, dropping them into the tops of the mixing bins as shown in Fig. 23, one kind of material to each bin. Some material is also delivered by the industrial rail-



FIG. 25. MILL 1

leased on signal, to secure a preliminary mixing on the belt. Entering the elevator boot at mill 1, mixed material is delivered to the Steadman shaker screens on the upper balcony (Fig. 25.) The fine material goes through to the mixing hopper shown suspended from the second balcony. The reject from the screen goes through the squirrel cage disintegrator, seen as a large revolving cylinder on the first balcony, and thence is returned to the shaker screen.

MIXING THE FERTILIZER AND BAGGING THE FINISHED MATERIAL

When the charge is completely screened and delivered to the mixing hopper it is released into the Steadman pan mixer. Here it is held until thoroughly mixed. This is the most important operation in the production of mixed fertilizers. The mixer discharges to the three bagging hoppers on the main floor. The finished material may either be bagged at the hoppers or returned to the floor as shown through the chute on the lower right. Here it is again picked up by the crane and conveyed to mixed material storage. The bagging mill is manufactured by the Atlanta Utility Works and is equipped with automatic scales.

Unloading mills 1 and 2 are simply elevator arrangements for receiving material from piles dumped into the boots by crane and conveying it to the cars on the industrial railway overhead.

Bagging mills 3 and 4 receive finished material from the mixed fertilizer storage piles by way of the crane and wooden bagging bins. These empty into an elevator hopper which feeds a shaker screen through inclined chute, upper left, Fig. 24. It passes downward through the shaker screen to the steel hopper directly below. Thence it is drawn off through the two bagging hoppers equipped with Sturtevant automatic scales.

The bagged fertilizers are stacked along the floors on each side of the building immediately accessible to the shipping platform. Elwell-Parker storage battery trucks are used for conveying the bagged material about

the storage and shipping platforms. Equipment for charging and maintaining the batteries is located next to the shop, Fig. 13.

AUXILIARY EQUIPMENTS

Completely equipped machine shop, electricians' shop, tool room and locker wash rooms for white and colored force are maintained in the fertilizer building. Every provision is made for taking care of the men. About 60 per cent of the personnel is colored labor. Fire protection is maintained by a Dayton-Dowd centrifugal pump rated 1,000 gal. per min. against 100 lb., with a full speed of 1,750 r.p.m. direct-connected to a 100-hp. 1,740 r.p.m. Northwestern Mfg. Co. motor, drawing its supply of water from a 200,000-gal. concrete reservoir.

The chemical laboratory occupies the top floor of the brick office building and is well equipped for both research and control work. Ten chemists make up the present staff.

CONCLUSION

Manufacturing plants, like men, have character, but the character of any plant is only a physical manifestation of the sum of human characters who carry on the daily operations. The designers, it is true, are responsible for the mechanical beauty of the process in all that the word means to the heart of an engineer, but the operators may mar or enhance its being. They alone are responsible for its becoming a marvelous living thing. If they do not put into the work that something we call morale or spirit, the total effect on the visitor is more depressing than an overgrown graveyard.

Those engineers who are privileged to observe the character of procedure of the Armour Fertilizer Works organization at Chicago Heights carry away an inspiration from both an æsthetic and economic viewpoint. The chemical engineers lay down alike the immediate and the new lines of work to follow and the common sense human touch carries it through.

Crisis in Swedish Tar Industry

The Swedish tar industry, which during the war reached considerable proportions, seems to be facing ruin, reports Consul Walter H. Sholes, of Goteberg. Of the about 900 factories of the country, not more than 100 are working, and these few are working under unfavorable conditions. Good wood tar, which before the war was sold at 30 to 35 ore per kilo (7.8 to 9.1c. per 2.2 lb.) now brings only 15 ore (3.9c.), while manufacturing expenses are estimated to be double. Factory owners have been forced to the unusual expedient of asking for a loan from the government. It is possible that this will appear before the coming Riksdag.

Production of Castor Beans in Java

Castor-bean production is now encouraged in Java states an issue of Holland's *East India*, the oil being already used by the natives, especially for the Battik textile industry. It has been found that the seed can be safely grown under copra trees, the yield per acre adding considerably to the native's profit on the copra. During the first half of 1920 exports of castor beans from Java amounted to 742,000 kilos (kilo equals 2.2 lb.), against 301,000 kilos for the corresponding period of 1919 and only 99,000 kilos during the first six months of 1918.

Macroscopic Examination of Metals

A Brief Statement of the Defects Which May Be Revealed by Visual Examination of Etched Smooth Surfaces of Steel and Other Alloys—Physical Unsoundness and Internal Strain May Be Detected by Special Methods

By HENRY S. RAWDON

Physicist, Bureau of Standards

THE term "structure," when employed with reference to metals and alloys, is used in a somewhat restricted sense. The metal microscopist ordinarily does not include in his definition of this term such characteristics as the minute crystalline structure, the arrangement of atoms and such other fundamental features of the structure of matter as may be revealed by suitably refined means. The term is used to include those features for which no refinement greater than that to reveal which the modern compound microscope is necessary. It should be borne in mind, however, that in a few special cases recourse must be had to very special means for suitably revealing the structural features of the metal.

MACROSCOPIC EXAMINATION

The study of the structure of any metal most properly begins with the macroscopic examination of the specimen—that is, with an examination which does not involve any magnification other than that obtained by the use of the simple magnifier. Although this survey is usually made for the purpose of revealing chemical non-homogeneity, generally by some suitable etching method, other important structural features are often revealed. The various features revealed by the macroscopic examination of metals may be summarized under the following types:

1. Chemical non-homogeneity, due to segregation, liquation, decarburization, cementation and similar causes. In wrought metals, lack of complete chemical homogeneity often serves the useful purpose of furnishing a record of the plastic flow of the metal during the various manufacturing operations. This is generally revealed by etching.

2. Crystalline heterogeneity due to rate of cooling and to local variations in the cooling. Local overheating may also contribute to this. Etching with ammonium persulphate is admirable for both steel and copper alloys.

3. Mechanical non-uniformity; presence of internal stresses. When the condition is very severe it may be revealed by deep etching with mercury solutions for copper alloys and concentrated acids for steels.

4. Physical unsoundness, blowholes, porosity, "flakes," internal discontinuities, etc. X-ray and the magnetic examination in addition to visual examination may be used to show such features.

CHEMICAL NON-HOMOGENEITY AND CRYSTALLINE HETEROGENEITY

One of the most serious and most common of the defects of alloys revealed by macroscopic examination is the lack of chemical homogeneity. Such variations in composition may be brought about in the material intentionally as, for examples, in case-hardened steels, partially malleable cast iron, and similar products, in which case it is hardly to be classed as a defect. In the greater number of examples by far, however,

chemical non-homogeneity represents an undesirable state resulting from conditions of manufacture, such as segregation and liquation. Such conditions often are so pronounced that they persist in the metal throughout the different treatments, both mechanical and thermal, that it received and so appear in the metal in its finished state. They may thus serve the useful purpose of furnishing a record of the plastic flow of the metal during the various manufacturing operations. Variations in the chemical composition of any alloy quite generally result in a differential attack of the material when it is subjected to the action of a corrosive or etching reagent of any kind. The greater the difference in composition in different portions of the metal the more pronounced are the relative differences in the etch-pattern which results.

GENERAL METHOD OF USING REAGENTS

Table I gives the more commonly used etching reagents for macroscopic examination of steel. Precautions in the manipulation may be as follows:

The specimen, which has been sectioned and roughly polished, carefully cleaned free from oil marks or fingerprints by washing in alcohol or gasoline and then dried, is immersed in the solution, polished surface up. Care must be taken that the solution quickly covers the entire surface, that no air bubbles are entrapped and that the liquid is agitated gently; otherwise queer misleading markings on the etched surface may result. If desired, the surface of the metal may be rubbed with a little emery flour on the tip of the finger washed with water and immersed while still wet so as to promote the even flow of the etching reagent over it.

Etch patterns produced by a prolonged attack by a dilute acid are often much less sharp and distinct than one produced in the same material by a rapid attack by a concentrated acid. A prolonged etching—for example, four or five hours—in 5 per cent alcoholic solution of picric acid is often very useful, however. The deeply etched specimen may be used for producing a permanent record by inking the face with printer's ink and making a print on paper.

SULPHUR-PRINTING

The distribution of sulphur is usually shown by the so-called sulphur-print method. The steel specimen is sectioned and the surface, after being smoothed off with a file, is pressed firmly against a sheet of photographic paper which has been moistened with a dilute sulphuric acid solution. Two c.c. concentrated acid in 100 c.c. water is the concentration generally used, though in many cases a more dilute one may be used to advantage. Particularly is this the case with metal very high in sulphur and also for very large specimens where considerable time is needed for placing the paper in

TABLE I. COMMON ETCHING REAGENTS FOR STEEL MACROSTRUCTURE

Name	Composition	Special Manipulation	Remarks
Heyn's.....	10 g. $\text{CuCl}_2 \cdot 2\text{NH}_4\text{Cl} + 2\text{H}_2\text{O}$ in 120 c.c. water.....	Copper film removed by wet cotton swab.....	
Iodine.....	10 g. I, 20 g. KI, 100 c.c. water.....		Markings not so clear as with Heyn's.
Concentrated acids.....	Conc. HCl Conc. HNO_3 in equal parts water..... 20 c.c. conc. H_2SO_4 in 100 c.c. water.....	At 100 deg. C..... Often used at 60 deg. C.....	
Ammonium persulphate....	1 or 2 g. $(\text{NH}_4)_2\text{S}_2\text{O}_8$ in 10 c.c. water.....		Excellent for crystalline heterogeneity. Also for copper alloys.
Mercuric chloride.....	10 g. HgCl_2 , 20 c.c. 1.12 HCl , 100 c.c. water.....	Dip thin silk in reagent and spread silk over metal.....	
Stead's.....	10 g. CuCl_2 , 40 g. MgCl_2 , 20 c.c. conc. HCl ; alcohol to make 1,000 c.c.....		
Le Chatelier.....	100 c.c. 95 per cent alcohol, 10 c.c. water, 1 g. CuCl_2 , 0.5 g. picric acid; 1 to 3 c.c. conc. HCl		

position. "Matt-finish" paper should be used. It is extremely difficult to prevent glossy paper from slipping on the metal surface, in which case a blurred print results. A fine polish of the surface such as is essential for microscopic examination is not necessary nor desirable for sulphur-printing. Very clear prints can be made on surfaces finished with a medium-fine file. Bromide paper or any of the common developing photographic papers may be used. By the use of a suitable press, prints which are as clear and definite as the photographs of the etched surfaces may be obtained.

The work of Le Chatelier and Bogitch¹ indicates that the darkening of the sensitized surface of the photographic paper is due to the action of the acid upon the sulphur alone and not to the combined action of sulphur and phosphorus, as was formerly generally supposed. The assumption is always made, however, that any non-homogeneity which may exist for the other metalloids, besides sulphur, occurs under the same conditions as does that of sulphur and that the distribution of sulphur recorded in the sulphur-print is an index of the distribution of the other constituents of the steel also.

For revealing the macrostructural features of brasses, bronzes and similar alloys of high copper content, an aqueous solution of ammonium persulphate is very often employed, although an acidified solution of ferric chloride or an ammoniacal solution of copper chloride may be used with very good results. The relative size and arrangement of the crystals are the features in which one is most interested—that is, in addition to the matter of soundness in the case of castings. In this case, however, an etching is usually unnecessary.

The reagent commonly employed for etching aluminum and its alloys for revealing the macrostructure is an aqueous solution of sodium hydroxide (approximately 10 per cent). It is customary to heat the specimen in the solution until the surface is sufficiently etched. A combination of alkali and hydrofluoric acid etching has been highly recommended by Carpenter.² The specimen is etched in an alcoholic solution of sodium hydroxide to remove the "flowed" surface metal. When the surface has been faintly etched, the sample is transferred to a dilute aqueous hydrofluoric acid solution (1 or 2 per cent) and allowed to remain until the etching is complete.

The occurrence of minute pores or intercrystalline cavities in castings of light aluminum alloys is a matter of grave importance. Their presence can often be detected in suspected metal by immersing a polished

specimen in alcohol colored with picric acid or some other brightly colored dye. The specimen, after rapid washing to remove all traces of the dye on the surface, is dried and allowed to stand in a warm place. The porosity of the metal is often indicated by the appearance of colored spots on the surface as the colored alcohol evaporates from within the internal cavities in which it was inclosed.

PHYSICAL UNSOUNDNESS

Much of the evidence of this phase of the structure of metals is furnished by a simple visual examination. In case the unsoundness is of a minute character, the method described for aluminum may be used. In other cases very special means must be used. If the surface of the specimen is carefully machined, a very light finishing out with a very sharp tool being made, evidence as to the *true* state of the soundness of material is often made available—information can be obtained in almost no other way. The ordinary methods which involve polishing and etching exaggerate the features of unsoundness to a considerable degree. In many alloys and metals which are rather coarsely crystalline careful machining is often sufficient also to reveal the structure of the material to a very surprising degree.

An examination by means of X-rays is often of value if the specimen is not too large. The features revealed by this method of examination are primarily those

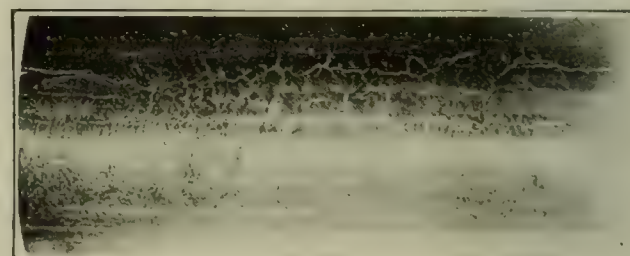


FIG. 1. SECTION OF A 1-IN. MANGANESE BRONZE ROD ETCHED WITH AN ACIDULATED AQUEOUS SOLUTION OF MERCUROUS NITRATE. $\times 1$

which result from considerable differences in density, hence it is of great value in locating internal cavities and similar flaws. Ordinary segregation cannot be revealed by this means, although it has been successfully used in detecting such features of composition as resulted from the addition of a lead alloy for filling cavities in light aluminum castings. Specimens of steel to be examined by this means should not exceed $\frac{1}{2}$ in. in thickness. As a general rule, the thicker the specimen the more pronounced must be the defect in order that its presence can be revealed by this means.

For the detection of surface cracks such as may be produced by hardening by quenching and similar operations upon steel, a magnetic method will be found very useful. The method is particularly valuable for

¹H. Le Chatelier and B. Bogitch, "Macrographie des Aciers," *Rev. Met.* vol. 16, p. 129, 1919; *CHEM. & MET.* vol. 23, p. 383, Sept. 1, 1920.

²H. C. H. Carpenter and C. F. Elam, "Crystal Growth and Recrystallization in Metals," *J. Inst. Metals*, vol. 24, 1920.

revealing them in an early stage in the shaping of a piece—for example, precision gages and similar pieces which must be ground to size—so that defective specimens may be discarded without much expenditure of wasted effort. The roughly polished specimen is magnetized and then immersed in a light oil containing very fine iron dust in suspension. Kerosene and “cast-iron mud” such as is obtained from lapping disks may be used.

The iron particles bridge across any slight discontinuity in the surface of the specimen and locate very accurately the system of surface cracks. The excess of iron dust may be removed by bathing the specimen in alcohol or clean kerosene. The method has also been successfully used for the detection of internal fractures in wrought steel parts.³

MECHANICAL NON-UNIFORMITY

The examination of metals for mechanical non-uniformity—i.e., for the presence of internal stresses of high magnitude which may later lead to serious deterioration—may be noted here. Fig. 1 shows a portion of a cold-worked rod of manganese bronze which



FIG. 2. HARDENED STEEL BALLS WHICH SPLIT OPEN WHEN DEEPLY ETCHED WITH CONCENTRATED HYDROCHLORIC ACID. $\times 2$

has been immersed in a solution of mercurous nitrate acidulated with nitric acid. The cracks which were formed by the action of this reagent may be taken as an indication of what would undoubtedly have occurred spontaneously later in service.⁴ Materials which crack readily when treated in this manner can be shown by other means to be highly stressed internally, as has been described at length elsewhere.⁵

Steel parts such as balls and roller bearings which are very vigorously hardened indicate by their behavior upon etching in the proper manner that a similar condition obtains there. Fig. 2 shows several hardened steel balls which split when they were etched with hot concentrated acid; cold-rolled steel shafting will sometimes behave similarly when deeply etched in the same manner.

The cracking of the metals illustrated above when subjected to the proper etching reagents and the similar deterioration “season cracking,” which may occur spontaneously in service, are not to be regarded simply as a result of structural variations. However, the distortion of the structure in the cold-worked metals in which such conditions occur is very pronounced and undoubtedly is contributory in a very large degree to the unusual behavior of the metal.

Present Status of the Belgian Iron and Steel Industry

In spite of the active reconstruction work which has been carried on in Belgian metallurgical centers since the armistice, this industry is still far from obtaining its pre-war position, reports Trade Commissioner Cross, of Brussels. Particularly in the large plants centering about Liège, regardless of relative success in recruiting skilled labor and in recovering confiscated machinery, it has not been possible during the two years which have elapsed since the armistice to efface the damage done by the invading forces, since the resumption of production has been complicated by the necessity of diverting to repair work a relatively large proportion of the available help.

In the Province of Liège, out of 240 metallurgical plants of all sorts, ten are completely shut down, fourteen are producing less than 25 per cent of their 1913 quota, sixty-two are producing between 25 and 50 per cent, sixty-five between 50 and 75 per cent, and sixty-three are producing between 75 and 100 per cent. Only sixteen are giving over 100 per cent of the pre-war production.

The necessary capital for restoration and increased running expenses has been obtained to some extent through indemnities paid by the Belgian Government and largely by issues of new capital and debentures.

Out of fifty-one blast furnaces now existing in Belgium, twenty-one are in operation and seven others are substantially ready for firing. There were but twelve blast furnaces in operation on Jan. 1, 1920. Those at present restored have a capacity of 65 per cent of the 1913 production. Though there appears to be enough coke for all immediate needs, there is an appreciable shortage of enough coal of high volatile content for gas generators and Martin converters, and the plants which do not exploit their own coal mines are not able to accumulate large stocks.

Owing to the general destruction of rolling mills and the difficulty of renewing stocks of rolls, Belgian market offerings present a somewhat limited scope, but with the further progress of restoration a wider variety of products may be looked for.

Until the spring of 1920 the production of Belgian metallurgical plants was entirely engaged by the needs of domestic construction and by exports to northern France, and the competition for their products resulted in a considerable rise in prices, which reached its peak about the middle of May, 1920. From this date forward a slow and steady downward movement began. German competition is already making itself felt in finished steel products, such as bars, beams and rails.

The autumn of 1920 found the Belgian iron and steel industry producing 51 per cent of its pre-war production of pig iron, 69 per cent of finished iron, 54 per cent of steel ingots and 62 per cent of finished steel, thus indicating notable progress since the beginning of the year. The situation in fuel and raw materials has improved, especially on account of regular supplies of German coking coal and the operations of restored coke ovens.

Many plants aside from reconstruction work have modernized and extended their installations. The high prices, which rendered production extremely profitable, since the armistice have since May, 1920, given way before a slackening of demand. Furthermore, the problem of readjusting labor costs to falling prices creates an element of uncertainty in the present situation.

³H. S. Rawdon and S. Epstein, Bureau of Standards Tech. Paper 156, “Metallographic Features Revealed by the Deep Etching of Iron and Steel”; CHEM. & MET., vol. 22, p. 505, March 17, 1920.

⁴H. S. Rawdon, “The Use of Mercury Solutions for Predicting the Season Cracking of Brass,” A.S.T.M. Proceedings, vol. 17, pt. 2, p. 189, 1917.

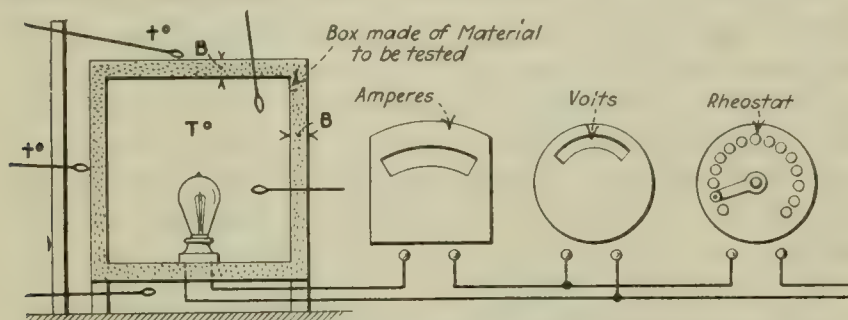
⁵P. D. Merica and R. W. Woodward, Bureau of Standards Tech. Paper 82, “Failure of Brass; 1.—Microstructure and Initial Stresses in Wrought Brasses of the Type 60 Per Cent Copper and 40 Per Cent Zinc.”

Relative Heat Conductivities of Some Insulating and Building Materials

BY JAMES J. LICHTIN

THE object of this investigation has been to determine by the so-called air box method the relative heat conductivities of materials used for insulation of apparatus, vessels, tanks, etc., used in the chemical industries or as building materials. Further, the aim has been to compare these conductivity values with the conductivity of a new porous insulating and building material "Porete," made of cement and sand, data of which have not been published before.

It was therefore necessary to conduct the tests of the different materials under equal conditions as nearly as



SCHEMATIC ARRANGEMENT FOR HEAT-CONDUCTIVITY TESTING

possible. A number of cube-shaped boxes were constructed of the different materials of practically the same dimensions, which were approximately 8 x 8 x 8 in. inside. The thickness of the walls was about 1 in. An electric lamp was used as a heating element inside these boxes. The electric current was regulated by a rheostat and measured by accurate voltmeter and ammeter.

The temperature inside was measured by two thermometers and outside by three thermometers, all located as shown in the accompanying drawing, and these thermometers were placed in the same relative position on each testing box.

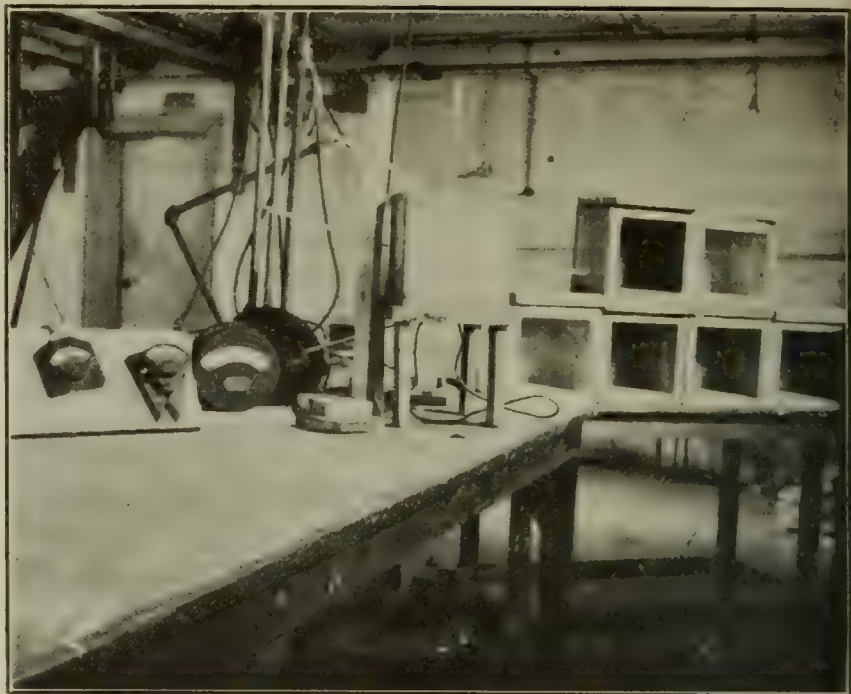
The testing apparatus was set up in the basement of the laboratory, where the room temperature was fairly constant. No readings were taken during the first twenty-four hours in order to allow time for all conditions to reach an equilibrium. After this readings were taken about every two hours.

The conductivities K as shown in the accompanying tables in B.t.u. were calculated from the formula

$$K = \frac{3.415 \times B \times W}{12 \times A \times (T - t)}$$

where B is the thickness of the walls in inches, A the area in sq.ft., W the watts from the voltmeter and ammeter readings and $T - t$ the difference between the inside and outside temperatures as indicated by the thermometers. Area A was considered to be the mean between the inside area and the outside area of the box.

The thermal conductivity so measured is the quantity of heat in B.t.u. that flows through 1 sq.ft. unit area



HEAT-CONDUCTIVITY TESTING APPARATUS

of plates, through a unit thickness of 1 ft. having a unit difference of 1 deg. F. between its faces.

It is clearly seen from the table that the conductivity of Porete stands midway between that of gypsum and yellow pine. Comparing our conductivity values with those obtained at the U. S. Bureau of Standards,¹ where the plate method has been used in testing approximately the same materials, we note how nearly our figures agree with theirs, thus:

	Our Conductivity Values in B.t.u.	Density, Lb./Cu.Ft.	Conductivity in B.t.u. Equiv., U. S. Bu. of Stand.	Density, Lb./Cu.Ft.
Yellow pine....	0.0719	40	0.0799	34
Air cell.....	0.0335	13	0.0399	8.8
Cork board....	0.0277	11.7	0.0256	11

We are aware that the results thus obtained cannot be accurately compared with results of similar tests made under different conditions, because the conductivity K found in this way is not the heat transmitted only through the tested material of the thickness B , but it is the heat which passes through the layer of air from the inside thermometer bulb to the wall, hence through the wall, and thence from the outside of the wall to the outside thermometer bulb.

The results will be different from the results of tests where air contact has been excluded, and they will also be different from results of tests where fans or other devices have been used to keep the air in motion, thereby diminishing the resistance to the air entering into the wall of the material to be tested. However, as the figures arrived at are those under which the materials are used ordinarily as insulators or in building construction, they will give a good idea of the relative values of heat conductivity of the materials tested.

Laboratory of the Verona Chemical Co., Newark, N. J.

¹"The testing of Thermal Insulators," by H. C. Dickinson and M. S. Van Dusen, *Journal, American Society of Refrigerating Engineers*, September, 1916.

Material	Box, Inside Dimension, In.	Walls, Mean Thickness, In.	Mean Area, A, Sq.Ft.	Vol. Box, Cu.In.	Weight Box, Lb.	Sp.Gr.	Wt. per Cu.Ft. Lb.	Elec. Current Consumed, Watts	Mean Inside Temp., T, Deg. F.	Mean Outside Temp., t, Deg. F.	Temp. Difference, T - t, Deg. F.	Heat Conductivity, K
Concrete, 1 cement : 2 sand.....	8½ x 8½ x 8½	1½	3.612	618	45.63	2.01	128	49.0	107.2	81.2	26.0	0.1760
Gypsum board.....	8½ x 8½ x 8½	1½	3.619	588	21.25	1.00	62.5	31.6	115.7	82.7	33.0	0.0846
Porete, reinforced with exp. metal.....	8½ x 8½ x 8½	1½	3.565	546	19.40	0.98	61	44.5	131.5	88.1	43.4	0.0786
Yellow pine, North Carolina.....	8½ x 8½ x 8½	1½	3.541	558	12.88	0.64	40	50.5	145.5	83.7	61.8	0.0719
Air cell, asbestos board.....	8 x 8 x 8½	1½	3.530	572	4.40	0.21	13	29.7	156.0	78.0	78.0	0.0335
Cork board.....	8 x 8 x 8	1½	3.470	566	3.83	0.187	11.7	6.82	94.9	72.9	22.7	0.0277

Possible Uses for the Spent Shale From Oil Shale Operations

BY KIRBY THOMAS
Consulting Engineer

ONE of the obvious problems in connection with the plans for the treatment of oil shales to recover oil and byproducts is the handling and disposal of the waste material. This waste amounts to from 60 to 80 per cent by weight of the material treated, depending on the amount of volatile hydrocarbons in the shale and on the amount of water, combined and uncombined. The bulk percentage is somewhat more than the weight percentage because of the expansion of the shale pieces and particles under the treatment process and because of the greater space necessarily occupied by broken or ground material of the physical character of shale.

DISPOSAL OF SPENT SHALE

In an operation having a throughput of a thousand tons daily the mere handling of the spent shale and its removal to a waste dump is a large mechanical problem. The cost of this feature of the operation must be a proportionately considerable item in the production costs. There exists also the necessity of providing suitable and adequate dumping sites. The factor of the cost of mining and breaking at the plant of this large percentage of waste material must be considered also, for the oil shale operations at best are in the class of the low-grade metal mines as to the relation of cost of operation and value of the product. In respect to the waste, the problem is somewhat similar to that with which the asbestos miners are confronted, only the value of the product is much greater in the case of the asbestos operations.

Fortunately the extensive oil shale deposits in Colorado and Utah, by reason of the usual cliff-like character of the shale beds which are likely to receive attention at the start and for a very long time, present very favorable conditions for the disposal of the waste, for gravity mill and waste dump sites generally can be selected and there is always plenty of outdoors for the unlimited extension of the dumps. In one instance it was proposed to place a treatment plant on a level site near the Grand River and it was planned to dispose of the waste by dumping it into the river. It was found that Uncle Sam and the state were likely to have something to say about such a procedure in the interests of control of flood waters for irrigation purposes and to protect the fish in the river. In the Eastern states the conditions as to waste disposal sites are not so favorable either from topographic considerations or from the standpoint of available dump area.

VALUE OF SPENT SHALE

Very little attention has been given to the waste disposal phase of the oil shale operations or to the investigation of possible uses for the waste material which would give it some value and aid in its handling and perhaps also contribute an important item to the aggregate of the products recovered from the shale by the processes proposed.

The waste shale is nothing more nor less than clay. Of course the different shale deposits vary somewhat in the general character of the mineral or inorganic material of which they are composed due to conditions affecting their origin especially as related to the character of the land surfaces from which in all cases the

material must have been derived in the first instance. The Colorado-Utah deposits have undergone no change through geological agencies such as result in the metamorphism and general rearrangement of the crystalline and molecular status of the original rock. In only a few localities have these beds been folded or even tilted since deposition. Such a condition does not prevail in some of the other shale deposits of the Western area. The Nevada deposits at Elko and the California deposits near Santa Barbara are steeply inclined and in some cases folded. Generally in these Western deposits there have been no changes or alteration through the heat agencies of volcanic intrusions or lava flows. Such conditions and relations prevail in a few Western localities, but these are not likely to be considered for the basis of operations now or for a long time to come.

It is to be noted that the recent flow of basaltic lava which covers some of the edges of the Green River shale beds of Colorado and which was once probably much more extensive has hardly changed the topmost layers lying in direct contact with the lava beds. The Eastern shale deposits are older than those of the West, being, in the Central states, mostly Devonian or belonging to the Mississippian member of the Lower Carboniferous. These are relatively undisturbed over large areas in Ohio, Indiana, Kentucky, Tennessee and Illinois and are free from the influence of all plutonic agencies. They have been somewhat tilted in some localities and in some cases there has been limited folding of such a character that it has changed the hydrocarbon elements of the shale into graphite. It is probable that some of the folding and orogenic movement has also resulted in the removal of the hydrocarbon material from the shale by influences of heat and pressure, or heat with pressure, and its transformation into the crude petroleum which is now being recovered by means of drilled wells tapping the natural catchment reservoirs in the overlying or perhaps also underlying strata. These Eastern shales are generally more indurated by reason of their greater age and perhaps the greater and longer pressure to which they have been subjected.

CHEMICAL COMPOSITION OF OIL SHALES

The shales everywhere vary slightly in their content of what may be called extraneous minerals. There is found a variation in the free silica and also in the silica which has come in by solution and percolation. There are small variations in the iron content and some also in the lime proportions. Sometimes other minerals, including the ores of the precious and common metals, are to be found in small amounts in the shale in irregular and limited localizations.

ANALYSIS OF A SAMPLE OF A KENTUCKY SHALE DEPOSIT

Analysis of Shale		Per Cent
Silica.....		36.32
Alumina.....		11.60
Iron oxide.....		2.00
Titanium oxide.....		.40
Calcium oxide.....		5.72
Magnesium oxide.....		3.82
Sulphur.....		2.01
Potash.....		2.91
Soda.....		1.30
Total nitrogen expressed as ammonia.....		1.21
Loss of ignition (organic matter, etc.).....		34.04
Distillation Test		
Maximum temperature of distillation, deg. F.....		1,560
Oil recovered per ton of shale, calculated from small-scale distillation test, 160 lb. or gal.....		20.1
Gas produced per ton of shale, calculated from small-scale distillation test at 30 in. mercury pressure and 60 deg. F., cu. ft.....		3,600
Yield of ammonium sulphate per ton of shale, calculated from small-scale distillation test, lb.....		4.32
Carbon in residue, per cent.....		13.02

A complete analysis of a sample of a Kentucky shale deposit in Powell County made by the Detroit Testing Laboratory is available. The analysis is given in the accompanying table.

This analysis is probably fairly typical of most of the Eastern shale deposits now under consideration. In the Western shale generally the percentage of the volatile matter is greater, but the ratio of the other elements in the residue is about the same judging from the small amount of precise chemical data at hand.

SPENT SHALE AS FUEL

After treatment the spent shale generally contains a considerable percentage of fixed carbon. This is called "coke" and it has a heat value which it is proposed to use as fuel in some of the process plans to supplement the non-condensable gas which is an unavoidable product of all of the retort operations. As this gas and the fixed carbon result from the imperfections of the applications of the method, they are a measure of the inefficiency of the process and it is small satisfaction to be able to convert them to some use of less value than would be the case if they had been recovered in the operation as valuable oil.

SPENT SHALE AS A NON-CONDUCTOR MATERIAL FOR ELECTRICAL APPLICATIONS

The spent shale with the fixed carbon—from 7 per cent up—has special qualities for use as a cheap material for a non-conductor for electrical applications. Experiments have been made in this use with reported good results. The material is molded wet and baked, or pressed into suitable shapes and forms. Similar experiments have been made with the untreated shale, and in consideration of the relatively larger carbon content, though not as fixed carbon, the results may be expected to be better than with the spent shale. This fact and the great abundance of the original shale make the effort in this line to find an outlet for the spent shale defeat itself.

SPENT SHALE AS A MATERIAL FOR MAKING BRICK

Practical tests of the availability of the spent shale for making brick for constructional purposes have been made with the material from the Colorado deposits. The results are very satisfactory, as might be expected. The brick have a greater strength for their size and weight than the brick from ordinary clay or slate. This point will give the shale brick a clear preference in an even competition aside from the probable lesser cost of the material for making brick, if the already mined and crushed waste shale is used. It is possible, too, that the physical condition of the clay from the spent shale and the effects of the preliminary heat-treatment may be beneficial and of advantage in its use for brick-making. This possible use for the waste will have a limited importance with the Western shale deposits mostly because of their remoteness from the best market for the brick. Of course tile and other similar products can be made from shale clay also, and these may furnish local needs in the West and have a better market as far as the Western operations are concerned.

In the East, where the shale deposits are situated in thickly settled regions, the making of brick affords an important and practical outlet for large quantities of the spent shale. In fact it is conceivable that some of the operations in Ohio and Indiana, as proposed, may find a profitable demand for their whole spent product

for making brick and tile and such products, which are used in great and increasing quantities at the present time.

USE OF SPENT SHALE IN THE CEMENT INDUSTRY

A use which has the possibility of taking care of a very large amount of the spent shale is connected with the plan to co-ordinate the shale operations with the cement industry. The waste heat from the cement kilns can be used to "boost" the heat for the oil shale retorts, and conversely the waste heat for the shale operation can be turned back to the cement kilns.

This idea has been embodied in patent 1,323,294, Dec. 2, 1919, taken out by Robert W. Lesley of Philadelphia. Mr. Lesley is a cement engineer of note and is largely interested in the cement companies of the East. The possibility of the making available of an essential ingredient of so low priced a product as cement at a lesser cost is conversely of more significance to the vast established cement industry than it is incidentally to the newer oil shale business.

It is probable that this relation is fully appreciated by the cement interests, which are now apparently quite well balanced in their competitive status. Generally it will be practicable to assemble the other materials for cement-making at the localities where the Eastern shale operations are proposed. These localities are chiefly in convenient positions to be correlated thus with the cement operations both as to assembling the raw materials and the distribution of the finished product. The projected shale operations in Kentucky are in the centrally located Powell County. The Indiana deposits of shale are in Floyd, Jefferson, Clark, Jennings, Scott and Jackson Counties. Other shale deposits are found in southern Ohio and eastern Tennessee, and in central Illinois. It is likely that they will be found in Pennsylvania and in western New York. This distribution is suggestive of a possible close interrelation between the shale industry and the cement industry if the mutual advantage as above discussed is proved by actual test on a large scale.

OTHER POSSIBLE USES FOR SPENT SHALE

A plan to mold the waste shale for railroad ties has been experimented with. It is claimed that a tie so made is strong and of course it is lasting. The claim is also made that a shale tie has a certain amount of elasticity which is lacking in a cement tie or in the sometimes used steel ties. The spent shale probably will soon make soil suitable for tilling, differing in this respect from most of the waste material from quarries and mines.

ECONOMIC ADVANTAGES RESULTING FROM THE USE OF SPENT SHALE

Taken in connection with the expectation that the shale will yield ammonia, and in some cases potash, in addition to the oil, the possibilities for useful applications for the waste are of great importance to the successful establishment of this new and needed industry in this country.

The determination of the practicability of these supplemental products from the oil shale will have the greater benefit to the Eastern shale deposits clearly and will go a long way, taken in connection with the collateral advantage in marketing the oil and other distillation products, in offsetting the lower oil yield of the Eastern shale—about one-half that of those of Colorado and Utah.

Manufacture of Synthetic Ammonia at Oppau, Germany*—III

Manufacture of Ammonium Sulphate, Ammonium Chloride and Ammonium Nitrate—Coke Plant, Power Stations and Other Supplementary Plants Required to Make the Oppau Works a Complete Entity—General Organization—Conclusion†

THE process employed at the Oppau works for the manufacture of ammonium sulphate with gypsum is based on the difference of solubility in water of calcium sulphate and calcium carbonate and is analogous to the Solvay process for the manufacture of soda. The process is protected by a French patent of the French Société Industrielle de Produits Chimiques.

The gypsum used is brought to the plant from the Neckarzümmer quarries by 108 special cars of thirty-four tons capacity.

The gypsum is first crushed to about fist size and charged into storage bins, whence it is carried by a bucket elevator to a belt conveyor leading to the hoppers of pulverizers. The pulverized gypsum is conveyed by an endless screw to a bucket elevator, which feeds the hopper of a recording automatic weighing machine. From this weighing machine the gypsum is carried into a hermetically closed reservoir provided with an agitator and into which is added water sufficient to prepare the required gypsum paste. The plant has three reservoirs of 3-m. diameter and 3 m. high. This paste can be stored in two reservoirs 5 m. in diameter and 5 m. high provided with agitators. The dust above the hoppers is collected by a ventilator and carried to a dust collector.

The paste is then brought into thirteen cylindro-conical reaction vats 3 m. in diameter and 1.5 m. high at the cylindrical part, and 1 m. high at the conical part. These vats are provided with belt-driven helicoidal agitators which are maintained at 45 deg.

The paste is fed through one pipe, the carbon dioxide through eleven pipes located around the cylinder and the ammonia through one pipe. The gases, after reacting, are brought by a pipe to a separator located above the cover. The separators are connected by a double piping, of which one is endless, the other leading to washing towers for the recovery of the ammonia. There are four such towers 12 m. high and filled with Raschig rings.

The circulation of the carbon dioxide is insured by a double compressor driven by a steam engine and by three ventilators driven by 150-kw. motors.

The contents of the reacting vats are led to two reservoirs 4 m. in diameter and 5 m. high provided with agitators and thence to three similar reservoirs in which the reaction is completed. The duration of the reaction is from nine to ten hours.

The mass is then sent to filtering vats. There are ten such vats 4 x 2 x 1.5 m., each vat containing twenty-eight 5-cm. thick plates, closed by filtering fabrics supported by sheet-iron plates provided with 5-mm. holes. Pipes from the bottom corner of the plates lead to a manifold which ends in three branches, each branch connected to a separator. The corners of the plates

diagonally opposite to the lower outlets are connected to a manifold vacuum duct. From the separators the filtrate is siphoned into reservoirs.

The calcium carbonate adhering to the plates is separated by the injection of compressed air and led into two separators 2.5 m. high and 1 m. in diameter, whence it is transported by an endless screw into two tanks 3 m. in diameter and 3 m. high. These tanks are emptied by a circulating jet of water from a centrifugal pump.

The ammonium sulphate solution is taken from the reservoirs, filtered and stored in reservoirs of 4-m. diameter and 5 m. high. The concentration of the solution is about 25 per cent. From these reservoirs the solution is brought into the concentration building, containing six double-effect evaporators of 2.5-m. diameter and 6 to 7 m. high, into which steam arrives at the middle part. The crystals formed are separated from mother-liquor in horizontal centrifugal dewaterers. The drained crystals are transported by belt conveyors to two coal-fired rotating drying furnaces. The dried crystals are then stored in storage bins 100 m. long, 50 m. high and 30 m. wide. Additional ammonium sulphate crystals are obtained by cooling the mother-liquors. These crystals are separated by filter presses or by draining, dried and stored in the above storage bins.

The Oppau works has a capacity for treating 1,000 tons of gypsum per day.

MANUFACTURE OF AMMONIUM CHLORIDE AND SOLVAY SODA

The preparation of ammonium chloride and sodium carbonate by the Solvay process (action of ammonia and carbon dioxide on salt) takes place in vats A (Fig. 15).

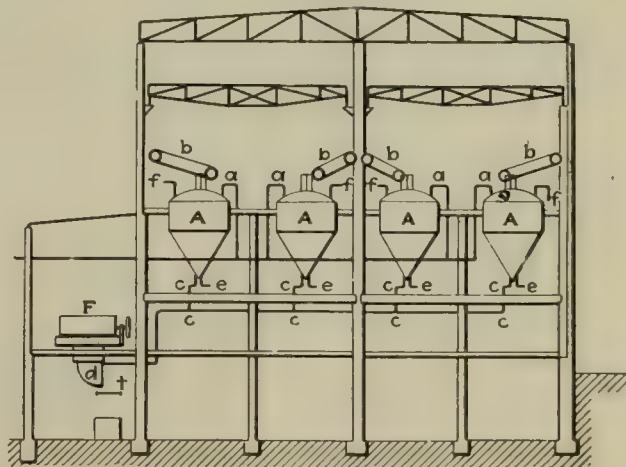


FIG. 15. SCHEMATIC ARRANGEMENT FOR THE MANUFACTURE OF AMMONIUM CHLORIDE

There are thirty-six brick-lined vats 3.5 m. in diameter, 1.5 m. high for the cylindrical part and 3 m. high for the conical part, and provided with helicoidal agitators driven by belts *b* and with cooling coils. The gases, ammonia and carbon dioxide arrive at the bottom of the vats through six pipes.

*From *La Technique Moderne*, November, 1920, pp. 449-460.

†For Parts I and II see *CHEMICAL & METALLURGICAL ENGINEERING*, vol. 24, Nos. 7 and 8, pp. 305 and 347, Feb. 16 and 23, 1921.

The brine is prepared in a semi-cylindrical trough, decanted and stored in reservoirs 4 m. in diameter and 4 m. high, provided with agitators and with water and steam inlets. This brine is led to the reaction vats through *e* at the bottom of the vats.

The gases escaping at *f* are sent to two ammonia recovery columns. The paste leaves at the lower part of the vats at *c* and enters four tanks with filtering bottoms. Some of the crystals remain on the filter and are drained, the others are separated in rotary filters *F*.

The sodium bicarbonate crystals collected from the drainer and filter are conveyed to storage by a belt conveyor *t*.

The filtered solution is pumped into three 60-cu.m. reservoirs and thence into twelve double-effect concentrators. The concentrated product is sent into draining tanks. The drained crystals of ammonium chloride are conveyed to the storage and the solution is pumped into four reservoirs of 2 m. diameter and 6 m. high, where an additional concentration takes place with the separation by draining of another part of crystals, which are conveyed to the storage. The final solution is pumped into reservoirs 4 m. in diameter and 5 m. high.

The crystals of ammonium chloride from the storage are conveyed by belt conveyors and bucket elevators to rotary driers which are similar to those used for the drying of the ammonium sulphate crystals. The dried ammonium chloride is stored in storage bins.

The proportions of the reacting products are 78 ammonia for 269 salt. The action of the ammonia lasts from one and one-half to two hours and that of the carbon dioxide eighteen hours. The production capacity is 160 tons of ammonium chloride per twenty-four hours.

MANUFACTURE OF AMMONIUM NITRATE

Ammonium nitrate is manufactured by the direct action of nitric acid on ammonia. The reaction takes place in eight vats similar to those used for the manufacture of ammonium sulphate or ammonium chloride. The ammonia enters at the bottom through six pipes; nitric acid, from brick reservoirs, tarred inside, 4 m. in diameter and 3 m. high, is pumped into three stone-ware cylinders 1.5 m. in diameter and 2 m. high, whence it flows into the reaction vats.

The nitrate solution is collected in reservoirs 3 m. in diameter and 3 m. high, whence it is sent to evaporators.

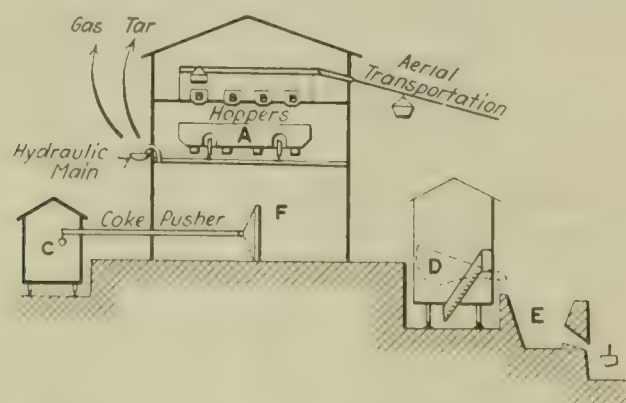


FIG. 16. SCHEMATIC ARRANGEMENT OF COKE PLANT

These evaporators are tubular boilers, eight in number, of 2-m. diameter and 3 m. long. Steam at 12 kg. pressure circulates in the tubes and the boiler is under a vacuum of 60 to 70 cm. of mercury. The steam formed is received into a tubular condenser. The concentrated solution is received in reservoirs, whence it is taken to be treated for the production of nitrate in a manner analogous to that for the production of ammonium

chloride or ammonium sulphate, or mixed with a powdered salt, particularly potassium chloride, for the production of special fertilizers. This mixing takes place in flat vats provided with agitators. The paste formed is emptied by an endless screw and will be (the installation is not yet completed) conveyed by belt conveyors and bucket elevators to rotary driers and the dried product stored in two 100-m. long storage bins now under construction.

There is also an ammonium nitrate solution concentration plant consisting of two open vats heated by steam coils.

SUPPLEMENTARY PLANTS AT THE OPPAU WORKS

The Oppau works has been erected with the idea of being a complete entity and thus, besides the different departments described above, it also has all the needed supplementary departments such as manufacture of catalysts, coke ovens, motive power, coal-handling, water supply and laboratories.

MANUFACTURE OF CATALYSTS

The catalytic masses are manufactured in a separate building which contains crushers, mixers, pugmills and furnaces. The conveying is done by belt conveyors and bucket elevators.

COKE PLANT

The coke plant consists of two batteries of sixty-five ovens of the Collins system. Size of ovens, 8 m. long, 2.5 m. high, 0.40 m. wide (Fig. 16).

The coal is brought in by aerial transportation, discharged into hoppers *B* and bins *A*, whence it is charged into the furnaces *F*. The coke pusher *C* sends the coke to the quenching chamber *D* and hopper *E*, whence it is conveyed by aerial transportation to wherever needed.

The ovens of each battery have a common hydraulic main. The gas is treated for the separation of light oils. This takes place in two groups working in parallel, each group consisting of six towers 12 m. high, 3 m. diameter, which work in series. The gas then passes a rotary meter and is stored in a 10,000-cu.m. gas holder.

About 850 tons of coal are coked per twenty-four hours, giving about 650 tons of coke.

MOTIVE POWER

There are two electric power stations, one using producer gas, the other equipped with turbo-alternators. Both stations produce three-phase, 50-cycle, 3,000-volt current.

The lean gas power station comprises two Siemens-Schuckert 1,875-kw. alternators direct-connected to two 2-cylinder tandem Nuremberg gas engines and two 3,380-kw. Siemens alternators direct-connected to Thyssen gas engines. The exhaust gases from the Nuremberg gas engine enter tubular boilers generating steam at 4-kg. pressure, and the exhaust gases from the Thyssen engines enter tubular boilers generating steam at 12-kg. pressure and superheated to 270 deg. C. About 13 per cent of the lost heat is thus recovered, giving about 0.36 kg. of steam per kw.-hr.

The turbo-alternators power station comprises one Curtiss 6,250-kw. turbine with an A. E. G. (Allgemeine Elektrizitäts Gesellschaft) alternator, two Quelly turbines with Siemens-Schuckert 4,000-kw. alternators and one Brown-Boveri turbine with a 4,000-kw. Brown-Boveri alternator.

The boilers (Fig. 17) are formed of four horizontal parallel cylinders *A, B, C, D*. The cylinders *A* and *C* are connected by ten vertical tubes *F* and the cylinders *B* and *D* are connected by ten tubes *E*, which form a 60-deg. angle with the horizontal. Cylinders *A* and *B, C* and *D* are also connected respectively by two 25-cm. tubes *G* and four 36-cm. tubes *H*. Cylinders *C* and *D* are besides connected by three vertical tubes with drums *I*. The steam is superheated in a superheater consisting of coils. Lignite briquets are used as fuel and are fed by mechanical stokers *K*. Four groups of boilers are also arranged for firing with gas. The total heating surface is 17,785 sq.m. and the grate surface 355.7 sq.m. The production of steam is about one ton per hour per sq.m. of grate. The consumption of fuel is 2,400 tons lignite briquets per day, which is equivalent to 1,300 tons of coal.

Besides these two central power stations there are a number of steam engines and steam turbines installed separately in different buildings and connected to different machinery such as pumps, compressors and ventilators. These steam engines and turbines receive the steam from the central boiler room or from individual boiler rooms, using the hot gases from the different reactions in the respective buildings.

COAL HANDLING

On the average the plant uses over 2,000 tons of fuel per day, practically all of which is handled mechanically (only 5 per cent of the total power required is furnished by manual labor). The fuel arrives by barges on the Rhine River, and is unloaded by hoists running on overhead rails located parallel to the river. These rails *A* form a U with the two branches of unequal length. The short branch (450 m.) runs along the Rhine, the long branch (700 m.) runs along the fuel storage yard. The cars are hauled by a continuous cable manipulated from the cabin *B* (Fig. 18).

The unloading is done by three hoists *C*. Each hoist consists essentially of a beam *D* (Fig. 19) inclined at 46 deg., the lower part of which is jointed and kept in the dotted position when not working. A bucket *e* runs along the beam. The coal taken from the barge is emptied into hopper *F* after it has been weighed by an automatic weighing machine. From the hopper the fuel may be loaded into cars *W* running on rails to the desired place, or into buckets running on aerial transportation *G* which is provided with a series of switches (Figs. 20 and 21) for directing the disposal of the fuel in the buckets. The switching is done as follows: The aerial rails have side tracks, *H*₁ and *H*₂ connected to the main track by inclines, *K*₁ and *K*₂, and a series of pulleys *L*₁, *L*₂, *L*₃, for the driving cable. The pulleys are so arranged that under normal conditions the buckets when approaching the side tracks *H*₁, *H*₂ are detached from the main driving cable and by their own momentum run over the sidetrack and incline back to the main track, where they are again caught by the driving cable.

If switching is needed the bucket, instead of running back to the main track, is directed to the desired track

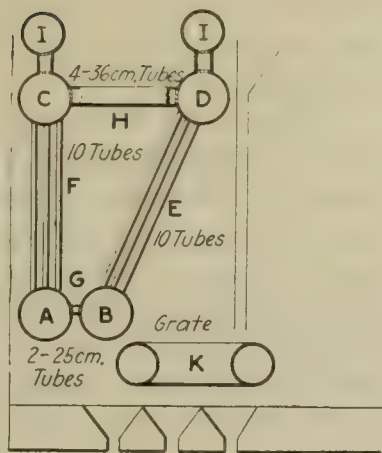


FIG. 17. ARRANGEMENT OF BOILERS, TURBO-ALTERNATORS CENTRAL STATION

branch and is pushed along this branch by manual labor until it is attached to the respective driving cable. *M* and *N* are transmission stations.

Along the other branch of the *U* there are five cranes *Q* and hoists *P* for loading the coal from the storage yard into bins running along the aerial transportation lines to wherever needed. By convenient switches the fuel can be directed to fuel storage bins located in different parts of the plant. Special switchings connect the main aerial transportation lines to the coke plant and gas producer buildings.

WATER SUPPLY

The plant consumes on the average 7,000 liters of water per second. This water is supplied from the River Rhine by seven centrifugal pumps driven by electric or gas motors. There are two water reservoirs connected to the river by two conduits respectively 1.70 m. and 1.10 m. in diameter. The water before being used is filtered through a 50-cm. sand layer in eighty sheet-iron vats of 15 x 3 x 1-m. dimensions. This filtering implies a loss of 2-m. pumping head, which is to be added to the 6-m. head required for supplying the plant. The size of the discharge pipes of the centrifugal pumps varies from 60 to 100 cm. according to the type of the pump. There are nine pumps, of which six are gas-motor-driven and three electric-motor-driven. All the water is first sent into a 1.3-m. diameter reservoir, whence it is distributed by three main branches to wherever needed.

LABORATORIES

Each department has its own laboratory where all the routine work analyses are made and in which there is besides a special personnel of chemists doing research work.

There is also a main laboratory directed by Dr.

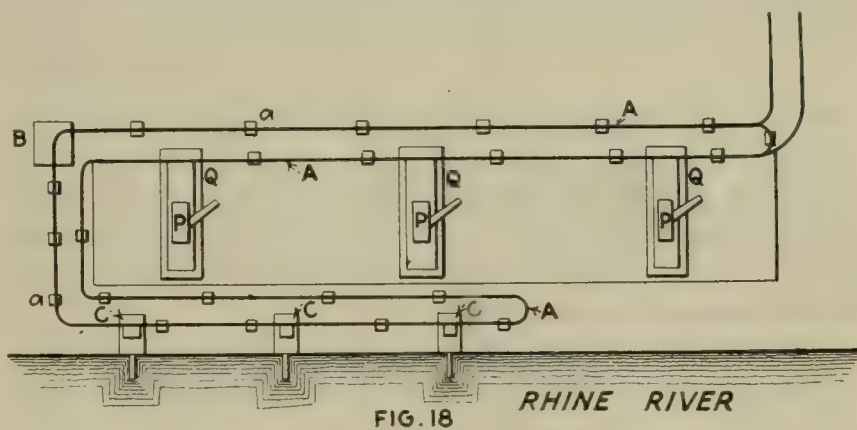


FIG. 18

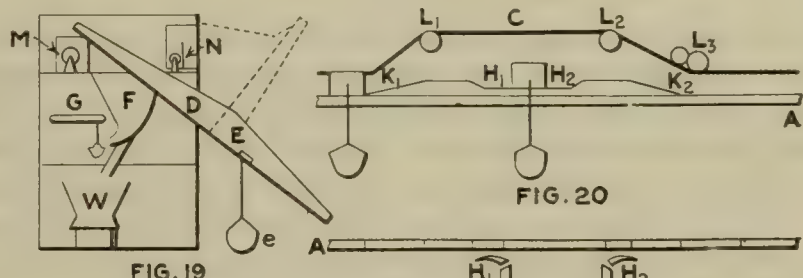


FIG. 19

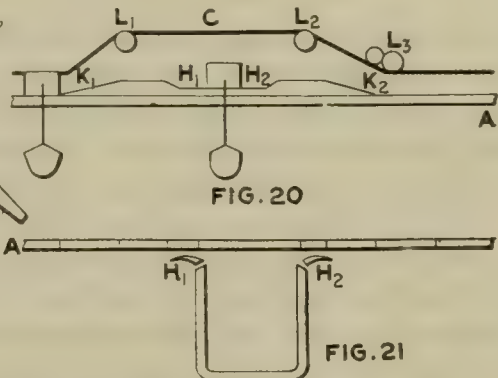


FIG. 21

FIGS. 18 TO 21

Fig. 18. Schematic arrangement of the coal unloading installation.

Fig. 19. Unloader.

Figs. 20 and 21. Switching arrangement.

Mittach, where fifteen to twenty chemists and fifty to sixty subordinates are employed for research work affecting the efficient operation and improvements of the general process.

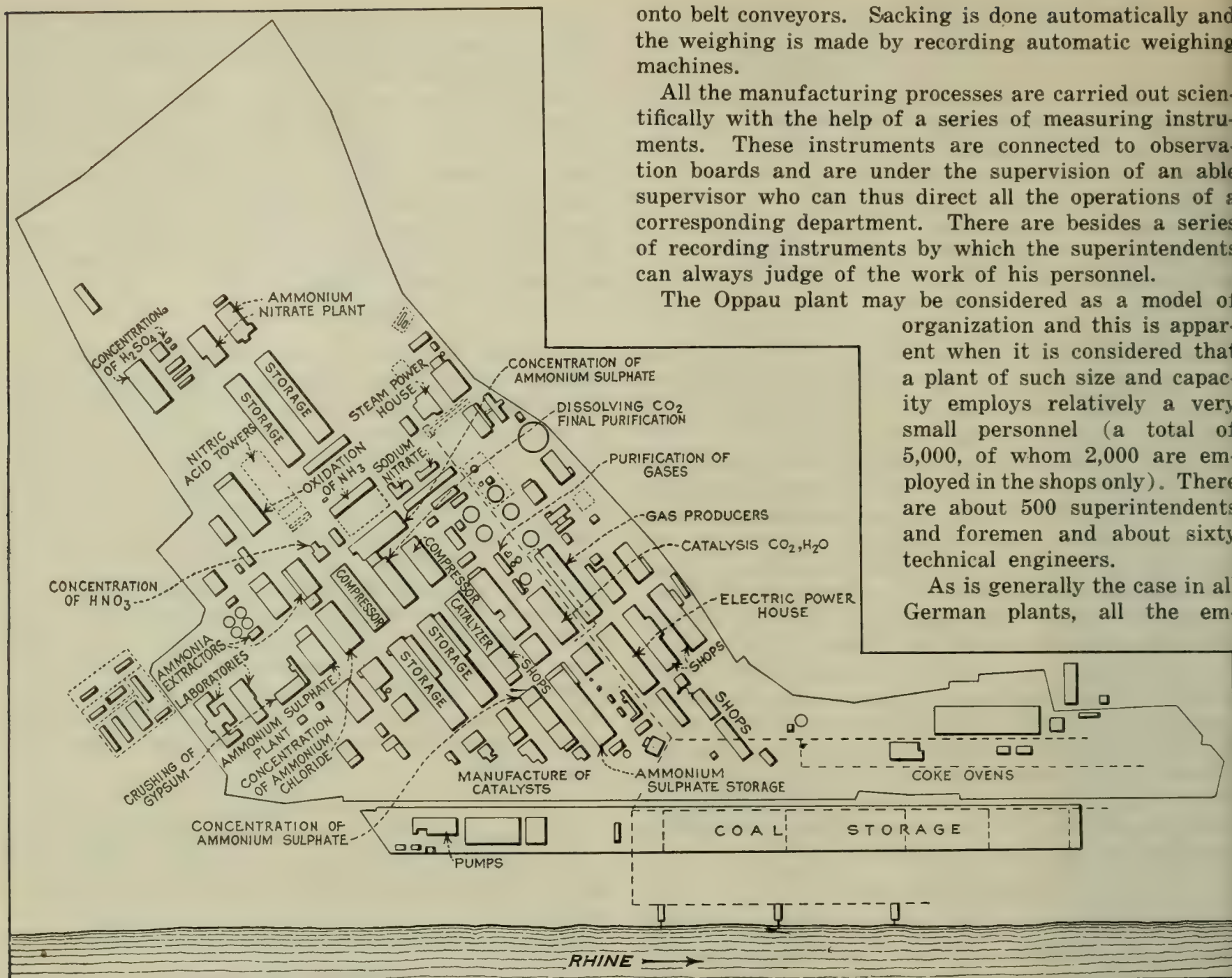


FIG. 22. PLAN OF THE WORKS

The Oppau plant has a number of special shops for forging, turning, mounting, carpentry, building, etc., in which practically all the requirements of the plant can be taken care of. Only the heavy forgings and foundry pieces, electric motors, steam engines and gas motors are of outside make.

The entire works at Oppau employs about 5,000 men, of whom about 2,000 are employed in the shops.

GENERAL ORGANIZATION

The plant as shown in Fig. 22 occupies an area of about 800 hectares. Its construction was begun in 1912 and offered some difficulties owing especially to the small resistance of the soil. It was necessary to go to a depth of 17 m. to find a solid base for the foundations.

All the buildings are spacious, well lighted and ventilated. Pipe lines for gas, steam and solutions are laid all over the plant, some overhead and some underground. When the pipes are laid underground they are inclosed in easily accessible conduits.

The greatest care has been exercised to reduce the manual labor in all the plant to a minimum. All the shops are provided with cranes, electrically-driven hoists of appropriate power and strength. The transportation of the solid materials is made in special cars with automatic discharge or by belt conveyors, endless screws or bucket elevators. The fertilizer storage bins are provided with hoists on cranes which charge the material

onto belt conveyors. Sacking is done automatically and the weighing is made by recording automatic weighing machines.

All the manufacturing processes are carried out scientifically with the help of a series of measuring instruments. These instruments are connected to observation boards and are under the supervision of an able supervisor who can thus direct all the operations of a corresponding department. There are besides a series of recording instruments by which the superintendents can always judge of the work of his personnel.

The Oppau plant may be considered as a model of organization and this is apparent when it is considered that a plant of such size and capacity employs relatively a very small personnel (a total of 5,000, of whom 2,000 are employed in the shops only). There are about 500 superintendents and foremen and about sixty technical engineers.

As is generally the case in all German plants, all the em-

ployees, engineers and laborers alike, are given well-determined tasks and do not have access to other departments than their own unless they have special permit.

CONCLUSION

The cost of the Oppau plant was 300,000,000 marks (\$75,000,000 at pre-war exchange rates). It has a capacity of 300 tons of ammonia. (It is said that the Merseburg plant has a capacity of 900 tons of ammonia.) It is estimated that at pre-war prices the cost per kg. of combined ammonia was 0.70 mark, and it is not surprising that with such production costs it was very easy to compete with the Chilean and Peruvian nitrates and to make Germany independent of these natural supplies. It is to be taken into consideration that this low cost was made possible by the abundance of fuel and river transportation facilities.

The French are now working in quite a different direction from that of the Germans for the manufacture of synthetic ammonia for fertilizer purposes. Georges Claude is doing excellent work on dispensing with the use of the costly sulphuric acid for making ammonium sulphate fertilizer and instead he will use the now wasted byproduct of the Solvay process and produce an ammonium chloride fertilizer.¹

¹The characteristic distinctions between the Haber and the Claude processes for the production of synthetic ammonia were summarized in CHEM. & MET. ENG., vol. 23, p. 395, Sept. 1, 1920.

Molybdenum Steels*

Development of Molybdenum Steel in America—Early Experiments with This Element in Complex Alloys for Tools—Recent Successful Utilization in Mechanical and Structural Steels of High Strength and Great Adaptability

BY JOHN A. MATTHEWS†

IT IS twenty years since the writer made his first molybdenum steels and others were making them commercially five years earlier, but the prevailing opinion seems to be that molybdenum steels are new; from time to time the daily press speaks of important discoveries in Europe and intimates that American steel makers have much to learn in regard to alloy steels. The earlier experiments were largely confined to the use of relatively high percentages of molybdenum in tool steels and permanent magnet steels. Recent developments deal with the types of alloy structural steels used for airplane, automobile and other engineering requirements; in these, the molybdenum content is usually less than 1 per cent. The earlier types generally have been unsuccessful commercially, but the newer types of steels are becoming of increasing importance.

The war showed our dependence on foreign sources for alloying metals; molybdenum alone is widely distributed in the United States and seemingly abundant. Many deposits are now of commercial interest, owing to location and relatively small amount of ore available, but other deposits are being developed and a stable source of supply seems well assured.

In tool and magnet steels, it was early found that 1 part of molybdenum was equivalent to from 2 to 2.5 parts of tungsten. The permanent magnet steels investigated by Mme. Curie,¹ in 1898, contained from 3.36 to 4.05 per cent molybdenum; in 1902, Dr. E. L. French and the writer thoroughly tested steels containing from 2.0 to 4.0 per cent. These steels gave satisfactory tests for permanence, but were low in residual density and much more sensitive to hardening than the corresponding tungsten products. We discontinued work with them therefore, and have no advice that such steels have been used commercially here or abroad.

Prior to the development of the Taylor-White process and the modern high-speed steels, air-hardening steels were in general use. These were high in carbon and usually contained tungsten and chromium, the latter having replaced the manganese of the original Mushet air-hardening steels. Later, the tungsten content was frequently replaced by molybdenum. An air-hardening steel largely used had the following analysis: carbon, 1.75 to 2.00 per cent; molybdenum, 3.75 to 4.25 per cent; chromium, 3.75 to 4.25 per cent.

In the earlier years of the twentieth century, high-speed steels quickly displaced the air-hardening steels. Most of the manufacturers confined their efforts to tungsten-chromium combinations, but in

America determined efforts were made to use molybdenum instead of tungsten. At the time that one European metallurgist was claiming that steel containing over 6 per cent molybdenum could not be rolled, we were commercially rolling large quantities of a steel containing over 9 per cent molybdenum and had successfully rolled steel containing up to 15 per cent. The use of molybdenum above 6 per cent was patented,² as was the use of vanadium with either tungsten or molybdenum in high-speed steel.³ So far as molybdenum was concerned, the manufacture of these steels was discontinued almost before the patents had been allowed. One of these patents has now expired, but "discoveries" of chrome-molybdenum-vanadium steel and molybdenum-vanadium steel for high-speed purposes were recently announced. Both of these types of steels were made and abandoned nearly twenty years ago, as they were found, after very exhaustive experiments and tests, to be unsatisfactory both to manufacturer and in use. Occasionally these steels gave extraordinarily good service, as measured by the standards of that time, which were much below the present standards of the leading high-speed steels. However, notwithstanding the discouraging results of the earlier experiments, the writer has felt that some time we should have to use molybdenum, due to shortage of tungsten, or for other economic reasons, and from time to time during the past twenty years we have repeated our experiments in the art of manufacture. This helped us to overcome the earlier difficulties and objectionable features.

PRINCIPAL DIFFICULTY WITH MOLYBDENUM IN HIGH-SPEED STEEL

One of the principal difficulties with molybdenum in high-speed steel is its tendency to volatilize at the high temperatures necessary in the working and hardening of the steel. Indeed, it is possible to detect high molybdenum steels under the hammer by the light yellow smoke arising, which is probably due to the oxide of molybdenum.

After prolonged or excessive heating, a well-defined zone on the outside of the bars or tools is entirely different from the interior in structure, and as a result, finished tools, such as drills and cutters, which cannot be given the grinding permissible with lathe tools are not satisfactory; this has greatly limited the use of molybdenum high-speed steels. Both vanadium and cobalt have been tried in an endeavor to overcome this difficulty. Recently it was stated that cobalt and vanadium are "stabilizers" for molybdenum, but the writer has seen

*Paper read at the New York meeting A. I. M. E., February, 1921.

†President, Crucible Steel Co. of America.

¹Bull. Soc. d'Encourage. l'Ind. Natle. (January, 1898).

²C. H. Halcomb: U. S. Pat. 722,504 (March 10, 1903).

³J. A. Mathews: U. S. Pat. 779,171 (Jan. 3, 1905).

no evidence to confirm these claims. On the other hand, molybdenum high-speed steel containing either or both of these elements has shown the defect in a marked degree. Some experiments now in progress promise more satisfactory results but it has not been determined whether our "stabilizer" in any way impairs the cutting qualities.

DEVELOPMENT OF MOLYBDENUM STEELS

Cobalt-molybdenum-vanadium high-speed steel was made and abandoned in America before the beginning of the European war, for it was found inferior to the regular tungsten-vanadium steel products with or without cobalt. After reading recently that cobalt-molybdenum-vanadium high-speed steel was the latest foreign contribution to tool-steel metallurgy, some of the cobalt-molybdenum-vanadium material made in 1914, some ingots made along similar lines in 1919, and some of the European steel were used in exhaustive and carefully conducted tests made by the Halcomb Steel Co., in which the leading brands of American and foreign manufacture were used. The molybdenum products failed to give satisfactory results and were rated much below the standard tungsten high-speed steels on the market today.

For the modern developments in the use of molybdenum, we are greatly indebted to C. Harold Wills, of Marysville, Mich. Having become convinced that there was abundant ore in this country, he experimented with molybdenum in a great variety of combinations. Much has been published regarding the physical properties and suggested types of molybdenum-alloy steels but we would refer to the papers by Dr. George W. Sargent,⁴ J. D. Cutter⁵ and Charles McKnight, Jr.,⁶ the booklet entitled "Molybdenum Commercial Steels" by the Climax Molybdenum Co. and the booklet of the Crucible Steel Co. of America entitled "Almo Steels." While much of this material is propaganda, it is based on experiments made in our own laboratories and plants, in those of the Carbon Steel Co., United Alloy Steel Co. and by Messrs. Wills and Chandler, formerly with the Ford Motor Co. The paper by Dr. Sargent refers to the work of Guillet, Saladin, Swinden and Giolitti in reference to prior use and manufacture of chrome-molybdenum steels of somewhat similar types to those in which interest is now centered. Mr. Cutter's paper proposes the use of a merit index for the comparison of different steels, and makes use of a formula in which the elastic limit, ultimate strength, elongation and reduction are all taken into consideration. A similar suggestion appears in the booklet "Almo Steels," in which the formula is limited to the tensile elastic limit and reduction of area.

In the mills, molybdenum steel has been found to work satisfactorily, being relatively as free from seams and similar defects as the older types of alloy steels; it is also freer from thick and tenacious scale than are the nickel and chrome-nickel types. It seems to flow readily, particularly in drop forgings, and can be worked over quite a wide range of temperature, say, from 2,100 to 2,500 deg. F. (1,150 to 1,370 deg. C.), though the higher temperature would not be recommended for steel above 0.25 to 0.30 per cent carbon.

The steel seems to have a wide safe heat-treatment range, as measured by static tests. But it is not advisable to stress this point as it leads to carelessness in heat treatment. In addition, it has been found that static tests are somewhat misleading in this regard. While many steels of high quality can be forged or heat treated through a considerable range of temperature without apparent loss in static qualities, dynamic or shock tests seem to indicate that for every steel there is a temperature at which the maximum of static and dynamic qualities are obtained. Shock-test methods in this regard are of especial value in supplementing our knowledge of materials or even in detecting faulty heat treatments that static tests do not show. Molybdenum steels seem to machine more readily at a given Brinell hardness than do other steels. This would mean, of course, that parts that must be heat treated and machined afterward could be utilized in a state showing higher physical properties than have been customarily obtainable. The physical property on which molybdenum seems to exert most effect is the reduction of area, which is considered a good measure of toughness.

INFLUENCE OF MOLYBDENUM IN ALLOY STEELS

Molybdenum, particularly in conjunction with chromium, seems to confer the property of deep hardening. This is to be expected from the observation that molybdenum steels resist the drawing temperature to quite an unusual degree. In other words, they require a higher drawing temperature to reduce the physical properties by the same amount that they would be reduced in similar steels without the presence of molybdenum. This indicates that molybdenum tends to keep the carbon in steel in the combined or martensitic form, and when in that condition to retard its passage to the sorbitic or troostitic state. Some years ago the writer sent to Prof. H. C. H. Carpenter,⁷ then at the National Physical Laboratory of Great Britain, a chrome-molybdenum steel together with a variety of commercial high-speed steels for use in his investigations upon the drawing or softening of hardened high-speed steels. This particular steel contained but 4 per cent of molybdenum, 3 per cent of chromium, and about 0.47 per cent carbon, yet it resisted the draw-back temperature, as measured by Prof. Carpenter's etching method, to a greater extent than any of the commercial tungsten high-speed steels used by him, whether of American or British manufacture.

It is possibly too early to make predictions, but the writer believes that molybdenum has established for itself a permanent place among the alloy steels found useful to the airplane, automobile and general engineering trades. It will not wholly displace any other type of steel, but the effect of improvements of this kind and new products has been rather to extend the field of usefulness than to eliminate products of previously demonstrated merit. The bessemer and open-hearth processes, and the electric furnace have not displaced the original crucible cast steel business. The demand for steels made by each method has arisen with the process itself.

Not only does molybdenum below 1 per cent give no trouble from volatilization, but it may be recovered from scrap when remelted in the open-hearth furnace to a large extent.

⁴"Molybdenum as an Alloying Element in Structural Steels," Amer. Soc. Test. Mat. (1920).

⁵"Suggested Method for Determining Comparative Efficiency of Certain Combinations of Alloy Steels," Trans. Amer. Soc. Steel Treat. (1920) vol. 1, p. 188.

⁶"Molybdenum Steels," Trans. Amer. Soc. Steel Treat. (1921).

⁷H. C. H. Carpenter, Tempering and Cutting Tests of High-Speed Steels," J. Iron and Steel Inst. (No. 3, 1906), vol. 71, p. 377.

Legal Notes

BY FREDERIC DANNERETH, PH.D.*

Legal and Official Chemistry

In modern chemical organizations considerable attention is being given to the centralization of the work pertaining to legal and official chemistry. This makes it possible for the executives of a corporation to obtain information quickly when a problem arises. In order to accomplish this purpose it is desirable to have on hand all the literature of importance which pertains to this phase of laboratory work. This includes the *Patent Office Gazette*, the *Treasury Decisions* (of the U. S. Custom House), the *Quarterly* of the National Fire Protection Association, the *Reports* issued by the State Boards of Health, *Transactions* of the Safety Institute of America and the *Rulings* of the Interstate Commerce Commission regarding transport of hazardous chemicals.

The data which are accumulated should be grouped, arranged by subjects and indexed so that they can be brought to the notice of department managers soon after they appear in print. Special attention should be given to patent infringement suits, and court decisions concerning them should, if of local interest, be brought to the attention of each department manager.

If the corporation is about to enter suit, or if it has been sued, it is important that all possible facts relating to the case be collected, so that they may be critically examined. The testimony of the chemist should be carefully prepared so that it may be skillfully presented. Among the commonest forms of law suits are those which arise from breach of contract. Before preparing testimony, the chemist should study all the processes through which a product has passed before it was sold and found to be defective. If for example a vendor has contracted to deliver "best quality rubber jar rings" to a food-canning company, but actually delivers a low-grade jar ring, all the food conserved in jars with the defective jar rings may spoil soon after it leaves the food factory. Here is a case with many possible complications.

CUSTOM HOUSE PRACTICE

In cases where imported products compete with the products of his own corporation, the legal chemist should study the methods used for classifying this imported merchandise according to the U. S. tariff act now in force. He must keep in mind that the meaning of words used in the tariff act is interpreted by the federal courts, and not by expert witnesses. An expert witness may, however, testify to the meaning of words, "as they are used in the trade." He should study the meaning of such terms as unmanufactured article, unenumerated, specific duty, ad valorem duty, similitude, component part of chief value and "products not otherwise specified." He will in the course of his studies find that the person who levies duties on merchandise imported at New York City is officially known as the Collector of Customs of the Port of New York. If the

duty levied is unsatisfactory to the importer, he may "protest" and appeal to the U. S. Board of General Appraisers for a consideration of his case.

CUSTOM HOUSE CASES

Pontianak or Jelutong. The protest of L. L. Littlejohn & Co. against the assessment of duty by the Collector of Customs was filed in 1917. This material had been assessed for duty as an unenumerated, unmanufactured article, but the importer claimed that it was known in the trade as rubber and therefore should be admitted duty free under the tariff act of 1913. The protest was heard before the U. S. Board of General Appraisers, and it was shown to the U. S. Assistant Attorney-General that pontianak is not rubber and is not known in the industry as rubber. However, owing to the stress of the war period, the Government did not push the case and the material was finally admitted duty free. (*Treasury Decisions* 37,284 of July 26, 1917, and *Treasury Decisions Abstract* 41,775 of Jan. 31, 1918.)

Balata Belting. In the case of Robins vs. United States, before the U. S. Court of Customs Appeals, it was decided Feb. 1, 1911, that balata is india rubber by similitude.

Reclaimed Rubber. In the case of United States vs. Michelin Tire Co., before the U. S. Court of Customs Appeals, it was decided, April 24, 1911, that reclaimed rubber is not a manufactured article.

OCCUPATIONAL DISEASES

The investigation of health hazards has been taken up by many of the states through their Boards of Health and is intimately related to the workmen's compensation laws. The duty of the chemist in charge of legal work is then to investigate the special health hazards present in the factory. These may be due to:

1. Overheated rooms.
2. Bad ventilation in rooms where volatile solvents are used.
3. Absence of suction drafts in rooms where powdered minerals are used.
4. Defective ventilation in rooms where poisonous liquids or gases are handled.
5. Bad water drainage in rooms where large quantities of water are constantly spilled out on the floor.
6. Defective flues in rooms where corrosive acid vapors are used for etching, plating or vulcanizing.
7. Absence of suction drafts in connection with lathes or buffing wheels, where fine powders or dusts are formed.

The bulletins on industrial accidents and hygiene published by the U. S. Department of Labor contain a great deal of valuable information on this subject.

FIRE HAZARDS

The legal chemist should collect and file data on fire hazards in factories due to improper storage or use of combustible gases, liquids or solids. For example: In one case it was found that a barrel of chlorate of potash had been stored in a dyehouse, without any label indicating its contents and without any danger signals. When a workman attempted to open the barrel with a hammer and chisel, the chlorate exploded, doing considerable damage to the plant. In another case ground waste rubber was stored in a wooden barrel while still warm from the grinders. Six hours later the material suddenly burst into flame. In the process of coating fabrics with rubber cements a special fire hazard is presented, as large volumes of gasoline are evaporated in a short

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*In presenting this paper the author feels that he has given only an outline of the possibilities in this field. Although he has used this plan in his own work for some time, he feels that the idea of grouping all these subjects in one section under the supervision of a special chemist is relatively new.

space of time. The spreading machines must therefore have careful supervision, and steam jets must be stationed so that they can be put in action quickly.

TRANSPORTATION HAZARDS

In the section for legal and official chemistry there should be on file information concerning the risks to which merchandise is exposed while in transit. This may be due to improper loading of freight or express cars; to negligence on the part of employees; to the elements, such as hot weather, cold weather, rain or ocean water. In one case it was found that kitchen ranges made of iron had been placed in a freight car directly next to a barrel of bleaching powder (chloride of lime). The chlorine which emanated from the barrel of bleach during a period of rain attacked the iron and detracted from the value of the stoves. In such cases the "common carrier" may contend that the shipper should mark his package with danger tags, but on the other hand it must be considered that the bleaching powder and not the stove was the real offender. In such instances a careful judge might hold that the "carrier," which in this case was the railway company, must inquire into the contents of all sealed packages delivered to him. This would enable him actually to sort out packages which may cause fire or other damage while in transit.

In one case a cargo of goat skins from the Levant was damaged on shipboard because the hatch had not been closed during a severe storm. As a result of this the salt sea water washed in over the skins, and in that way their value was impaired.

ACCIDENTAL POISONING

In many factories which use chemicals in their processes there are some chemicals which lie around unprotected because they are so commonly used. This in some cases has led to accidental poisoning because of the similarity in name of two substances, one of which was harmless and the other harmful. For example: In one case a workman in a dyehouse was preparing a refreshing drink for a hot summer day. He wanted to mix in some cream of tartar, but accidentally used "tartar emetic," which is a distinct poison. In such cases error should be guarded against by carefully branding all chemicals which are in the class of poisons. Workmen should likewise be cautioned against the careless use of such chemicals as sugar of lead, bichromate of potash and aniline oil. These chemicals are so often exposed in large quantities that the workmen become careless in handling them if not cautioned.

AIR AND STREAM POLLUTION

Most of the industrial states now have enacted statutes governing the pollution of streams with factory wastes. It is therefore desirable to have on file all the recent state laws relating to this subject, as they may affect the dumping of factory effluents into the stream near the factory. In the State of New Jersey it was found about ten years ago that the Passaic River was gradually being converted into an open sewer by the factories situated on its banks. To prevent this from becoming worse, an arrangement was finally made whereby a certain percentage of effluents will ultimately pass out into the open sea through a concrete sewer 20 ft. in diameter.

As an example of air pollution it may be of interest to cite the case of a plant making sulphuric acid in

rotary burners. This plant purchased power from a public utilities company, and one afternoon the power was suddenly shut off, due to a storm. This interfered with the process of manufacture in the sulphuric acid plant in such a way that dense fumes of sulphur dioxide suddenly swept over the surrounding district, killing all vegetation. In this case the pollution of the air was not continuous and was not due to any fault in the management of the plant. However, in the case of the smoke nuisance in large cities containing many steel mills, air pollution may become a permanent health hazard, because it is continuous.

A rather interesting case which grew out of the pollution of a stream is related by Thomas Hancock in his personal narrative published in 1857. When coal gas was introduced in England for the purpose of lighting apartments as well as the streets of towns and cities, the manufacturers of the article found that the tar and other liquid products resulting from the process accumulated upon their hands. By 1800 this had already attracted public attention because the gas companies had begun to dump this "unpleasant and undesirable byproduct" into the rivers. In 1819 Charles Macintosh of Manchester was looking for ammonia to use in the manufacture of cudbear. With this in mind he entered into a contract with the Glasgow Gas Works to receive, for a term of years, the tar and ammoniacal water produced at its works.

In 1823 he had progressed so far with his investigation of the material that he obtained coal-tar naphtha as a distillation product and pitch as a retort residue. He then took out a British patent for preparing a waterproof varnish for cloth, in which he dissolved the pitch in the naphtha and used this to coat the fabric. He also dissolved rubber in the naphtha for similar purposes. The earliest attempts at waterproofing fabrics were in fact made with the use of coal tar and later coal-tar pitch, because many persons at that time were trying to find a use for this product. In the final analysis it was the pollution of the streams which caused these investigators to begin their experiments.

CONTRACT WORDING

The chemist in charge of the work in legal and official chemistry should render assistance to the purchasing agent whenever possible. In the case of contracts and specifications for the purchase of chemicals, the wording used should be such that misunderstandings at a later date will be avoided. This is why many corporations usually append to the contract a specification showing the chemical and physical tests which the delivery must meet. Such items as the shape, composition, size and weight of containers should be noted. Attention must also be given to such general laboratory specifications as color; boiling point in the case of volatile solvents; fineness in the case of mineral powders; and moisture content in the case of textile fibers, rubber and other materials containing large and variable amounts of water.

PATENTS

In order to be of most value a patent should be basic and fundamental. According to section 4,886 of the Revised Statutes of the U. S. it must possess novelty and usefulness. It must not cover, (1) a principle; (2) a property of matter or (3) a result. For this reason it will be well to study the style used in drawing up patents which have stood the test of the courts. It will be found that patents are issued for such things as

chemical processes, chemical products or a composition of matter, machinery used in chemical processes, and the application of a product in the arts to produce new and useful effects. It is important that the student of legal chemistry know the meaning of such terms as priority, interference, validity, abandonment, anticipation, infringement, shop rights and invalid. He should also know what steps are necessary to establish priority for any invention which he or his colleagues may make.

Charles Goodyear discovered that *soft* vulcanized rubber products could be obtained by mixing 6 to 20 per cent of sulphur with crude rubber, whereas Nelson Goodyear, the younger brother of Charles, discovered that if the sulphur be increased 25 per cent or more, he could produce *hard* rubber products. Both inventors were granted patents in the United States for their inventions. Here is an instance where the first inventor did not realize the full possibilities of his discovery.

SPECIAL CASES IN THE RUBBER INDUSTRY

U. S. patent 3,633 was issued to Charles Goodyear of New Haven, Conn., June 15, 1844, for "improvements in the manufacture of india rubber." This patent was contested in the case of Goodyear vs. Providence Rubber Co. It resulted in a decision for the plaintiff, but the defendant appealed and the case was finally decided in the U. S. Supreme Court in 1870. (See Brodix on "Patent Cases," 1869 to 1872, p. 150; and 2 Clifford, p. 35.) Other patents granted to Charles Goodyear in the same year were Nos. 3,461 and 3,462.

U. S. patent 16 was issued to E. N. Chaffee in 1836, for "improvements in preparing and applying india rubber to cloth." Goodyear obtained the rights to this patent in 1844. The patent was, however, contested in the suit of Day vs. Union India Rubber Co., decided by the U. S. Supreme Court in 1857. A U. S. patent was granted on June 7, 1845, to Day, Tyre and Helm for a "machine for cutting india rubber threads." U. S. patent 9,319 was issued to Charles Goodyear, Oct. 12, 1852, for a "method of making india rubber cloth." U. S. patent 4,047 was issued May 13, 1845, to Nelson Goodyear of Newtown, Conn., for the "manufacture of india rubber fabrics."

A U. S. patent was granted on Jan. 11, 1859, to Henry W. Joslin for "improvements in the treatment of india rubber." This process consisted in mixing rubber with zinc sulphide in place of sulphur. In the case of Charles Goodyear and the New England Car Spring Co. vs. Hiram P. Dunbar and Henry W. Joslin, Goodyear asked for an injunction against Joslin. The case was heard in the U. S. Circuit Court, District of New Jersey, in March, 1859, no injunction being granted.

Thomas Hancock on March 18, 1846, was granted a patent in England for an invention covering the use of sulphur to vulcanize rubber, but his original patent is dated Nov. 21, 1843, and this describes how to change the character of caoutchouc by treating it with sulphur and heat. Hancock was a partner of Charles Macintosh, a maker of waterproof cloths in Manchester, England.

Alexander Parkes of Birmingham, England, on March 25, 1846, was granted a British patent for vulcanizing rubber by means of sulphur chloride. He suggested the use of a solution of sulphur chloride in carbon disulphide of about 1.0 per cent concentration.

THE TIRE PATENTS

U. S. patent 554,675 was issued to Arthur Grant Feb. 18, 1896, for "a solid rubber tire for horse-drawn

vehicles." After much litigation the patent was declared valid by the U. S. Supreme Court, April 10, 1911. This patent was also involved in the suit of the Kelly-Springfield Tire Co. vs. Diamond Rubber Co. A decision was rendered in this case by the U. S. Circuit Court of Appeals in New York City, March, 1916. In its decision, the court awarded the plaintiffs 5c. per lb. on the total number of pounds of tires made under the infringement by the defendant rubber company.

U. S. Patent 822,561 was issued to Peter D. Thropp of Trenton, N. J., June 5, 1906, for a "method for vulcanizing rubber tires in a mold, using open steam." This is the one-cure process. The patent was contested in John E. Thropp Sons Co. vs. U. S. Tire Co. A decision rendered by the U. S. District Court, Southern District, New York, in 1915, declared the patent invalid. (226 Federal, 941.)

U. S. Patent 578,551 was issued to E. C. Duryea in 1897 for "an improvement in vehicle tires." The validity of this was contested in the case Buffalo Specialty Co. vs. Indiana Rubber & Insulated Wire Co. in the U. S. Circuit Court of Appeals, Seventh District. (334 Fed. Rep., 334.)

THE RECLAIMED RUBBER PATENTS

U. S. patent 635,141 was issued to Arthur H. Marks of Akron, Ohio, Oct. 17, 1899. The validity of this was contested in the case of Philadelphia Rubber Works Co. vs. Portage Rubber Co. In the U. S. District Court, Northern District, Ohio, April 8, 1915, Judge Charles Clarke presiding, the patent was declared invalid. Another case was that of Philadelphia Rubber Works Co. vs. U. S. Rubber Reclaiming Co. in the U. S. District Court, Western District, New York, June 29, 1915, in which Judge Hazel declared the patent valid. This case was appealed to U. S. Circuit Court of Appeals, Second Circuit, and on Nov. 9, 1915, the patent was declared by Judge Lacombe to be valid. (See Fed. Rep., 225, p. 789; 227, p. 623; 229, p. 150.)

U. S. patent 395,987 was issued to J. K. Mitchell of Philadelphia, Jan. 8, 1889. This patent refers to the reclaiming of rubber from manufactured rubber goods by treating the ground waste with mineral acid under pressure. The textile fibers and a certain part of the mineral matter are thus destroyed or dissolved. In the Marks patent the sulphur is removed from the scrap rubber by treatment with caustic soda under pressure.

U. S. patent 12,983, issued to Beers in 1855, also refers to a process of reclaiming.

THE RUBBER SPONGE PATENT

U. S. patent 1,045,234 was issued to G. Willis and B. Felix on Nov. 26, 1912, for a process of making artificial sponges. In the appealed case of Featheredge Rubber Co. vs. Miller Rubber Co., heard in the U. S. Circuit Court of Appeals, Sixth Circuit, a decision of June 30, 1919, declared the patent invalid, and the case was given to the defendants. The case rested upon the distinction between sponge rubber and rubber sponge. In commenting on this suit the judge remarked: "In some patents we find that the real discovery is not disclosed in the patent specifications, the purpose being to get the protection of a patent and at the same time hold back the knowledge which would allow the public to manufacture successfully at the end of the patent term." (See 250 Fed., 255, and 259 Fed., 565.)

Rubber Trade Laboratory,
Newark, N. J.

Electric Heating in Ceramics

BY WIRT S. SCOTT

Industrial electric heating, which began with the melting of iron in electric furnaces, has proved so successful that its application has spread rapidly. Almost every industry that uses heat is a logical plant for electrical heating, and the glass industry is therefore affected. In fact, many installations have already been made for the treating of glassware.

A 72-kw. furnace is used for annealing glassware, at a temperature of 1,200 deg. F. This furnace is 22 in. wide, 10 ft. long and 5 ft. high, of the overhead conveyor type.

In one test, several thousand goblets were annealed, the goblets being placed in metal containers consisting of nine trays, each tray holding twenty-five goblets, five per row and five rows deep.

RESULTS OF THE TEST

Sixty-five goblets were selected at random during the test, care being taken to select them from different parts of the furnace and were tested in a spectrometer. Sixty-four showed absolutely no refraction of light rays and were passed as A1 grade. One goblet had almost imperceptible refraction of light rays and was therefore rated in this test as B1. The physicist making the test stated that compared with their general run of product this one goblet would ordinarily have been A1 grade. In their natural-gas-fired annealing ovens they have very few strictly A1 grade, a majority being B1 grade, but a quantity also of C1, the lowest possible grade.

All glasses passing through the furnace were bright polish finish. Glasses through the natural-gas furnace have a slight blue finish. Manufactured gas presents a deposit greater than natural gas. Fuel oil deposits a decided white powder finish necessitating washing and polishing, and is therefore prohibitive.

FUSING BIFOCAL OPTICAL LENSES

The work of fusing bifocal optical lenses must be done at a very critical temperature, besides requiring a uniform temperature to prevent resulting strains and a clean atmosphere to prevent spoiling the polished faces of the lenses that are being fused. The lenses are placed on small plaques, four per plaque, and each plaque is covered with a vitreous enameled steel square cup, and fed automatically through the furnace chamber and discharged into an annealing oven. The furnace chamber is in four sections, two sections 18 in. long, each maintained at a different temperature. The annealing oven is 60 ft. long.

When the work was carried on originally through gas-fired furnaces the loss was approximately 20 per cent, whereas the average loss is 3 to 4 per cent when electrically treated.

VITREOUS ENAMELED KITCHEN WARE

Tests were made to determine the practicability of using an electric furnace for vitreous enameled kitchen ware. Thirty-six miscellaneous pieces were fired in the furnace, and a most careful inspection showed that the results were perfect as to polish, absence of pitting, and general smoothness. Due to the ease with which a definite temperature could be maintained it was a very easy matter to get results of the highest order with almost no attention.

Industrial Heating Section,
Westinghouse Electric & Manufacturing Co.

Belgian Experiments on Palm Oil As Motor Fuel

A series of experiments begun in 1914, but interrupted by the war, has recently been resumed in Brussels on the use of palm oil in internal-combustion motors, announces Trade Commissioner Cross. The question of motor fuel in the Belgian Kongo is a serious one, since a ton of crude oil delivered at Kinshasa in metal casks has an estimated price of 2,000 fr., as against 1,050 fr. in Brussels. Palm oil, on the other hand, costs on the native market an average of 25 centimes per kilo, but varies in price between 8 and 40 centimes. The calorific power of palm oil is from 20 to 25 per cent less than that of crude oil, so that a relatively large consumption of palm oil must be reckoned with, while the comparatively high temperature at which palm oil fuses (37 deg. C.) indicates the possibility of rapidly clogging the motor.

COMPLETE COMBUSTION NECESSARY TO THE UTILIZATION OF PALM OIL

According to engineers closely connected with the experiments, without constructing a special palm-oil motor it was necessary to find a machine in which complete combustion is assured by a complete vaporization of the fuel, which should be introduced in a quantity strictly proportionate to the load. It was further essential that the gaseous mixture should be constant and capable of regulation by a supply of water, varying according to the load and the amount of oil being fed in. Thorough clearing of the exhaust gases was also a requisite.

TESTS PROVED SATISFACTORY

The Belgian colonial company Omnium Africain has been successful in finding a two-cycle semi-Diesel motor of Swedish manufacture developing 10 hp. at 500 r.p.m. which satisfies these conditions, and motors of larger and smaller sizes of the same character have been run on palm oil with good results without special changes for the use of the new fuel. The palm oil, which at normal winter temperature in Belgium has about the consistency of soft butter or lard, is placed in a tank divided into three compartments by wire screening. As this tank is heated either through the circulation of hot water from the cooling system or other mechanical means, the palm oil liquefies and passes through the screening to the feed pipe leading to the injection pump. For experimental purposes this motor is started on crude oil. Once it has warmed up, and as soon as the palm oil begins to liquefy, the crude oil is turned off, so that the engine then runs on palm oil exclusively with no slackening of the number of revolutions or of the power produced. At the temperatures prevailing in the Kongo, engineers claim that this motor could be immediately started on palm oil, and it is proposed to install motors of this type on launches and other small river craft, as well as to conduct further experiments for their use in industry and traction. Analysis shows that there are no incombustible components in palm oil, and, contrary to general expectation, the oil neither clogs the motor nor leaves any perceptible solid residue behind it.

WILL SIMPLIFY FUEL PROBLEM

In case further development of this fuel proves practicable, it will simplify the fuel problems not only of the Belgian Kongo but also of other colonial domains remote from mineral fuel, and where the use of wood only entails much extra labor and other difficulties con-

ected with the various heating capacities of the woods used, to say nothing of the risk of indiscriminate deforestation. The French Ministry of Colonies has conducted experiments with peanut oil, and in July, 1920, the Belgian Ministry of Colonies announced a competition of tractors run on vegetable oils produced in the Kongo, but only one contestant put in an appearance.

The Elaeis palm, from the pulp of the fruits of which this oil is extracted, grows in Africa from Senegal to Angola in a north and south direction, and east to the great lakes. The oil of this tree has been heretofore exported from the Gold Coast, Sierra Leone, Nigeria, Guinea, the Ivory Coast, Dahomey, Togoland, Cameroon, Angola and the Belgian Kongo.

COMPOSITION OF THE OIL

According to analyses by Belgian chemists, palm oil is a mixture of palmitate and oleate of glycerine, with some variable quantities of palmitic and oleic acid. It contains about 95 per cent of fatty acids and appears as a pasty substance of yellowish or salmon color. Its calorific power is estimated at 9,228 calories (Berthelot-fahler), and it is flammable at 210 deg. C. It thus possesses the advantages of being widely grown and easily obtainable, of large calorific power in small volume, of safety in handling and of having no damaging effect on machinery in which it is used.

Synopsis of Recent Chemical & Metallurgical Literature

Manufacture of Linseed Oil.—An excellent illustrated review of the modern technology of linseed oil manufacture as published in the Jan. 5, 1921, issue of *Paint, Oil and Chemical Review* by permission of the William O. Goodrich Co., Milwaukee. The raw material is flaxseed or linseed, the seed of the flax plant. When fibers for use in the manufacture of linen are desired, the flax must be harvested before the seeds are ripe enough to yield a good grade of oil. Thus raising flax for linen and for oil are separate undertakings. Argentina, the United States, India, Russia and Canada are the leading flaxseed producers in the order given. Their combined output has fallen from a maximum of 150,000,000 bu. in 1912 to an average to 50,000,000 bu. for the last four years.

Linseed contains from 33 to 40 per cent of oil, but the actual yield of oil varies from 26 to 35 per cent. The oil may be obtained by three processes: Hot-pressing, cold-pressing and extraction with volatile solvents. The first of these—known as the "old process"—is used almost exclusively in this country. After cleaning, the linseed is pressed through 5-high chilled crushing rolls the function of which is not to express the oil but simply to break down the structure of the kernel to a flaky condition. This assures a stratified cake with a minimum resistance to the flow of oil in the press. The ground seed is carried by screw conveyors to jacketed kettles, where it is heated to about 180 deg. F. in order to soften the oil cells and decrease the viscosity of the oil. A hydraulic cake-former molds the meal into proper size and form to fit the press boxes. Sufficient pressure is exerted in the former so that the hydraulic presses can be built of an economical working height without sacrificing capacity. In order to hold the cakes in the press and prevent them from squeezing out, firecloth is wrapped around the meal. Pressure control in the presses is automatic and after about an hour the cakes are removed to automatic trimming machines, where the dry edges are removed and returned to the process. The

cleaned cakes are sold for cattle feed or fertilizer. The raw oil is settled to remove foots, filtered, and is then ready for sale as such or it may be converted into boiled or refined oil. As a rule, boiled oil is made at present from raw oil by the addition of red lead and manganese driers, by expelling the moisture and by bodying the oil to the desired gravity. The refined oils are many in number to meet the exacting requirements of the trade.

While the paint grinder is still the largest consumer of raw linseed oil, there is a constantly growing demand from makers of foundry core oils, putty and linseed oil soaps. Boiled oil is used largely as a ready-mixed paint vehicle, though lesser quantities are consumed in the manufacture of window-shade cloth and similar fabrics.

The refined oils may be classified according to use as grinding oils, varnish oils, and oils of the blown or oxidized type. Refined linseed oil in some form or other is used chiefly in the manufacture of paints, varnishes, enamels, linoleum and oilcloth, patent leather, oiled clothing, imitation leathers and printing inks. It has no value as an edible oil, an illuminant or a lubricant. A discussion of the use of metal containers instead of cooperage, an outline of methods of analysis and a glossary of technical terms conclude the article.

Note:—The following data, compiled recently by the Tariff Commission, form a logical supplement to the above review of the industry:

Domestic production of flaxseed for 1912-1916 averaged 15,000,000 bu. of 56 lb. North Dakota, Minnesota, Montana and South Dakota produce the bulk. Imports in 1918 were 12,785,034 bu. valued at \$33,830,735. Exports are relatively insignificant, 21,481 bu. in 1918, mostly going to the United Kingdom and Canada. In 1919, domestic production of linseed oil amounted to 224,627 tons (59,900,000 gal.) obtained from 678,903 tons of flaxseed. Imports since 1912 have been less than 0.3 per cent of the production in this country. Since 1914 the exports of linseed oil have been about 1,200,000 gal. per year.

Selenium Chloride.—In the January number of the *Journal of the American Chemical Society* (vol. 43, p. 29) there is a very interesting note on selenium oxychloride by Victor Lenher. It may be recalled that when Dr. W. R. Whitney received the Perkin Medal this year he said in his address on "The Biggest Things in Chemistry," "and so I note such researches as Prof. Lenher's on selenium oxychloride, and I say to myself, 'Watch it grow!'"

The present paper contains a great deal of information of which we repeat some of the high lights. It is slightly yellow, transparent to visual light, but so opaque to ultraviolet that it makes practically a screen for all wave lengths below 4,050. It is miscible in all proportions with carbon tetrachloride, chloroform, carbon disulphide and benzene. With saturated aliphatic hydrocarbons at ordinary temperatures there is apparently no chemical reaction, or if there is any it is very slight. The unsaturated hydrocarbons of the same series, on the other hand, unite with selenium oxychloride directly, frequently with the manifestation of great energy. Amylene, for instance, reacts with it with great violence, and with such hydrocarbons as turpentine the reaction is like that of halogens on turpentine. It is thus possible to separate such unsaturated aliphatic hydrocarbons as amylene from the saturated heptane by simple contact with this solvent. Again, if a mixture of heptane and benzene is treated with it, the benzene goes into solution, while the lighter heptane rises to the top and forms an immiscible layer.

Sulphur, tellurium and selenium dissolve with ease in the cold liquid; most metals react with it, forming the chloride of the metal and red-brown selenium chloride. It dissolves many metallic oxides, and solutions of molybdenum trioxide and the pink carbonate of cobalt show remarkable photochemical reactions. With carbonates its reactions are of considerable variety. Barium sulphate is peptized by it to a gel much resembling freshly precipitated aluminum hydroxide, but the colloidal form of barium sulphate is immediately changed back to the ordinary form when treated with water.

Protein materials, such as hair, bristles, silk and leather, are readily dissolved in the cold. Vegetable and fish oils

behave in a way similar to treatment with sulphur monochloride. With linseed oil it forms a rubber-like mass similar to that produced by sulphur monochloride. Menhaden oil reacts with selenium oxychloride also to form a waterproof rubber-like mass. Rubber reacts chemically with it, and the chemical character is changed in the process. Phenolic condensation products, gums, resins, dried paints, shellac, dried varnish, agar, celluloid, gelatine, glue—including the insoluble casein glue—are all readily dissolved by it in the cold.

Natural asphalts, resins and bitumens dissolve with ease in the cold when they are of unsaturated character. Such a product as ozokerite, which consists principally of saturated hydrocarbons, behaves very like paraffine with it. Natural coals brought into contact with selenium oxychloride react so far as the bituminous and resinic materials are concerned, leaving a carbonaceous residue behind. Thoroughly ignited coke loses nothing with the reagent, whereas incompletely coked soft coal goes partially into solution. Anthracite coal shows little reaction, semi-anthracite loses considerable, and bituminous coals lose a great deal. Lampblack loses its hydrocarbon content, leaving behind carbon.

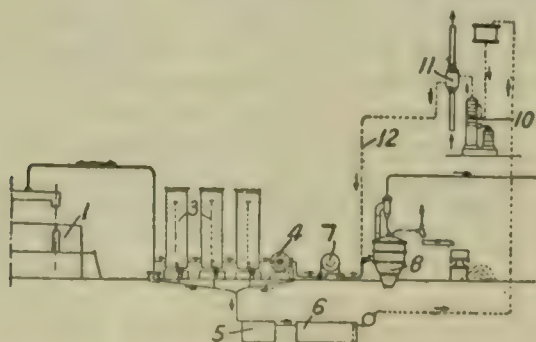
The carbonaceous material separated from iron and steel by the copper chloride treatment consists of graphite and what is believed to be unsaturated hydrocarbons. With selenium oxychloride a black extract is produced which shows that at least a part of the material has been acted on. Further study of this with a view to throwing light on the constitution of iron and steel is advised by Prof. Lenher. It is truly a remarkable solvent.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Ammonium Sulphate.—In the "semi-direct" method of recovering ammonia as sulphate from coke-oven gases the hot vapors from the ammonia still are further heated by means of the waste gases from the coke ovens and then mixed with the cooled gases from the tar extractors, the mixture then passing to the saturator; the heat thus supplied prevents dilution of the acid in the saturator by the water present in the gases. Using the apparatus shown, the gases from the ovens 1 pass through coolers 3, a tar

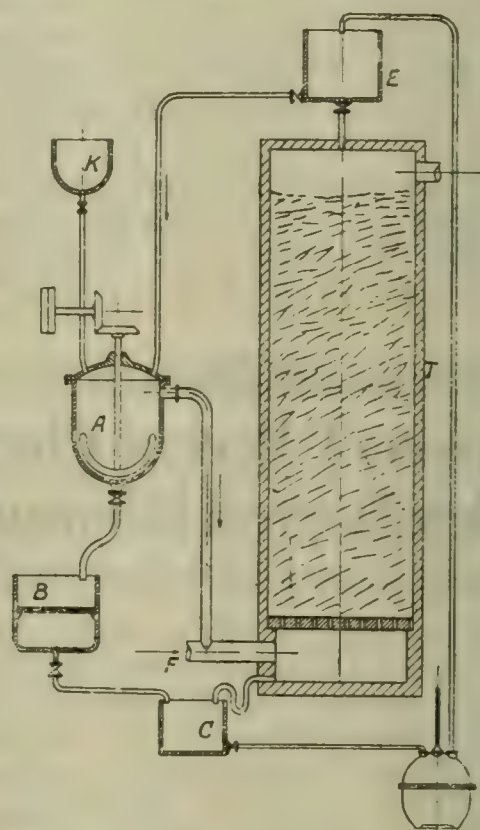


condenser 4 and a tar extractor 7 to the saturator 8; the ammoniacal liquor and tar from the coolers 3 and condenser 4 flow to a tank 5, whence the ammoniacal liquor passes to a tank 6, from which it is pumped to a still 10; the vapors from the still pass through a heater 11, in which they are heated to about 200 deg. C. by the waste heating gases from the ovens, and the heated vapors pass by pipe 12 to mix with the cooled gas on its way to the saturator. (Br. Pat. 153,177; SOC. FRANCO-BELGE DE FOIRS A COKE, Brussels. Jan. 12, 1921.)

Separation of Alkaloids.—Alkaloids are selectively isolated from drugs containing more than one constituent by taking advantage of their varying basicities and their

different solubilities in various solvents. The raw alkaloidal material containing more than one constituent, mixed if necessary with powdered vegetable tissue, is acidified and treated with a suitable solvent, whereby the weakly basic alkaloids are extracted, leaving the strongly basic alkaloids fixed in the tissue. Further vegetable tissue is then added to the concentrated extract and the weakly basic alkaloids fixed thereto by the addition of acid. By a choice of solvent, one alkaloid can be extracted from all the remainder. The isolation of morphine from opium and the separation of the remaining alkaloids into weakly and strongly basic components are described in the example. Alkaloids of the narcotine group comprise the weakly basic components. (Br. Pat. 153,219; CHEMISCHE FABRIK VORM. SANDOZ, Basel, Switzerland. Jan. 12, 1921.)

Dinitrophenol.—Phenol is nitrated at 95 deg. C. with dilute nitric acid, which is fitted for further use by addition of strong acid from a nitrogen oxides absorption tower. The phenol is fused in a vessel *K* and nitrated in a vessel *A* fitted with a stirrer, the nitrous gases evolved being absorbed by dilute nitric acid in the tower *T*. The dinitrophenol is then collected on the filter *B* and the spent acid, after



mixture in the tank *C* with strong acid from the tower *T*, is forced to the vessel *E*, which supplies the nitration acid and the absorption acid. The nitric acid content of the system is maintained by introducing fresh nitrous gases by the pipe *F*. (Br. Pat. 153,265; not yet accepted; NORSK HYDRO-ELEKTRISK KVAELSTOFKTIKESKAB, Christiania, Jan. 12, 1921.)

Catalyst for Synthetic Ammonia.—A catalytic material, for use in the synthetic manufacture of ammonia under conditions of super pressure, consists of an oxide of iron, approximating in composition to Fe_3O_4 , prepared by directing a jet of oxygen on to molten iron monoxide. A small quantity of lime may preferably be incorporated in the product. A bar of iron or steel is fused under a jet of oxygen and the molten product, which consists of iron monoxide mixed with iron, is collected in a crucible preferably of magnesia. At this stage 5 to 10 per cent of lime may be added, together with a small amount of alkaline oxides. The jet of oxygen is then directed upon the molten mass, whereby large quantities of heat are evolved, the mass becomes agitated, and the lime is dissolved in the oxidized melt, as well as some of the magnesia of the crucible. The treatment is continued until the mass is completely homogeneous, or if impurities are present, until the surface begins to congeal, when the product is cast on a sheet of iron. Specification 130,086 is referred to. (Br. Pat. 153,254; not yet accepted; SOC. L'AIR LIQUIDE—SOC. ANON. POUR L'ETUDE ET L'EXPLOITATION DES PROCÉDES G. CLAUDE, Paris. Jan. 12, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Tariff Hearings on Chemical and Metallurgical Products

In framing the new tariff bill, the Committee on Ways and Means of the House of Representatives has been asked by representatives of the chemical glassware industry, the chemical porcelain industry, and by representatives of the manufacturers of scientific apparatus to eliminate the duty free clause on such materials which are intended for educational or scientific purposes. It was contended that 50 per cent of the chemical porcelain imported comes in duty free under this paragraph. Since the last hearing on this subject, the opinion of students has been consulted and it is found that a large percentage of them favor paying a slightly higher price for their apparatus so as to encourage an American industry. It was testified that the domestic industry cannot hope to expand if it cannot undertake quantity production. To do that it must have the full market rather than 50 per cent of it, it was stated.

In connection with this item, Dr. Charles H. Herty was asked this question by Representative Garner: "How is it that the German people can pay \$2,000,000,000 a year taxes to a foreign country, pay 12 per cent export duty, and still be able to destroy their competitors throughout the world? What I cannot understand is how some people are so superior to other people that they can come over here and put our commercial people out of business." In his reply Dr. Herty stated that the practice is to sell articles below cost until competitors are destroyed and then advance prices to the very limit, thus recouping losses. In addition, he said, the exchange rate offsets some of the disadvantages against which the Germans must contend.

PHOSPHORUS

A duty of 18 cents a pound on phosphorus has been asked by C. W. Asbury of the American Phosphorus Company. This is the old Payne-Aldrich rate. If it were not for the difficulties of transportation, Mr. Asbury declared, a much higher rate would be necessary to enable an American manufacturer to compete with foreign producers.

The witness introduced a letter from General Fries of the Chemical Warfare Service to the effect that phosphorus is a most essential commodity for the prosecution of war and that the country should be independent of foreign sources of production. Mr. Asbury testified that the plant of his company at Philadelphia is the only one in the United States and that it has been closed since November 1 because of inability to compete with foreign producers. He stated that the annual peace-time consumption of phosphorus in the United States is 1,000,000 pounds. In addition to the use of phosphorus in the making of matches, it is used in quantities in the manufacture of phosphor-bronze bearings and as a substitute for camphor in the manufacture of celluloid articles. Small quantities are used in laboratories and as drugs. The military uses of phosphorus, Mr. Asbury testified, are to create smoke-screens, in the manufacture of range-finding bullets, and in chemical warfare.

FERROMANGANESE

Ferromanganese will be dutiable at two cents a pound if Congress should approve the rate requested by E. G. Lavino and other ferromanganese manufacturers, who appeared before the Committee, and testified that this rate is necessary to protect the domestic industry against the very aggressive competition afforded by English manufacturers. It was stated that the English manufacturers have formed a pool and that it is its deliberate intention to wreck the American ferromanganese manufacturing industry.

These witnesses pointed out, however, that should a duty

be placed upon imports of manganese ore, it would be necessary to increase accordingly the rate of duty asked on ferromanganese. They are not opposed to some degree of protection for the domestic manganese mining industry but it was very apparent that this position was taken simply to avoid the inconsistency of urging protection for their products while at the same time asking that the product of another industry be placed on the free list. Mr. Lavino stated that there is not a sufficient quantity of manganese ore in the United States to permit of any great development of manganese mining while at the same time deposits are of poor quality and at a distance from the points of consumption.

ARSENIC

Arsenious acid and arsenic acid are now on the free list. Congress has been requested to place a duty of five cents per pound on these articles and a proportionate rate on the arsenic content of Paris green and London purple, in the interest of the domestic arsenic industry. An ad valorem duty of 20 per cent is asked for other arsenical compounds. The Committee was also advised that a modern plant for the manufacture of white arsenic just has been completed at Toulon, Nevada.

Continuance of Work at Wilson Dam and Muscle Shoals

During a hearing on the item in the Sundry Civil Bill calling for \$10,000,000 for the continuation of the work on the Wilson dam, the proposed operation of the nitrate plants at Muscle Shoals was discussed at length. One of the important developments was a statement by Colonel Hugh L. Cooper, who is acting in a consulting capacity with the Corps of Engineers, to the effect that it would defeat the power plan if the first 80,000 horsepower of secondary power were used to operate the nitrate plant. In that connection, Colonel Cooper said:

"Such a first use of 80,000 horsepower secondary power would defeat my power plan. The first 80,000 horsepower secondary power will produce 446,000,000 kilowatt hours for an average period of slightly over 10 months per year. Compare this first 80,000 horsepower with the last 80,000 horsepower of secondary power. The last 80,000 horsepower of secondary power will produce an average of only 172,000,000 kilowatt hours for an average period of 4 months per year. Power that is good for 10 months per year is worth at least 33½ per cent more per kilowatt hour than the same kilowatt hour power that is good for 4 months per year. I feel quite certain that the taking away from the secondary earning capacity in my plan now before you of the first 446,000,000 kilowatt hours per annum would be taking off so much of the cream of this business as to make the remaining skim milk not worth building transmission lines for. Transmission lines cost practically the same whether used 4 months or 12 months of the time per year."

Colonel Cooper stated that the development can be made a paying one, provided it is confined to power. In addition to saving \$9,500,000 a year to the consumers of power within a radius of 250 miles of Muscle Shoals, he has submitted figures showing that the government can make 5 per cent on its investment after the project is complete and ultimately get back all of the money invested. In view of the great benefits to be derived from this development, he said it would be a national crime if the work were stopped now and the \$17,000,000 invested thrown away.

Dr. Charles L. Parsons appeared in opposition to the operation by the government of the nitrate plant. He dis-

cussed the various processes used in the fixation of atmospheric nitrogen, declaring among other things that the cyanamide process is in a condition of obsolescence and that he does not expect to see it in operation in any country within a few years. He declared that the question of sludge disposal alone would make it very difficult to operate the cyanamide plant at Muscle Shoals, and that such a scheme as proposed by the War Department never would be able to meet its expenses. He called attention to the fact that it will be necessary to build an ammonium sulphate plant at a cost of at least \$3,000,000.

Patents for Government Employees

Determined opposition has developed in the Senate against that section of the conference report on the Patent Office bill which authorizes the Federal Trade Commission to administer patents for Government employees. As this is written, it seems likely that the Senate conferees will recede from their demand that this section be included in the bill. Senator Reed of Missouri has stated on the floor of the Senate that the bill cannot become a law at this session, unless that section is eliminated.

The House has accepted the conference report including the Government employees section. The Senate is willing that the salaries in the Patent Office be increased and that the force be enlarged as is provided by the main bill. The Government employees section is a rider on that measure, which was attached in the Senate.

Senator Reed based his opposition to the measure on his belief that the bill would give an unfair advantage to a Government inventor as compared with an outsider who might not have a salary to keep him going. He also objected to the licensing feature of the plan. By right, he said, an invention made by a Government employee should belong to the Government, but to stimulate effort he admitted the advisability of allowing a Government employee to take out a patent. His objection to the bill was that it places them on a different footing than other persons.

Senator Norris of Nebraska, who is supporting the conference bill, declared it would be a step toward protecting the poor inventor against infringement of his patents by powerful interests. He said that it is admitted by all that any poor inventor can be worn out in the courts and his patent infringed with impunity. He accused large interests of suppressing thousands of inventions annually so as to prevent competition in their line or make necessary improvements in their plants, to the great detriment of the public.

Investigation of Sulphur and Phosphorus in Steel

An interesting co-operative investigation on the effect of sulphur and phosphorus in steel has already been described in these columns.¹ Thirteen heats of rivet steel having "residual" sulphur varying from low to quite high were made some months ago by the Carnegie Steel Co., and a comprehensive program of physical tests is now being conducted at the Watertown Arsenal.

In co-operation with the Bethlehem Steel Co. a beginning has been made in the manufacture of material to show the effect of additions of sulphur to otherwise first-class steel. Three heats have been manufactured of steel having carbon contents of 0.18 to 0.22 per cent, 0.35 to 0.45 and 0.65 to 0.75 per cent, typifying roughly plate and structural steels, forging steels, and wheel, tire and rail steels. The steel was made by the regular commercial basic open-hearth practice and each lot was a part of a 45-ton heat. The original sulphur content of each heat was 0.04 per cent or below; more sulphur was added in the form of iron sulphide in a pouring box located between the ladle and the ingot mold. For each carbon content it was aimed to have a series of sulphur content ranging from 0.04 to 0.15 per cent. The object was thus the production of ingots of steel identical in composition in all respects except the sulphur content. Ingots, 16x16x57 in. in dimension were rolled to 4x4 in. billets and then portions of them for test

were further rolled to 1 in. rounds, and a portion of the billets rolled also to 1 in. flats, so that material for test can be taken transverse to the direction of rolling. In order to compare the effects of added and residual sulphur it is planned to remelt the discarded portions in two lots, one high in sulphur and one low in sulphur.

An active search is being made for stock material containing abnormal amounts of sulphur and phosphorus which has given good service, or on the other hand, stock material containing normal impurities which has been unsatisfactory. Automobile manufacturers, railroads, and steel foundries are requested to notify the committee (C. L. Warwick, Chairman, 1315 Spruce St., Philadelphia) whether they have material of this sort which would be available for test. So far little or no material of high phosphorus or sulphur content has been obtained, and there seem to be practically no records in the companies interviewed of failures that can be attributed to high phosphorus or sulphur.

Philippine Palm Products

Dr. H. D. Gibbs addressed the South Jersey Section of the American Chemical Society at the regular meeting in Carney's Point, N. J., on Wednesday evening, February 16, 1921. His subject was "The Palm Trees and Their Products." The lecture was illustrated with many interesting views taken by the Bureau of Science during the speaker's service in the Philippine Islands. Although there are about seventy-eight species of the palm tree known, there are only five that are of commercial importance in the Philippines, namely, the coconut, nipa, cabonegro, fish-tail, and buri palms. The date palm requires a dry climate and therefore is not found in the Philippines. The coconut palm yields a wide variety of products ranging from nut-butter to thatched roofs. The nipa palm is an important source of alcohol.

Nipa palms can be tapped every year for an indefinite number of years. The flower stalks are cut off, and the sap flows for two to three months. Buri palms can be tapped but once. They grow to a height of 60 to 80 ft., compared with 15 to 20 ft. for nipa palms. The trunk of a buri palm may be over 2 ft. in diameter, and often contains several tons of starch. The top of the tree is cut off, and due to the action of a diastase the sap that flows out contains practically nothing but sugar. During a period of several months all of the starch in the tree is converted into sucrose. The flow of sap then stops and the tree is dead.

The sap from these palm trees analyzes about 15 per cent sucrose. Immediately after it is exposed to the air it starts to ferment, and within a very few hours all of the sugar is converted to alcohol. This occurs while the sap is being transported to the distilleries. The speaker said that by painting the inside of the sap-collecting vessels with a lime-sulphur preparation, he was able to prevent this fermentation, and thus the sucrose solutions could be preserved for several weeks until they could be transported to a sugar refinery. This opens the possibility of converting the palm alcohol industry into a palm sugar industry and promises a very cheap source of sugar.

International Steel Conference Proposed

At a meeting of the directors of the American Iron and Steel Institute held in New York on Feb. 25, the chief topic of discussion was concerning the international aspects of the steel market. A suggestion has been received from steel producers in England, France and Belgium for the calling of an international steel conference of steel makers of all nations active in the trade. The object of such a conference would be discussion of general economic conditions in the industry as well as an interchange of ideas dealing with economies in manufacturing. The matter was referred to Judge Elbert H. Gary in his capacity as president of the American Iron and Steel Institute. It is expected that the plan for the proposed conference will be studied by officials of the Institute and a report made at the spring meeting.

¹CHEM. & MET. ENG., VOL. 22, PP. 297, 609, 952.

Personal

Dr. RAYMOND F. BACON, director of the Mellon Institute of Industrial Research of the University of Pittsburgh, has returned from Europe, where he spent the holidays in France and Italy in the investigation of nitrogen-fixation processes.

STUART CROASDALE of Denver, Col., announces that he and his associates have opened an Eastern office in the Magee Building, Pittsburgh, Pa., for the purpose of conducting a business in mining and metallurgical engineering. The new organization will operate under the name of Stuart Croasdale & Co., and will maintain a Western office in Denver, Col.

J. V. N. DORR addressed the Cleveland section of the American Chemical Society on Feb. 21 on the subject of "Some Continuous Operations in Chemical Industry."

JUNIUS D. EDWARDS, chief of the physical chemistry division of the research bureau, Aluminum Co. of America, at New Kensington, Pa., has been appointed assistant director of research.

JAMES B. GRAHAM, president of the Northern Central Trust Co. of Williamsport, Pa., has been elected president of the board of managers of the Crescent Refractories Co., Curwensville, Pa.

H. H. HILL has been appointed superintendent of the Bureau of Mines petroleum experiment station at Bartlesville, Okla., succeeding A. W. Ambrose. Mr. Hill was formerly employed as a chemist in the Pittsburgh and Washington laboratories of the bureau and was transferred to Bartlesville about a year ago for work on refining problems.

FRANK HODSON, president of the Electric Furnace Construction Co., Philadelphia, Pa., has been elected a member of the executive committee of the Philadelphia Foundrymen's Association.

N. C. HOYLES has been appointed manager of the Cincinnati branch of the Pittsburgh Testing Laboratory, at 813 Race Street, Cincinnati, Ohio. From 1909 to 1914 Mr. Hoyles was manager of the Birmingham, Ala., branch of this company. In 1914 he joined the Canadian military forces and went overseas with the Canadian engineers. For the past year he has been assistant manager of the Pittsburgh Testing Laboratory's New York office.

W. W. ODELL of Urbana, Ill., has been selected to take immediate charge of the lignite investigation which is being conducted by the Bureau of Mines. The bureau is preparing to conduct experiments on a commercial scale with North Dakota lignite. Mr. Odell, who has been doing coal gas work at the Urbana Station of the Bureau of Mines, has 15 years' experience in this type of work, and has been with the Bureau of Mines since 1917.

Mrs. FREDONIA JOHNSON PRATT of St. Louis, Mo., widow of the late Dr. David S. Pratt, assistant director of the Mellon Institute of Industrial Research of the University of Pittsburgh, has established in that institution an industrial fellowship as a memorial to Dr. Pratt. The incumbent of this industrial fellowship will conduct research in that field of organic chemistry in which Dr. Pratt was especially interested.

EDGAR S. ROSS, who has been doing private research work with Professor C. James, New Hampshire College, Durham, N. H., for the past 18 months, was recently transferred to Philadelphia, and will continue research investigations at the Greenwich Point Laboratories of the Pennsylvania Salt Mfg. Co. Previous to the work at New Hampshire Mr. Ross was engaged as chief chemist and plant supervisor for Charlotte Chemical Laboratories, Inc., and Columbite Reduction Co., both of Charlotte, N. C.

C. W. SUTTON has been re-elected president and general manager of the American Vulcanized Fibre Co., Wilmington, Del., at a recent meeting of the board of directors.

WILLIAM BOYCE THOMPSON received the honorary degree

of doctor of laws at the Charter Day exercises of the University of Pittsburgh, on Feb. 18. On the same occasion the honorary degree of doctor of science was conferred upon C. H. MacDowell, president of the Armour Fertilizer Co. and director of the chemicals division of the War Industries Board during 1918. These honors were given upon the recommendation of the Mellon Institute of Industrial Research.

CARL A. WENDELL, chief engineer of the American Ore Reclamation Co., New York, has been retained by the General Briquetting Co. as consulting engineer in flue dust briquetting, coal washing, and coal briquetting.

CHARLES S. WITHERELL, recently on the metallurgical staff of Guggenheim Brothers, has entered private practice as metallurgical engineer at 150 Nassau Street, New York.

Dr. J. C. WITT has been placed in charge of chemical research for the Portland Cement Association. This work is being carried on at the Structural Materials Research Laboratory in co-operation with Lewis Institute, Chicago. For a number of years, as chemist and chemical engineer, Dr. Witt has been identified in various ways with the manufacture and use of cement and other materials of construction.

Obituary

H. B. ROSENGARTEN, for many years one of the most widely known chemical manufacturers of Philadelphia, died Feb. 20 at his home. He was eighty-four years old. Mr. Rosengarten formerly was head of the Powers-Weightman-Rosengarten Co. of Philadelphia. He retired from active business several years ago.

Book Reviews

THE MANUFACTURE OF SUGAR FROM THE CANE AND BEET. By T. H. P. Heriot, F.I.C., Lecturer on Sugar Technology at the Royal Technical College, Glasgow. New York: Longmans, Green & Co., 1920. x + 426 pp., 39 figs. Price, \$8.50.

Treatises on manufacturing technology usually emphasize either the theoretical or, more commonly, the descriptive side. That this book falls within the former classification may be seen from the opening paragraph of the preface:

It has often been stated that the sugar producer can only be trained in the factory, theoretical knowledge being of little value. The aim of the present work is to show that successful practice is becoming more and more dependent on scientific principles, which can be studied more effectively outside the factory than inside.

In the plan of the book the manufacture of cane and beet sugar is carried along in parallel chapters, the theoretical treatment usually being followed by some description of the important machinery. While this dual arrangement may appeal to some, the reader who is particularly interested in either branch will be apt to find it more annoying and confusing than valuable. It also leads to some difficulties, as we find the filtration of beet juices discussed in chapter XVIII before the chemical treatment is reached in the following chapter. In the reviewer's opinion, the point more deserving of emphasis is that the sugar technologist should acquire familiarity with the technic of other manufacturing industries; for example, it is only recently that certain improved types of filters have been introduced into the sugar industry which have been standard in metallurgical work for a number of years.

The subject of juice extraction from the cane is thoroughly and interestingly handled, and a good theoretical treatment of the diffusion process for extracting sugar from the beet is given. Mention should be made here, however, of the importance of having battery supply water as low as possible in dissolved solids. The chapter on

evaporation is meager and wholly unsatisfactory. No discussion is given of the value of vapor heating, and the Wellner-Jelinek type of evaporator is not even mentioned. On the subject of crystallization the author is plainly more at home and deserves credit for his treatment of this section. The use of the term "first molasses" is unfortunate, as it is general practice, at least outside of the British Isles, to restrict the designation "molasses" to the final, exhausted mother sirup.

The subject of refining is treated in the last section of twenty-six pages. The author has attempted a good deal in trying to cover the three branches of sugar technology in a book of 400 pages. Under these circumstances it is hardly fair to criticize him for concentrating on the important phases and omitting many details of less importance. In some respects, however, the book could be improved by a more comprehensive treatment of some things and by the omission of others, such as some of the antiquated desugarization processes for molasses.

So many technological works are mere descriptions of processes and machinery that a book which deals primarily with the "scientific principles" is a relief and more than welcome. As such it should offer much stimulation both to the student and to the so-called "practical man." Less can be said for the descriptive matter, which is inadequate except in a few cases.

S. J. OSBORN.

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MACRAE'S BLUE BOOK, VOL. XI, 1920. 1855 pages.

Chicago: MacRae's Blue Book Co., 1920. Price, \$10.

Chemical and metallurgical engineers will find much to interest them in this unusual directory. Its classified material section serves as a buying guide for the wide variety of materials required by any large industrial organization.

In addition to the alphabetical lists of manufacturers and of trade names which are common to directories of this type there are two special sections which serve to round out the usefulness of the book. The first of these is an indexed collection of miscellaneous data including weights and sizes of sheet lead, lead pipe, copper, brass and steel tubing, cast and wrought iron pipe, pipe fittings, wire, sheets, structural shapes, etc. Finally there is a standard list price section (including differentials and extras) covering a multitude of iron and steel products, belting, glass and other plant supplies. The calculation of discounts is facilitated by the use of a table giving the equivalent discount and net price corresponding to the usual trade discounts. This is supplemented by a five-place logarithm table of numbers from 0 to 999.

ALAN G. WIKOFF.

Current Market Reports

The Chemical and Allied Industrial Market

NEW YORK, Feb. 25, 1921.

The chemical business in general appeared quiet during the past week and spot material was not moved in very large dimensions on account of the accumulated stocks of important material in the warehouses. A fair amount of miscellaneous inquiries, however, have been filled in the open market, but the major portion of these were for small lots for immediate delivery. Underneath the surface of the market, some of the largest manufacturers have been able to place a good volume of business on contract with their regular trade and this condition holds true of several important lines. Offerings of foreign chemicals have not caused much of a dent in domestic quotations, but have created a feeling of uncertainty among large buyers which tended to retard actual consummation of new business.

Factors close to the heart of trade conditions admit that sentiment is somewhat mixed. In some industries a marked improvement is noted, although indications are still for a period of a hand-to-mouth business based to a large extent, upon immediate requirements. It now seems clear that the process of placing business upon a level fairly comparable with that which prevailed prior to the war is in progress.

Precipitate declines in commodity markets seem to be passed. Even with the continued declining tendency normal business at a satisfactory profit is possible.

One of the strongest items in the chemical list was *soda ash*. The relatively small supplies in the hands of dealers and jobbers were fully reflected at intervals and prices were occasionally advanced where buyers needed immediate delivery. Inquiries of carlots from Western consumers kept trading moderately active at well sustained prices which ranged from \$2@2.10 per 100 lb. for carload lots and up to \$2.50 for smaller quantities. On the other hand resale offerings of solid *caustic soda* appeared slightly freer and these had a tendency to depreciate spot prices because the demand did not assume active proportions. At intervals during the week caustic sold as low as \$3.70 and as high as \$3.90 per 100 lb. At the close resale material was quoted at \$3.70@3.80 per 100 lb. with contract prices unchanged at \$3.60 per 100 lb. basis 60 per cent f.o.b. works. Foreign *muriate of potash* was offered at \$67@70 per ton basis 80 per cent f.o.b. N. Y. A good inquiry is reported for this important basic chemical and some business is going through. Buyers, however, are below these figures and it looks as though concessions would have to be granted to insure any active business.

Slightly lower prices were named by prominent dealers of *acetate of soda* and goods could be obtained at 5½c. per lb. f.o.b. works for prompt and future shipments. This price holds good only for round lots, smaller quantities being held as high as 6½c. per lb. Inquiry at present seems to be confined mostly to small lots for actual requirements. Moderate quantities of resale *bicarbonate of soda* are offered by dealers at \$2.50 per 100 lb. in barrels, spot N. Y. Producers still quote the market at 2½c. per lb. in barrels and 3c. in kegs f.o.b. works. Most holders of *bichromate of soda*, resale stock, are quoting the market at 8½c. per lb. Occasional sales of small lots went through at 8½c., but there seems to be no apparent pressure of round lot offerings and it is doubtful if better than the outside figure could be done on carlots. Moderate offerings of outside makes were on the market at concessions, prices depending chiefly on the quantity desired. March shipments were generally quoted at 8½c. per lb.

Amyl acetate, technical, was quoted lower by some prominent sellers, and it was stated that business could be placed at \$3.25 per gal. Quotations were heard at \$3.25@3.50 per gal. depending upon the quantity. Scattered sales of imported *barium peroxide* have been reported of late and in one quarter the sale of a carlot at 17c. per lb. is recorded. The general quotation, however, ranges from 18@22c. per lb. Producers of *formaldehyde* remained steady at 18c. per lb. minimum for round lots and 20c. for smaller quantities. Moderate lots of resale stock are obtainable through second hands at 17½@17¾c. per lb. Some sales were reported at the inside figure. An easier feeling was noted in *prussiate of soda* on spot during the week and there were sellers from 16c. down to 15½c. per lb. Absence of important consuming inquiry has stimulated competition among dealers and prices have been reduced accordingly. Prompt shipments from abroad were obtainable at 15c. per lb. Scarcity in offerings of yellow *prussiate of potash* is keeping this chemical in a firm position and the best price heard was 28c. per lb. for small quantities only. Prompt shipments were quoted at 27c. per lb. The red variety also remained very scarce with sellers quoting 50@55c. per lb.

White *arsenic* on spot is to be had as low as 9c. per lb. in very fair volume. In some quarters prices are named up to 10½c. per lb., but no business has been reported above 10c. Producers' prices on *caustic potash* are lower, but in view of the demoralized state of the market this factor has had no noticeable effect. Resale lots of caustic of standard domestic brands are offered on the spot as low as 10@12c. per lb. with some dealers even in a position to shade the low figure on firm business. Imported caustic potash is offered at 11@13c. per lb. Producers are quoting 16@18c. per lb. admitting they are willing to shade these figures for real business. Producers of *copper sulphate* have reduced their quotations and in some directions stocks are to be had as low as 5½c. per lb. from manufacturers, although others are quoting up to 6c. per lb. The market for imported

material is very uncertain with a nominal quotation given as 5½c. per lb. No large stocks of imported sulphate could be located.

Manufacturers of *sulphuric acid* are holding prices fairly firm, although in the absence of actual business some shading has been done in certain quarters. Slowness throughout the chemical industry is reflected in the light demand for sulphuric. Producers, however, have held prices exceptionally firm considering all these conditions. Their attitude is that requirements will have to be taken care of whatever the price and they are not disposed to set a figure which will not yield them a fair profit. Prices remained quatably unchanged at former levels throughout the entire group.

COAL-TAR PRODUCTS

Interest in the different branches of the coal tar products market reflected improvement. Buyers for both domestic consumption and export are entering the market with orders of larger volume for spot material, but there still lacks keen interest beyond present needs and little talk of contract business is heard. A few factors are trying hard to encourage future business since they believe that prices will be fairly steady for some time to come. Manufacturers of crude products have done business on an increasing scale and prices have held steady. Consumers of intermediates are showing more interest in supplies and sellers realizing that there is more honest intention of buyers to come into the market to buy and not merely shop around are showing more disposition to meet buyers' views, and lower prices are being quoted among manufacturers as well as second hands.

Prices on *benzene* remained unchanged in producers' hands although reports were heard to the effect that business has picked up perceptibly. Quotations are made on the basis of 30@35c. per gal. for pure benzene in drums and tank cars. The 90 per cent grade is held at 28@32c. per gal. on the same basis. The increased business in this material has seemed to confine itself mostly to the 90 per cent grade, although some increase has been noted in the amount of business done in pure benzene. The market on *naphthalene* seems to be taking on some activity and with supplies scarce in second hands prices are holding steady. Resale lots of the ball variety were heard toward the close at 9½c. per lb., while flakes ranged from 8½@8½c. per lb. Producers' figures on flakes are quoted around 9@10c. per lb. and balls from 10@12c. Continued small lot buying of *phenol* has placed the spot market in an increasingly stronger position. The only stocks which are available in the open market are quite firmly held with most sellers asking as high as 11c. per lb. There seem to be small lots around at 10c. per lb., although these are becoming much harder to locate. Government surplus phenol is still offered at 12c. per lb.

The past week has shown the *aniline oil* market rather weak with available material easy and sellers offering as low as 20½c. per lb. Consumers are showing little disposition to take hold of any but small lots. Trading in *aniline salt* showed a tendency to improve with sales in a little larger volume. While supplies seem to be fairly easy, prices are more firmly held at 28@30c. per lb. Business in *beta-naphthol* below 33½c. per lb. seems to be impossible, but some sales were recorded at or near this figure. Quotations range from 33½c. up to 45c. per lb. according to seller. The spot lots of distressed material which have held the market in its recent weak position seem to be moving into stronger hands and the market is correspondingly firmer. The lowest price quoted at present by producers is 40c. per lb.

Prices on *paranitraniline* quoted by producers continue well above the spot market. Second hands offer stocks as low as 85c. per lb. with producers quoting up to \$1.05 per lb. There has been very little change in the quiet trading of *dimethylaniline*. Sellers are not pushing business very hard and it is not thought that much better than 55@60c. per lb. could be done. Sales of U. S. P. *salicylic acid* have been reported in the market at prices approaching the technical grade. Producers are quoting 22@23c. for the technical acid, but are doing little business at this figure. Quotations on *alpha-naphthylamine* have remained unchanged

on a dull market. Prices are variously given at 38@40c. per lb. according to seller. Business has been of such limited proportion that producers have not felt the necessity of bringing prices into better alignment.

WAXES

The demand for refined *beeswax* is reported good, but trading in the raw material has fallen off so that prices in some directions are barely steady. For the lower grade of crude beeswax prices range from 17@19c. per lb., depending upon color, quantity and seller. Refined wax is held at 27@35c. per lb. With little change in prices at primary points the market on *carnauba wax* was an uninteresting affair. Demand was described as routine. Offerings of the higher grades on spot were limited, but the common varieties appeared plentiful. No. 2 North Country grade closed unchanged at 18@19c. per lb. with the flora grade held at 70@71c. per lb.

Spot quotations for *Japan wax* were steady under moderate offerings and leading factors continued to quote from 19@20c. per lb. With the crude oil situation easier and no improvement in the export call the market for *paraffine wax* was unsettled throughout the week. Round lots of scale wax were offered by producers on the basis of 3½c. per lb. f.o.b. refinery without attracting any buyers. Refined wax of 130 degree melting point closed nominally at 6½c. per lb.

The Iron and Steel Market

PITTSBURGH, Feb. 25, 1921.

Conditions in the steel industry are working out in harmony with the theory stated in this report a week ago, that the price cutting produces no more business for the independent producers, and reduces the operation of the Steel Corporation. The price cutting has proceeded somewhat farther, but not much farther, chiefly because there is so little incentive by way of important inquiry coming out.

It is very doubtful whether the bookings of the independent mills, since the price cutting began, have been as heavy as they would have been if there had been no price cutting.

As to Steel Corporation operations there has been a very marked effect. It must be understood, of course, that the corporation's operations were marked for a decline, since at the beginning of the year many customers of the corporation were taking steel at a rate well beyond their current consumption, but the corporation's operations have been decreasing by reason of the price cutting much more rapidly than would otherwise have been the case. In the fore part of January the corporation operated at an average of about 92 per cent, measured in steel ingot production against rated capacity. Last week the corporation operated at not over 75 per cent and this week it is averaging not over 65 per cent. A somewhat similar rate of recession is to be expected in the next few weeks.

It is now rather generally understood that the independents, in cutting prices, did not expect to book any considerable tonnage of business, but hoped to produce eventually a redistribution of business, and expected to induce the Steel Corporation to reduce wages, as the majority of independents had already done, the reductions beginning in the fore part of last December. Effective February 16 the independents in the Youngstown district reduced wages and salaries generally by about 20 per cent. Yesterday the Jones & Laughlin Steel Company announced a similar reduction, effective March 1. These latest reductions involve, in the case of common labor, a reduction from 46 to 37 cents an hour.

STEEL CORPORATION FIRM

The United States Steel Corporation displays no indication whatever of being moved by these developments, in price and wage reductions. The corporation refuses to be stampeded, and that is certainly not remarkable in view of the truly spectacular performance of the corporation last year in refraining from advancing its prices when all the independents advanced and when the corporation's costs were somewhat increased by what occurred at independent mills, as well as by the wage advance of February 1 and the freight rate advance of August 26.

There is no question, of course, that the corporation will eventually reduce both prices and wages. The question is merely as to the time. No one has basis for predicting that the corporation will not wait months, although it is possible that action will be taken within a very short time.

INDEPENDENT DECLINES

Plainly defined declines in finished steel prices from the prices quoted a week ago are not particularly important. Plates can be done at \$3 a ton less, black sheets at \$1 a ton less and galvanized sheets at \$2 a ton less. Prices now quoted as the minimum of the open market, however, are probably in all cases subject to further discount in the event of a buyer offering an order sufficiently attractive in point of tonnage and specifications. Indeed, an outstanding feature of the attitude of some mills in quoting prices is that they do not represent the prices quoted as being a set minimum, but merely as being their price on the particular inquiry involved. The mills are careful to say nothing that might be interpreted by a possible buyer as a suggestion not to come back with other inquiries. Prices openly quotable, compared with Industrial Board or Steel Corporation prices, are now as follows: Bars, 2c. against 2.35c.; shapes, 2.20c. against 2.45c.; plates, 2.10c. against 2.65c.; plain wire, 3c. against 3.25c.; wire nails, \$3.10 against \$3.25; hoops, 2.85c. against 3.05c.; blue annealed sheets, 3.20c. against 3.55c.; black sheets, 4.10c. against 4.35c.; galvanized sheets, 5.25c. against 5.70c.

Tin plate remains firm at \$7 per base box, 100-lb. As for quite a while past there are offerings at second hand at deep cuts. Independent tin plate mills seem to be booking a trifle more business than formerly. The leading interest is in the third week of a four-week schedule of 70 per cent operation at its tin plate mills, and finds the operation involves the making of less stock than was expected, there being very fair shipments.

Standard steel pipe is not yet openly quotable at any decline, but some jobbers are selling at the mill price, and some other descriptions of welded steel tubular goods are going at concessions. Pipe mill operations are still heavy, even by the independents, pipe being quite different from all other finished steel commodities.

SEMI-FINISHED STEEL

Cut prices on sheet bars are now appearing freely. While the official price of the Steel Corporation is still \$47, independent mills have willingly quoted \$42 and it is reported one \$40 quotation has been made, but \$42 is merely the old Industrial Board price, the Steel Corporation having made a \$5 advance last September. Some sheet mills speak as if they might take hold at \$35, but in sheets as in some other lines the matter is still open whether the price of the raw material will make the price of the finished product, or the other way about. The market may be quoted nominal at \$42 for sheet bars and \$40 for billets.

PIG IRON AND COKE

As a result of a very few sales basic pig iron is quotable down \$2.50, to \$25, valley, and foundry down \$1, to \$27, valley. Bessemer by inference from basic drops from \$29, to \$27, valley. These prices are well below cost of production based on cost of ore piles, purchased at last season's ore prices, and well below the recent cost of coke. The furnaces merely do not know how much their ore piles have depreciated in value, that depending on prices that will be developed for the 1921 ore season. As to coke, operators will sell at flat prices, below those that would be dictated by contracts now nominally in force, a typical contract being at 5 to 1 against basic pig iron, but with a \$5.75 minimum, so that when basic iron declined below \$28.75 the minimum would obtain instead of the ratio. One could buy at \$5 and perhaps at less, certainly at much less if wages in the coke region were reduced. That seems to await action by the Steel Corporation on the general subject of wages, the independent operators in the Connellsville region being indisposed to act except under leadership of the Frick company.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
			\$0.55 - \$0.60	
Acetic anhydride.....lb.	\$0.13 - \$0.13		.13 - .14	
Acetone.....lb.	3.00 - 3.25		3.50 - 3.75	
Acid, acetic, 28 per cent.....100 lbs.	6.00 - 6.25		6.50 - 6.75	
Acetic, 56 per cent.....100 lbs.				
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	10.50 - 11.00		11.25 - 11.50	
Boric, crystals.....lb.	.14 - .15		.15 - .16	
Boric, powder.....lb.	.15 - .16		.17 - .18	
Citric.....lb.			.45 - .47	
Hydrochloric.....100 lb.	1.45 - 1.60		1.75 - 2.00	
Hydrofluoric, 52 per cent.....lb.	.15 - .16		.16 - .18	
Lactic, 44 per cent tech.....lb.	.10 - .11		.11 - .12	
Lactic, 22 per cent tech.....lb.	.04 - .05		.06 - .07	
Molybdic, C. P.....lb.	4.00 - 4.50		4.50 - 5.00	
Muriatic, 20 deg. (see hydrochloric).....lb.				
Nitric, 40 deg.....lb.	.07 - .07		.08 - .08	
Nitric, 42 deg.....lb.	.08 - .09		.09 - .10	
Oxalic, crystals.....lb.	.15 - .15		.16 - .17	
Phosphoric, Ortho, 50 per cent solution, lb.	.15 - .15		.16 - .16	
Picric.....lb.	.30 - .32		.35 - .40	
Pyrogallol, resublimed.....lb.			2.30 - 2.40	
Sulphuric, 60 deg., tank cars.....ton				
Sulphuric, 60 deg., drums.....ton			14.00 - 15.00	
Sulphuric, 66 deg., tank cars.....ton	18.00 - 19.00			
Sulphuric, 66 deg., drums.....ton	21.00 - 22.00		22.50 - 23.00	
Sulphuric, 66 deg., carboys.....ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 - 24.00			
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 - 26.00		26.50 - 27.00	
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 - 35.00		40.00 -	
Tannic, U. S. P.....lb.			1.15 - 1.25	
Tannic (tech.).....lb.	.45 - .47		.48 - .50	
Tartaric, crystals.....lb.			.31 - .35	
Tungstic, per lb. of WO.....lb.			1.00 - 1.20	
Alcohol, Ethyl.....gal.			4.80 - 5.00	
Alcohol, Methyl (see methanol).....gal.				
Alcohol, denatured, 188 proof.....gal.			.50 - .52	
Alcohol, denatured, 190 proof.....gal.			.54 - .56	
Alum, ammonia lump.....lb.	.04 - .04		.05 - .05	
Alum, potash lump.....lb.	.05 - .06		.06 - .07	
Alum, chrome lump.....lb.	.13 - .13		.14 - .14	
Aluminum sulphate, commercial.....lb.	.02 - .02		.02 - .03	
Aluminum sulphate, iron free.....lb.	.03 - .03		.03 - .03	
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07 - .07		.07 - .08	
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 - .32		.33 - .35	
Ammonium carbonate, powder.....lb.	.11 - .11		.12 - .12	
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	.07 - .08		.08 - .08	
Ammonium chloride, granular (gray salamoniac).....lb.	.09 - .09		.09 - .10	
Ammonium nitrate.....lb.	.08 - .08		.09 - .10	
Ammonium sulphate.....100 lb.	3.25 - 3.35		3.40 - 3.60	
Amylacetate.....gal.			4.00 - 4.25	
Am acetate tech.....gal.			3.25 - 3.50	
Arsenic oxide, (white arsenic).....lb.	.09 - .09		.10 - .10	
Arsenic, sulphide, powdered (red arsenic).....lb.	.14 - .14		.15 - .15	
Barium chloride.....ton	65.00 - 70.00		75.00 - 80.00	
Barium dioxide (peroxide).....lb.	.18 - .19		.19 - .22	
Barium nitrate.....lb.	.10 - .10		.10 - .11	
Barium sulphate (precip.) (blanc fixe).....lb.	.04 - .05		.05 - .06	
Bleaching powder (see calc. hypochlorite).....lb.				
Blue vitriol (see copper sulphate).....lb.				
Borax (see sodium borate).....lb.				
Brimstone (see sulphur, roll).....lb.				
Bromine.....lb.	.40 - .41		.42 - .45	
Calcium acetate.....100 lbs.	2.00 - 2.05			
Calcium carbide.....lb.	.04 - .04		.04 - .05	
Calcium chloride, fused, lump.....ton	27.00 - 29.00		30.00 - 32.00	
Calcium chloride, granulated.....lb.	.01 - .01		.02 - .02	
Calcium hypochlorite (bleach'g powder).....lb.	.02 - .03		.03 - .03	
Calcium peroxide.....lb.			1.00 - 1.10	
Calcium phosphate, monobasic.....lb.			.15 - .16	
Camphor.....lb.			.70 - .75	
Carbon bisulphide.....lb.	.08 - .08		.09 - .09	
Carbon tetrachloride, drums.....lb.	.11 - .11		.12 - .12	
Carbonyl chloride (phosgene).....lb.			.75 - 1.00	
Caustic potash (see potassium hydroxide).....lb.				
Caustic soda (see sodium hydroxide).....lb.				
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.09 - .09		.10 - .10	
Chloroform.....lb.			.38 - .40	
Cobalt oxide.....lb.			3.00 - 3.10	
Copperas (see iron sulphate).....lb.				
Copper carbonate, green precipitate.....lb.	.24 - .25		.26 - .27	
Copper cyanide.....lb.			.50 - .60	
Copper sulphate, crystals.....lb.	.05 - .05		.06 - .06	
Cream of tartar (see potassium bitartrate).....lb.				
Epsom salt (see magnesium sulphate).....lb.				
Ethyl Acetate Com. 85%.....gal.			1.05 - 1.10	
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.				
Formaldehyde, 40 per cent.....lb.	.17 - .17		.17 - .18	
Fusel oil, ref.....gal.			4.00 - 4.50	
Fusel oil, crude.....gal.			2.50 - 2.75	
Glauber's salt (see sodium sulphate).....lb.				
Glycerine, C. P. drums extra.....lb.			.20 - .21	
Iodine, resublimed.....lb.			3.75 - 3.85	
Iron oxide, red.....lb.			.10 - .20	
Iron sulphate (copperas).....100 lb.	1.00 - 1.25		1.50 - 1.75	
Lead acetate, normal.....lb.			.14 - .16	
Lead arsenate (paste).....lb.	.11 - .12		.12 - .13	
Lead nitrate.....lb.			.15 - .20	
Litharge.....lb.	.08 - .09		.09 - .10	
Lithium carbonate.....lb.			1.25 -	
Magnesium carbonate, technical.....lb.	.10 - .11		.11 - .12	
Magnesium sulphate, U. S. P.....100 lb.	2.00 - 2.50			
Magnesium sulphate, commercial.....100 lb.			1.50 - 1.75	
Methanol, 95%.....gal.			1.22 - 1.24	
Methanol, pure.....gal.			1.55 - 1.60	
Nickel salt, double.....lb.			.12 - .12	
Nickel salt, single.....lb.			.13 - .13	
Phosgene (see carbonyl chloride).....lb.				
Phosphorus, red.....lb.	.45 - .46		.47 - .50	
Phosphorus, yellow.....lb.			.35 - .37	
Potassium bichromate.....lb.	.13 - .13		.14 - .14	

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$.35 — .40	\$0.30 — \$0.35
Potassium bromide, granular..... lb.	.35 — .40	.20 — .40
Potassium carbonate, U. S. P..... lb.	.35 — .40	.45 — .50
Potassium carbonate, crude..... lb.	.08 — .08½	.09 — .10
Potassium chlorate, crystals..... lb.	.08 — .10	.11 — .18
Potassium cyanide..... lb.	.10 — .11	.45 — .50
Potassium hydroxide (caustic potash)..... lb.	.10 — .11	.12 — .13
Potassium muriate..... ton	67.00 — 70.00	
Potassium iodide..... lb.		2.75 — 3.00
Potassium nitrate..... lb.	.09½ — .09½	.10 — .12½
Potassium permanganate..... lb.	.45 — .46	.48 — .50
Potassium prussiate, red..... lb.	.50 — .52	.53 — .55
Potassium prussiate, yellow..... lb.	.28 — .29	.30 — .32
Potassium sulphate (powdered)..... per unit		— 2.25
Rochelle salts (see sodium potassium tartrate)		
Salammoniac (see ammonium chloride)		
Sal soda (see sodium carbonate)		
Salt cake..... ton		32.00 — 33.00
Silver cyanide..... oz.		1.25 — 1.40
Silver nitrate..... oz.		.40½ — .41½
Soda ash, light..... 100 lb.	2.00 — 2.10	2.20 — 2.50
Soda ash, dense..... 100 lb.	2.20 — 2.30	2.40 — 2.60
Sodium acetate..... lb.	.05½ — .05½	.06 — .06½
Sodium bicarbonate..... 100 lb.	2.50 — 2.75	3.00 — 3.25
Sodium bichromate..... lb.	.08½ — .08½	.09 — .09½
Sodium bisulphate (nitre cake)..... ton	7.00 — 7.50	8.00 — 11.00
Sodium bisulphate, powdered, U.S.P..... lb.	.05 — .05½	.06 — .06½
Sodium borate (borax)..... lb.	.08½ — .08½	.08½ — .09
Sodium carbonate (sal soda)..... 100 lb.	2.00 — 2.25	2.50 — 2.75
Sodium chl rate..... lb.	.10 — .10½	.10½ — .11
Sodium cyanide, 96-98 per cent..... lb.	.18 — .19	.20 — .28
Sodium fluoride..... lb.	.13 — .14	.14½ — .15
Sodium hydroxide (caustic soda)..... 100 lb.	3.70 — 3.80	3.90 — 4.10
Sodium hyposulphite..... lb.		.03½ — .04
Sodium nitrate..... 100 lb.	2.85 — 3.00	3.00 — 3.10
Sodium nitrite..... lb.	.06 — .06½	.06½ — .07
Sodium peroxide, powdered..... lb.	.30 — .31	.32 — .34
Sodium phosphate, dibasic..... lb.	.04 — .04½	.04½ — .05
Sodium potassium tartrate (Rochelle salts) lb.		.29 — .31
Sodium prussiate, yellow..... lb.	.15½ — .15½	.15½ — .16
Sodium silicate, solution (40 deg.)..... lb.	1.10 — 1.15	1.20 — 1.40
Sodium silicate, solution (60 deg.)..... lb.	.02½ — .03	.03½ — .03½
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.75 — 2.00	2.25 — 2.50
Sodium sulphide, crystal, 60-62 per cent (conc.) lb.	.05 — .05½	.05½ — .06
Sodium sulphite, crystals..... lb.	.04 — .04½	.04½ — .05
Strontium nitrate, powdered..... lb.	.16 — .16½	.16½ — .17
Sulphur chloride, red..... lb.	.07 — .07½	.07½ — .08
Sulphur, crude..... ton	16.00 — 20.00	
Sulphur dioxide, liquid, cylinders..... lb.	.08 — .08½	.08½ — .09
Sulphur (sublimed), flour..... 100 lb.		2.25 — 3.10
Sulphur, roll (brim tone)..... 100 lb.		2.00 — 2.75
Tin bichloride, 50 per cent..... lb.	.18 — .19	
Tin oxide..... lb.		.45 — .47
Zinc carbonate, precipitate..... lb.	.16 — .18	.19 — .20
Zinc chloride, gran..... lb.	.11 — .11½	.11½ — .12
Zinc cyanide..... lb.	.45 — .49	.50 — .60
Zinc dust..... lb.	.12 — .13	.13½ — .14
Zinc oxide, XX..... lb.	.08½ — .09	.09½ — .11
Zinc sulphate..... lb.	.03½ — .03½	.04 — .06

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 — \$1.15
Alpha-naphthol, refined..... lb.	1.45 — 1.50
Alpha-naphthylamine..... lb.	.38 — .40
Aniline oil, drums extra..... lb.	.20½ — .26
Aniline salts..... lb.	.27 — .30
Anthracene, 80% in drums (100 lb.)..... lb.	.75 — 1.00
Benzaldehyde U.S.P..... lb.	1.00 — 1.50
Benzidine, base..... lb.	.95 — 1.05
Benzidine sulphate..... lb.	.80 — .90
Benzoic acid, U.S.P..... lb.	.70 — .75
Benzoate of soda, U.S.P..... lb.	.70 — .80
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.30 — .35
Benzene, 90%, in drums (100 gal.)..... gal.	.28 — .32
Benzyl chloride, 95-97%, refined..... lb.	.30 — .35
Benzyl chloride, tech..... lb.	.25 — .30
Beta-naphthol benzoate..... lb.	3.50 — 4.00
Beta-naphthol, sublimed..... lb.	.70 — .75
Beta-naphthol, tech..... lb.	.33½ — .40
Beta-naphthylamine, sublimed..... lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)..... lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums..... gal.	.95 — 1.00
Cresylic acid, 75-97%, dark, in drums..... gal.	.90 — .95
Cresylic acid, 50%, first quality, drums..... gal.	.60 — .65
Dichlorobenzene..... lb.	.06 — .09
Diethylaniline..... lb.	1.20 — 1.30
Dimethylaniline..... lb.	.55 — .65
Dinitrobenzene..... lb.	.30 — .32
Dinitrochlorobenzene..... lb.	.25 — .30
Dinitronaphthalene..... lb.	.33 — .35
Dinitrophenol..... lb.	.40 — .45
Dinitrotoluene..... lb.	.25 — .30
Dip oil, 25%, tar acids, car lots, in drums..... gal.	.38 — .40
Diphenylamine..... lb.	.60 — .70
H-acid..... lb.	1.30 — 1.50
Meta-phenylenediamine..... lb.	1.25 — 1.30
Monochlorobenzene..... lb.	.14 — .16
Monoethylaniline..... lb.	1.75 — 2.00
Naphthalene crushed, in bbls. (250 lb.)..... lb.	.08 — .08½
Naphthalene, flake..... lb.	.08½ — .08½
Naphthalene, balls..... lb.	.09½ — .10
Naphthionic acid, crude..... lb.	.70 — .75
Nitrobenzene..... lb.	.12 — .15
Nitro-naphthalene..... lb.	.30 — .35
Nitro-toluene..... lb.	.18 — .25
Ortho-amidophenol..... lb.	3.20 — 3.75
Ortho-dichlor-benzene..... lb.	.15 — .20
Ortho-nitro-phenol..... lb.	.75 — .80
Ortho-nitro-toluene..... lb.	.20 — .24
Ortho-toluidine..... lb.	.25 — .30
Para-amidophenol, base..... lb.	1.90 — 2.00
Para-amidophenol, HCl..... lb.	2.10 — 2.20

Para-dichlorobenzene..... lb.	.15 — .25
Paranitroaniline..... lb.	.85 — 1.00
Para-nitrotoluene..... lb.	.90 — 1.05
Para-phenylenediamine..... lb.	1.90 — 2.00
Para-toluidine..... lb.	1.30 — 1.60
Phthalic anhydride..... lb.	.55 — .60
Phenol, U. S. P., drums (dest.), (240 lb.)..... lb.	.10 — .12
Pyridine..... gal.	2.00 — 3.50
Resorcinol, technical..... lb.	1.85 — 2.00
Resorcinol, pure..... lb.	2.30 — 2.50
Salicylic acid, tech., in bbls. (110 lb.)..... lb.	.22 — .23
Salicylic acid, U. S. P..... lb.	.25 — .27
Salol..... lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.28 — .31
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.15 — .18
Sulphanilic acid, crude..... lb.	.30 — .35
Tolidine..... lb.	1.35 — 1.45
Toluidine, mixed..... lb.	.40 — .45
Toluene, in tank cars..... gal.	.28 — .32
Toluene, in drums..... gal.	.31 — .35
Xylidine, drums, 100 gal..... lb.	.40 — .45
Xylene, pure, in drums..... gal.	.42 — .45
Xylene, pure, in tank cars..... gal.	.45 — .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 — .35
Xylene, commercial, in tank cars..... gal.	.30 — .35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.24 — \$0.26
Beeswax, refined, light..... lb.	.27 — .28
Beeswax, white pure..... lb.	.40 — .45
Carnauba, Fla..... lb.	.70 — .71
Carnauba, No. 2, North Country..... lb.	.30 — .32
Carnauba, No. 3, North Country..... lb.	.18 — .19
Japan..... lb.	.19 — .20
Montan, crude..... lb.	.07 — .08
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.04½ — .04½
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.03½ — .03½
Paraffine waxes, refined, 118-120 m.p..... lb.	.04 — .05
Paraffine waxes, refined, 125 m.p..... lb.	.05½ — .05½
Paraffine waxes, refined, 128-130 m.p..... lb.	.06½ — .06½
Paraffine waxes, refined, 133-135 m.p..... lb.	.07½ — .07½
Paraffine waxes, refined, 135-137 m.p..... lb.	.08½ — .09
Stearic acid, single pressed..... lb.	.12 — .12
Stearic acid, double pressed..... lb.	.12½ — .12½
Stearic acid, triple pressed..... lb.	.13½ — .13½

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.70
Pine oil, pure, dest. dist..... gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970..... gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.37
Pinewood creosote, ref..... gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-..... bbl.	280 lb.	\$6.75 —
Rosin E-I..... bbl.	280 lb.	6.75 —
Rosin K-N..... bbl.	280 lb.	6.75 —
Rosin W. G.-W. W..... bbl.	280 lb.	7.00 —
Wood rosin, bbl..... bbl.	280 lb.	7.25 —
Spirits of turpentine..... gal.		.56 —
Wood turpentine steam dist..... gal.		.54 —
Wood turpentine, dest. dist..... gal.		.53 —
Pine tar pitch, bbl..... 200 lb.		8.50 —
Tar, kiln burned, bbl. (500 lb.)..... bbl.		15.00 —
Retort tar, bbl..... 500 lb.		15.00 —
Rosin oil, first run..... gal.		.50 —
Rosin oil, second run..... gal.		.52 —
Rosin oil, third run..... gal.		.60 —

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41
70-72 deg., steel bbls. (85 lb.)..... gal.	.39
68-70 deg., steel bbls. (85 lb.)..... gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30

Crude Rubber

Para-Upriver fine..... lb.	\$0.17 — \$0.18
Upriver coarse..... lb.	.13 — .14
Upriver caucho ball..... lb.	.14 — .14½
Plantation—First latex crepe..... lb.	.19½ — .19½
Ribbed smoked sheets..... lb.	.18½ — .18½
Brown crepe, thin, clean..... lb.	.18 — .18
Amber crepe No. 1..... lb.	.20 — .20

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.09 — \$0.09½
Castor oil, AA, in bbls..... lb.	.10 — .10½
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.08 — .08½
Cocoonut oil, Ceylon grade, in bbls..... lb.	.11½ — .11½
Cocoonut oil, Cochon grade, in bbls..... lb.	.11½ — .12
Cori oil, crude, in bbls..... lb.	.08½ — .09
Cottonseed oil, crude (f. o. b. mill)..... lb.	.05½ — .05½
Cottonseed oil, summer yellow..... lb.	.07 — .07½
Cottonseed oil, winter yellow..... lb.	.08 — .08½
Linseed oil, raw, car lots (domestic)..... gal.	.67 — .68
Linseed oil, raw, tank cars (domestic)..... gal.	.60 — .60
Linseed oil, boiled, car lots (domestic)..... gal.	.69 — .70

Olive oil, commercial.....	gal.	\$2.60	—	\$2.75
Palm, Lagos.....	lb.	.07½	—	.07¾
Palm, Niger.....	lb.	.06½	—	.06¾
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.06½	—	.06¾
Peanut oil, refined, in bbls.....	lb.	.12½	—	.13
Rapeseed oil, refined in bbls.....	gal.	1.05	—	1.10
Rapeseed oil, blown, in bbls.....	gal.	1.15	—	1.20
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07½	—	.07¾
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.04½	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.46	—	\$0.48
Yellow bleached menhaden.....	gal.	.48	—	.50
White bleached menhaden.....	gal.	.50	—	.52
Blown menhaden.....	gal.	.85	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	.....
Blanc fixe, dry.....	lb.	.05	—	.05½
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.16
Chalk, domestic, extra light.....	lb.	.05	—	.05½
Chalk, domestic, light.....	lb.	.04½	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04½	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mires.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Fla.....	net ton	25.00	—	.....
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	35.00	—	40.00
Graphite, crucible, 90% carbon, Ashland, Ala.....	lb.	.....	—	.09
Graphite, crucible, 85% carbon, Ashland, Ala.....	lb.	.07	—	.09
Graphite, higher lubricating grades.....	lb.	.11	—	.40
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.65	—	.....
Shellac, orange superfine.....	lb.	.70	—	.....
Shellac, A. C. garnet.....	lb.	.57	—	.....
Shellac, T. N.....	lb.	.55	—	.....
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	14.00	—	15.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	40.00	—	50.00
Talc, California talcum powder grade.....	ton	20.00	—	45.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	.....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	80-100	.....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	45- 50	.....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	- 55	.....
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55- 60	.....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45- 50	.....
Magnesite brick, 9-in. straight.....	net ton	100	.....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105	.....
Magnesite brick, soaps and splits.....	net ton	120	.....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65- 70	.....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56- 61	.....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	50- 60	.....

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.16	—	.....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.16	—	.17
Ferromanganese, 76-80% Mn, domestic.....	gross ton	95.00	—	100.00
Ferromanganese, 76-80% Mn, English.....	gross ton	95.00	—	100.00
Spiegelisen, 18-22% Mn.....	gross ton	38.00	—	40.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.00	—	2.50
Ferrosilicon, 10-15%.....	gross ton	50.00	—	55.00
Ferrosilicon, 50%.....	gross ton	80.00	—	85.00
Ferrosilicon, 75%.....	gross ton	150.00	—	155.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.55	—	.60
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	7.00	—	.....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00	—	5.25

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content, less than 2% Fe ₂ O ₃ , up to 20% silica, not more than H 4% moisture.....	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.55	—	.60
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	50	—	55
Coke, foundry, f.o.b. ovens.....	net ton	6.00	—	6.50
Coke, furnace, f.o.b. ovens.....	net ton	5.00	—	5.50
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	16.00	—	17.00
Fluorspar, lump, f.o.b. Heathden, New Mexico.....	net ton	17.50	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	—	25.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01¾
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.40	—	.45
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.16	—	.....
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.16½	—	.....
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	—	3.25
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	.....
Zircon, washed, iron free.....	lb.	.03	—	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.50
Aluminum, 98 to 99 per cent.....	28.3 @ 28.5
Antimony, wholesale lots, Chinese and Japanese.....	5.25
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	.35
Monel metal ingots.....	.38
Monel metal, sheet bars.....	.40
Tin, 5-ton lots.....	32.00
Lead, New York, spot.....	4.00
Lead, E. St. Louis, spot.....	4.00
Zinc, spot, New York.....	7.00
Zinc, spot, E. St. Louis.....	4.80 @ 4.90

OTHER METALS

Silver (commercial).....	oz.	\$0.56
Cadmium.....	lb.	1.40 @ 1.50
Bismuth (500 lb. lots).....	lb.	2.35 @ 2.40
Cobalt.....	lb.	4.50
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	70.00
Iridium.....	oz.	325.00
Palladium.....	oz.	65.00 @ 70.00
Mercury.....	.75 lb.	46.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	21.25
Copper bottoms.....	33.00
Copper rods.....	28.00
High brass wire and sheets.....	18.75
High brass rods.....	16.75
Low brass wire and sheets.....	27.50
Low brass rods.....	18.50
Brazed brass tubing.....	35.25
Brazed bronze tubing.....	40.50
Seamless copper tubing.....	25.00
Seamless high brass tubing.....	24.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	11.50	18.50	10.00	10.50
Copper, heavy and wire.....	11.00	16.50	9.50	9.50
Copper, light and bottoms.....	9.00	14.50	9.00	8.50
Lead, heavy.....	4.00	7.25	4.00	4.00
Lead, tea.....	3.00	5.25	3.00	3.00
Brass, heavy.....	7.00	9.50	7.00	10.00
Brass, light.....	5.50	8.00	5.00	5.50
No. 1 yellow brass turnings.....	6.00	9.50	5.50	6.00
Zinc.....	4.00	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York		Cleveland		Chicago	
	One Month Ago	One Year Ago	One Month Ago	One Year Ago	One Month Ago	One Year Ago
*Current						
Structural shapes.....	\$3.73	\$3.80	\$3.47	\$3.58	\$3.37	\$3.47
Soft steel bars.....	3.93	3.70	3.52	3.34	3.27	3.48
Soft steel bar shapes.....	3.93	3.70	3.52	3.48	3.27	3.48
Soft steel bands.....	4.33	4.65	4.22	6.25	3.57	3.78
Plates, ½ to 1 in. thick.....	3.93	4.00	3.67	3.78	3.57	3.78

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

HUNTSVILLE—The F. & O. Cedar Works, specializing in the manufacture of cedar and other oils, is planning for the rebuilding of its plant, recently destroyed by fire. Lucien Hewlett is manager.

Arkansas

BATESVILLE—The Planters' Lime, Phosphate & Fertilizer Co., recently organized with a capital of \$1,500,000, is planning for the erection of a new plant for the production of hydrated lime and other lime products, with department of the works devoted to the manufacture of fertilizer. The company has a large tract of property in this section. J. R. Alexander, Scotts, Ark., is president; J. W. Williamson, Batesville, is secretary.

California

SAN FRANCISCO—The General Petroleum Co., 310 Sansome Street, has arranged for a note issue of \$7,500,000, the proceeds to be used, in part, for proposed extensions in refineries, improvements, and general expansion.

BURBANK—The Empire China Co. has commenced the erection of a new plant, consisting of three one-story, brick factories, 140 x 318 ft., 32 x 318 ft., and 24 x 125 ft., respectively. The works will be used for the manufacture of chinaware, porcelain, etc., and is estimated to cost about \$80,000. Farley & Farley, Burbank, have the construction contract.

LOS ANGELES—The Pacific Clay Products Co., American Bank Building, has preliminary plans under way for the construction of an addition to its plant at Los Nietos, near Whittier, to be used for the manufacture of brick and other burned clay products. The first unit will have a capacity of 25,000 bricks per day to be supplemented later with a second unit of about 15,000 daily output.

Delaware

WILMINGTON—The Martin Leather Co. has acquired the former leather works of Barr & Dougherty, 707 East Fifth St., more recently owned by the Standard Kid Mfg. Co., for a consideration said to be about \$90,000. The new owner will improve the works, with the installation of new equipment as required. Production will be inaugurated on a small scale and increased as soon as conditions warrant.

Florida

MIAMI—The Standard Poured Brick Co. is planning for the erection of a large addition to its plant in the Miami Canal district, increasing the present output of about 5,000 bricks per day to 50,000 bricks daily.

WEST PALM BEACH—W. J. Carroll, P. O. Box 611, and associates, have plans under way for the construction of a new glass manufacturing plant. A site has been selected and machinery will be purchased at an early date.

Georgia

SAVANNAH—The Southern Fertilizer & Chemical Co. will inaugurate operations at once at its new local plant, recently completed. The new factory represents an investment of close to \$1,000,000 and will replace the company's works at Hutchinson Island, destroyed by fire in 1920. The new plant will specialize in the manufacture of finished fertilizer, with large department devoted to the production of acid phosphate. The production of the company's works at St. Mary's, Ga., and Philadelphia, Pa., will be utilized at the new factory.

METTER—The Metter Naval Stores Co. has preliminary plans under way for the construction of a new turpentine manufacturing plant in the vicinity of Register, Ga., to cost about \$23,000.

Maryland

BALTIMORE—The Zirconium Co. of America, recently organized under state laws to manufacture ferrozirconium, zirconium oxide, and other refractory products, has acquired the property of the Baltimore Rubber Tire Mfg. Co., Monument and Eleventh Streets, consisting of about 2½ acres of land and 6 factory buildings. The present structures will be remodeled and improved, and equipped for the manufacture of the new line. It is proposed to commence operations at an early date. The company is headed by George F. Dixon, president; Philip C. Spencer, vice-president; Morris Meyer, treasurer; and Charles W. Smiley, 1622 Smallwood Street, secretary.

Massachusetts

EAST BRIDGEWATER—The Old Colony Foundry Co., Cook Street, will break ground early in March for the erection of an addition to its plant. Plans are now being prepared. Improvements will also be made in the present building. Charles L. Nutter is treasurer.

SPRINGFIELD—The United States Envelope Co., manufacturer of paper specialties, is arranging for the early occupancy of its new four-story plant addition now nearing completion. The factory with machinery is estimated to cost about \$400,000.

Minnesota

MINNEAPOLIS—The plant of the Minneapolis Paper Supply was destroyed by fire, Feb. 20, with loss estimated at about \$450,000, including equipment. The company is reported to be planning for the rebuilding of the works.

MINNEAPOLIS—The Twin City Separator Co., 2830 Colfax Avenue, manufacturer of separating equipment for mechanical service, has plans under way for the erection of a one-story addition to be located at Seventeenth and Madison Sts. C. O. Paulson is secretary and treasurer.

Michigan

SAGINAW—The Standard Oil Co., 910 South Michigan Avenue, Chicago, Ill., has preliminary plans under way for the erection of a new 2-story and basement building at Saginaw, 75 x 150 ft., to cost about \$100,000.

New Jersey

NEWARK—The Ocean Leather Co., Inc., 33 New York Ave., has plans under way for the erection of a new plant in the vicinity of Beaufort, S. C., for converting the skins of sharks and other sea monsters into leather. A large reduction works will be established in connection with the plant.

North Carolina

GLENDON—The Talc Products Co., 7-9 Hanover Street, New York, N. Y., has plans under way for the construction of a new plant at Glendon. The company has a tract of about 200 acres of talc deposits, and the new plant will have an initial output of about 100 tons per day. A grinding plant will be installed. Charles A. Breiting is manager.

Ohio

BALTIMORE—The Fairfield Paper Box Co. has awarded a contract to the H. K. Ferguson Co., 6523 Euclid Ave., Cleveland, Ohio, for the erection of a new 2-story factory, with power house, at Delaware, Ohio, to cost about \$160,000 with machinery. The works will consist of a paper mill and paper box factory. T. D. Griley is manager.

DAYTON—The Refinera Oil Co., 315 South Main St., is having plans prepared for the erection of a new 1- and 2-story building on South Ludlow St. R. S. King is president.

WILLARD—The Pioneer Rubber Co. is having plans prepared for the erection of an addition to its plant to cost about \$50,-

000, to be 2-story, 60 x 160 ft. A number of homes for employees at the plant will also be constructed at an approximately like cost. B. O. Smith is president.

Oklahoma

YALE—The Buffalo Refining Co., recently organized, is planning for the erection of a new oil refinery with initial capacity of about 1,500 bbl. per day. G. W. Lillie is president, and Edward M. Weist, secretary and general manager.

Oregon

EUGENE—The Studebaker Rubber Co., Spokane, Wash., is negotiating for a local site for the erection of a new plant for the manufacture of automobile tires and other rubber products.

Pennsylvania

PHILADELPHIA—Fire, Feb. 17, at the plant of the Atlantic Refining Co., Thirty-fifth St. and River Road, caused a loss of about 100,000 gal. of oil and considerable equipment, including coke stills, etc. No official estimate of amount of loss has been made.

PHILADELPHIA—The Pennsylvania Wire Glass Co., Pennsylvania Bldg., is completing plans for the erection of its proposed new plant at Lewistown, Pa., to consist of a number of buildings of different sizes. It is expected to call for estimates at an early date.

South Carolina

CARLISLE—The Carlisle Cotton Oil Co. is planning for the rebuilding of its local plant, recently destroyed by fire.

Texas

EL PASO—The International Fiber Co., 610 Caples Bldg., recently organized with a capital of \$500,000, has acquired a local building for its initial works, to be used for the manufacture of fiber specialties from certain kind of cacti. Equipment will be installed at once, including machine shop apparatus. At a later date the company proposes to build a new plant in this section. W. J. Rand is president.

GALVESTON—The Ribbon Works, Inc., recently organized to manufacture ribbons for writing and adding machines, etc., will establish a chemical and dye works in connection with its proposed new plant. Carbon-coating machinery for the manufacture of carbon papers, and other kindred equipment will be installed. J. D. Claitor is president and manager.

UVALDE—W. A. White, P. O. Box 247, and associates, have plans under way for the establishment of a new local plant for the manufacture soap products. A list of equipment to be installed will be arranged at an early date.

Virginia

LYNCHBURG—The Lynchburg Glass Works is planning for extensions and improvements in its plant for increased production. New machinery will be installed.

RICHMOND—The Phospho-Germ Mfg. Co., manufacturer of fertilizer, has completed plans for the erection of a new plant 65 x 76 ft., to be equipped for general manufacture. The plant will replace a factory recently destroyed by fire.

West Virginia

ROUND BOTTOM—H. J. Booth, Pittsburgh, Pa., is organizing a company to build a new plant here for the manufacture of glass products. Preliminary details of the factory are being arranged.

Washington

VANCOUVER—The Johnson Metal Refining Co. has filed plans for extensions and improvements in its plant. A new tinning works will be established.

ANACORTES—Plans are under way for the resumption of operations at the Anacortes Glass Co. plant. The works have been shut down for some time and a committee is obtaining funds through local subscriptions for remodeling and improving the factory, including the installation of new equipment.

SEATTLE—The General Basic Products Co., Harbor Island, is having plans prepared for the erection of a new four-story plant to be located on the East Marginal Way. Bids for construction and equipment will be asked at an early date. Henry Bittman, Securities Building, is architect and engineer.

Capital Increases, Etc.

THE COLONIAL CHEMICAL CORP., Reading, Pa., has filed notice of increase in its capital from \$50,000 to \$250,000 for financing and expansion.

THE LILLY VARNISH CO., Indianapolis, Ind., has filed notice of increase in its capital from \$100,000 to \$250,000 for general expansion.

THE ROCO CHEMICAL CO., Lawrenceburg, Ind., has filed notice of change of name to the Rossville Chemical Co.

THE WESTERN GLASS CO., Streator, Ill., manufacturer of glass products, has filed notice of increase in capital from \$250,000 to \$1,000,000.

THE PIEDMONT, MOUNT AIRY GUANO CO., Keyser Bldg., Baltimore, Md., manufacturer of fertilizer products, has increased its capital to \$1,000,000. E. W. Levering is president.

THE CONNECTICUT OIL CO., Waterbury, Conn., has increased its outstanding capital to an amount of \$95,150.

THE NEW MARTINSVILLE GLASS & MFG. CO., New Martinsville, W. Va., has increased its capital from \$100,000 to \$150,000. Ira Clarke is manager.

THE STANDARD METALS REFINING CO., South Bend, Ind., has filed notice of increase in capital from \$50,000 to \$75,000.

THE SARGENT PAINT CO., Indianapolis, Ind., has filed notice of increase in capital from \$75,000 to \$200,000.

THE PORTLAND CEMENT PRODUCT CO., La Salle, Ill., has filed notice of dissolution under state laws.

THE CHICAGO WRAPPER BOX & LABEL CO., Chicago, Ill., has filed notice of change of name to the Chicago-Elgin Carton Co., at the same time increasing its capital from \$10,000 to \$30,000.

New Companies

THE INDEPENDENT OIL & SUPPLY CO., 140 West Van Buren St., Chicago, Ill., has been incorporated with a capital of \$15,000 to manufacture vegetable oils, etc. The incorporators are M. L. Coleman, Edward R. Drake, George N. Vail.

THE CO-OPERATIVE PHOSPHATE CO., Mulberry, Fla., has been incorporated with a capital of \$500,000 to operate phosphate properties, manufacture fertilizers, etc. The incorporators are L. N. Pipkin, H. W. Wear and A. D. West, Mulberry.

THE O-C-T SECTIONAL TIRE & RUBBER CO., Kansas City, Mo., has been incorporated under Delaware laws with a capital of \$1,000,000 to manufacture automobile tires and other rubber products. The incorporators are James B. O'Connor, Lawson Tarwater and S. L. Carter, all of Kansas City.

THE PROGRESSIVE VARNISH WORKS, 2458 E. 24th St., Los Angeles, Cal., has filed notice of organization to manufacture paints, varnish, oils, etc. The company is headed by Osmond Olsen and Albert Sail-and.

A. F. LUCATI & CO., INC., New York, has been incorporated with a capital of \$15,000 to manufacture chemicals and byproducts. The incorporators are C. Vignone, A. Barratta and A. Lucati, 23 W. 8th St.

THE HANSA CO., INC., Hoboken, N. J., has been incorporated with a capital of \$30,000 to manufacture chemical products. The incorporators are M. Dillon, Thomas M. and William S. Stuhr, Hoboken.

THE KALBFLEISCH CORP., 31 Union Sq., New York, has been incorporated under Delaware laws with capital of \$7,500,000 to manufacture chemicals and byproducts.

THE PAUL J. KREZ CO., 444 North La Salle St., Chicago, Ill., has been incorporated with a capital of 250 shares of stock, no par value, to manufacture asbestos, Magnesia and kindred products. The incorporators are Paul J. and John J. Krez, and Michael Koch.

THE SODIPHENE CO., 928 Central Ave., Kansas City, Mo., has been incorporated with a capital of \$200,000 to manufacture chemical products. The incorporators are R. M. Seibel, B. A. Parsons and H. C. Campbell.

THE CONTINENTAL PAPER GRADING CO., 1451 South Peoria Street, Chicago, Ill., has been incorporated with a capital of \$50,000 to manufacture paper products. The incorporators are Edward L. Kennedy, Arnold Epstein and Isaac Sanderff.

THE HOME LEATHER CO., INC., Detroit, Mich., has been incorporated with a capital of \$50,000 to manufacture leather goods, findings, etc. The incorporators are Anton Martin, Olin A. Bullock and Vincent Elias,

337 East Farnum Street, Royal Oak, Detroit.

THE ENTLE & MUDGE CO., Feller's Hall Building, Martinsburg, W. Va., has been incorporated with a capital of \$35,000 to manufacture paints, varnishes, etc. The incorporators are E. E. Entler, George E. Mudge and A. H. Stanley.

THE EAGLE PAINT & VARNISH WORKS, Brooklyn, N. Y., has been incorporated with a capital of \$50,000 to manufacture paints, varnishes, oils, etc. The incorporators are M. R. Hillman, M. A. Plunkett and W. S. Rising, 1082 East Thirty-seventh Street, Brooklyn.

THE KIMMEL GLASS CO., Paterson, N. J., has been incorporated with a capital of \$100,000 to manufacture glass products. The incorporators are Paul Wolff, S. and Hyman Kimmel, 14 West Street.

THE CLARK RUBBER CO., Franklin, Mass., has been incorporated with a capital of \$100,000 to manufacture rubber products. The incorporators are Maurice C. Clark, Herbert L. Metcalfe and Leon B. Conant, Franklin.

THE BUILDERS' PAINT CO., Okmulgee, Okla., has been incorporated with a capital of \$10,000 to manufacture paints, varnishes, etc. The incorporators are Carl Barnhart and O. J. Trussell, Okmulgee; and M. A. Oxley, Kansas City, Mo.

THE SPECIAL PRODUCTS CO., Boston, Mass., has been incorporated with a capital of \$100,000 to manufacture chemicals and affiliated products. The incorporators are James R. Emmett, Justin Edwards and Arthur L. Norton, 113 High Street.

THE MERIT GLASS CO., New York, has been incorporated with a capital of \$10,000 to manufacture glass specialties. The incorporators are A. L. Gaston, S. Kirschner and J. J. Friedman, 925 St. Nicholas Avenue.

THE RADIO X. SUPPLY CO., Detroit, Mich., has been incorporated with a capital of \$50,000 to manufacture radio and chemical compounds and preparations. The incorporators are H. F. Carpenter, R. C. Burns and J. C. Hoover, 205 Woodward Avenue.

THE MARYLAND LIME MARL CO., Hagerstown, Md., has been incorporated with a capital of \$75,000 to manufacture lime and affiliated products. The incorporators are Henry E. Bester, Frank D. Adams and Thomas L. Smith, Hagerstown.

THE M. C. CORNEZ LEATHER CO., INC., Boston, Mass., has been incorporated with a capital of \$25,000 to manufacture leather products. The incorporators are R. C. Cornez, Archie E. Balter, and M. C. Cornez, 16 Parkman Street, Brookline, Mass.

THE REFINERS' PETROLEUM CO., 220 South State Street, Chicago, Ill., has been incorporated with a capital of \$25,000 to manufacture refined petroleum products. The incorporators are H. A., G. S., and O. H. McCornack.

THE TRAXOL CO., 415 North Cicero Avenue, Chicago, Ill., has been incorporated with a capital of \$6,000 to manufacture chemicals and drugs. The incorporators are D. and Charles A. Treckman, and Harry Goldberg.

THE ATLAS RUBBER CO., 912 Third Avenue, Huntington, W. Va., has been incorporated with a capital of \$5,000 to manufacture rubber products. The incorporators are E. F. Hartley, C. L. Hibner and E. A. Jordan.

THE WELLSBORO SHALE BRICK CO., Wellsboro, Pa., has been incorporated with a capital of \$20,000 to manufacture brick, tile and kindred products. The incorporators are Emil E. Rose, Toledo, Ohio, and associates.

THE MAXINE CO., Connersville, Ind., has been incorporated with a capital of \$50,000 to manufacture chemicals and affiliated products. The incorporators are M. R. C. McKennan, and M. B. Murray.

ALEXANDER FRASER, INC., Oldtown, Me., has been incorporated with a capital of \$50,000 to manufacture chemicals, drugs and affiliated products. The incorporators are Alexander Fraser and N. O'Connell, Oldtown.

THE BECKER-TABB PAINT CO., Louisville, Ky., has been incorporated with a capital of \$20,000 to manufacture paints, varnishes, etc. The incorporators are C. H. Becker, J. Preston Tabb and John Manly.

THE LOCKPORT DEOXIDIZED BRONZE & METAL CO., Lockport, N. Y., has been incorporated with a capital of \$30,000 to manufacture bronze and brass products, metal alloys, etc. The incorporators are P. K. Haber, J. Zaluski and J. C. Rock, Lockport.

THE W. D. YOUNG CO., Boston, Mass., has been incorporated with a capital of \$75,000

to manufacture chemicals, drugs, and kindred products. The incorporators are Harry D. Evans, Guy A. Ham, and Harold P. Newell, 947 Boylston Street, Newton, Mass.

THE SOUTHERN CEDAR OIL CO., 1759 West Forty-eighth Street, Chicago, Ill., has been incorporated with a capital of \$40,000 to manufacture oil products. The incorporators are Walter J. Warczak and Frank A. Kolesiak.

THE WALLACE PETROLEUM CO., Huntington, W. Va., has been incorporated with a capital of \$50,000 to manufacture petroleum products. The company will operate in the vicinity of Louisa, Ky. The incorporators are M. E. Griffin, G. R. Jackson, Huntington; and F. D. T. Wallace, Jr., Louisa.

THE GRANADA SYRUP & SUGAR CO., Plaquemine, La., has been incorporated with a capital of \$125,000 to operate a sugar mill. The incorporators are Oscar Richard, Sr., Sunshine, La.; and Edmund Becnell, Plaquemine.

S. L. CALECHMAN & SON, INC., New York, has been incorporated with a capital of \$25,000 to manufacture chemicals and chemical compounds. The incorporators are S. L. Calechman, G. C. Stickleck and S. Glick, 20 West Ninety-sixth Street.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY, CHICAGO SECTION, plans to hold a joint meeting with the Illinois Clay Manufacturers Association of Chicago about March 8.

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17.

AMERICAN PAPER & PULP ASSOCIATION will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

CANADIAN INSTITUTE OF MINING AND METALLURGY is holding its annual general meeting in the Chateau Laurier, Ottawa, Ont., March 2, 3 and 4.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

HARVARD ALUMNI CHEMISTS' ASSOCIATION will meet Tuesday noon April 26 at Rochester, N. Y., for luncheon.

NATIONAL PETROLEUM CONGRESS will meet at the Hotel Baltimore, Kansas City, Mo., March 22 to 25.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27, 28 and 29.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: March 11, American Chemical Society; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

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The Great Cemetery Of Archives

IN A late number of *Science* Prof. HERDMAN F. CLELAND suggests that information about places in the United States which is available in Washington be also made available in the places themselves. The idea is so reasonable that anyone might well blush to say that he didn't think of it before.

Dr. CLELAND, who is a geologist, gives some instances which speak for themselves. At Uvalde, Tex., he observes, there are interesting volcanic necks which are all mapped and described in a United States Geological Survey folio, but when he went there to study the formations there was no folio available or within reach. At Ardmore, Okla., he wished to consult the geological literature of that region, but at the Carnegie Library he found neither the state publications nor the excellent professional paper of the United States Survey of the district. The same holds true of most of the scientific data, obtained at great labor and expense by the Government, of the country and for (it would seem) the records at Washington.

Now there's no use in blaming Washington for this. Society at Uvalde, for instance, or Ardmore, is probably more interested in the beautiful columnar throats described in the best sellers in fiction than it is in volcanic necks, and the librarian of the local storehouse of literature can truthfully say that there isn't any call for books on geology, or botany, or biology.

But why hold Uvalde or Ardmore up to ridicule? Curiosity is a hidden gift in most of us; we have it as little children, then we learn a few things and we bury the gift within us under a wretched, ill-selected bundle of facts which we think we know. The way to arouse curiosity is to stimulate it, and Prof. CLELAND proposes an excellent method. His remedy is:

"That every first-, second- and third-class postoffice be provided with a framed printed list of the federal and state publications which deal with the region in which it is situated, as well as of historical and other publications of local interest. . . . If it became generally known that every postoffice contained such a list of publications the traveler or resident in search of information would immediately go there to consult it."

The second suggestion is "that every postoffice have on sale all the federal and state publications on the exhibited list."

He then gives a delightful example of what might be displayed in his own bally of Williamstown, Mass. It includes topographic maps, a list of three works on local history with notes where the books may be consulted, a memorandum of the publications on the geology, the zoölogy, the botany and the agriculture of the region, with directions where the information may be obtained, and finally a list of collections and objects of local interest.

What an inspiration that would be! Instead of the natural resources of a district being discovered and recorded and then buried in archives and forgotten they would thus become subjects of public knowledge. The simple record of available information in a public place would stimulate industry and arouse minds that are caked to lethargy by the muddy sediment of dull, thoughtless days. Instead of sitting around the stove in the store discussing Judge DOGBERRY'S new teeth, or whose dog killed JOHN FERGUSON'S sheep, the neighbors would get a lead not only to talk but to think. It is the road to national enlightenment. The Scotch achieved merit by the discussion of free grace and foreordination, and made of themselves a race of thinkers. If we Americans discuss the resources of the home county we shall learn how to think too. We've been rather shy along that line since the war.

The Value of Short Reports

THE art of stenography, the recording dictagraph, and the typewriting machine are to blame for many troubles. It is a bother and a labor to write long-hand, and it is much easier to talk. And a great many of us do talk too much. The troublesome business of long-hand writing and the cost of printing a limited number of reports had the salutary effect in days gone by of inducing us to number our words. Nowadays the busy man gets too much to read. Newspapers are plastered over with useless "Bed Time Stories" and other mush, or news items carried over from a few inches of space on some other page, to provide that advertisements may be "next to reading matter." Nobody wants to learn how little Willie saved a robin's egg, and the inspiring fact that Cordonnier, Schuster & Shoemaker are having a great sale of boots and shoes, all at the same time.

The burden of complaint, however, is with the vast quantity of text that has to be read. Every professional man knows the task of keeping up with his profession, and we admit frankly that it is our business to add to this burden. His daily newspaper is almost a miracle of inconvenience, as far as an orderly presentation of the news of the day is concerned. His daily mail contains as many if not more circulars of tailors, automobile dealers, appeals, etc., which he throws away unread, than it does of actual communications which call for his attention.

The engineer or business man with his technical or trade paper has less to do than the professional man, but if he is a live wire he has still a great deal to read.

Then comes a report on something he wants to know. If he wants an exhaustive treatise he is likely to say so beforehand, but unless he calls for it he doesn't want it. If it is too long he gives a sigh and digs in for a few minutes, and then puts it into his basket of

unfinished business. He takes it home with him at night, and loses patience over having to wade through information that he does not want. Then the chances are that he will turn to the summary and reach his conclusions from that, being a little nettled over the fact that he did not get what he wanted earlier.

When he goes to his lawyer he is not charged for the length of the interview: it may last 15 minutes the first visit, the lawyer may work two weeks over the problem and then telephone the one word "Don't." But his counsel fee will not be nominal.

With no suggestion that reports of research of any kind shall be superficial, we make the plea for conciseness in technical reports whenever this is possible. All details should be duly annexed and speedily available, but the reports themselves should measure up to the novelist's rule: "First catch the reader, and then hold him."

Shuffling the Pack and Dealing a New Hand

PLAYING cards have been personified by the fortune teller ever since they came into vogue centuries ago. It may be stated without hesitation that cartomancy, which is the scientific name of fortune telling with cards, has had and continues to exert a far greater influence on human affairs than the oracles did in pre-Christian times. This was due to the fact that there was but one Delphian and one Dodona, each of which was no more productive of interpretation signs upon which to base plausible stories than a 32-card pack with sevens low. The card pack had distinct advantages over the oracle in that it was portable and was not limited as to number. It was in the manufacture of cards that the printer found the first great outlet for his craft, which was too crude in the early days to merit any monetary return on an art basis. In this contribution alone cards have had a stupendous influence on human affairs.

This is not the place to dwell on the phases of a subject which properly belongs to EDMOND HOYLE, so the rank of hearts and diamonds and the hundreds of other human points involved in cards will not be discussed. We only want to look at an ancient analogy from a new point of view and reverse on seeing humans in cards and see humans in terms of cards. We are already familiar with the Ace in this light, thanks to our aviator friends. During the past year we have witnessed the greatest human shuffle and redeal in the personnel of our industrial companies that has ever been known. We have seen some companies exchange their old cards for better ones and improve their hand. Others have lost very seriously. Some have gambled rather recklessly and let luck take its course.

Satisfaction with any hand all depends whether poker, euchre, whist or bridge is going to be the game in which the hand is to be played. Right and left bowers may top the aces in euchre. A straight flush made up of humble number cards is a hard hand to beat in poker. The idea in general that a hand must be all aces to be high is a false one in personnel as well as in cards. A proper conception of this fact is of vital importance to those concerned with personnel. Men are not labeled with simply read marks like cards and here lies one of the greatest difficulties. Character analysis may and may not be as exact a science as is being openly and publicly claimed at the present time. There is no

doubt that some executives are endowed with extraordinary faculties of sizing up men. There are many individuals, however, who are mere quack practitioners. Recently one of the latter variety was called in to reorganize the personnel of a firm, and going up the elevator, he observed that the elevator operator showed financial characteristics. In the course of his examinations, he found the cashier of this firm had mechanical tendencies. So he had the jobs of the two changed. The result was that the following day both cash and new cashier had disappeared. The elevator boy had lifted the cash. And so the human shuffle goes.

Authoritative Opinion On Synthetic Food

A FEW days ago Mr. Ford told a reporter of the *New York Tribune* that the gentle cow is doomed to follow into oblivion that expensive hay motor known as the horse. The chemist, it seems, is about to synthesize milk and cream from grain. We are glad to have the particulars because we might have guessed he would do it from acetylene and air and ammonia. Commenting on Mr. FORD's assertion, however, a chemist attached to the New York State Dairy Commission declared that the motor manufacturer was in error and that the cow is likely to be with us for some time. Mr. FORD's opinion on synthetic milk took him far afield from the subject about which he knows most and is best qualified to express an opinion.

Chemists, however, are addressing themselves to the important and pertinent subject of human food, as indicated in recent articles in this magazine by Dr. ALSBERG and Mr. HILTNER. Referring to synthetic food, the latter went so far as to say: "The kitchen is not the normal place for the chemist. The trained appetite will not willingly open its mouth for chemical food. The layman in his mind associates chemicals with poisonous acids and vile smells and wants none of them for food. 'God-made' foods are to be preferred to 'man-made.'"

We are not certain about any of these opinions, expert or inexpert. We have no idea how we should feel or what we should think if we had as many millions as Mr. FORD. Probably it would make us didactic also. If we had the conviction that milk and cream might be synthesized from grain, we should probably instigate research in the matter. Cows are a nuisance, and they are subject to all sorts of disorders. The Dairy Commission chemist is evidently interested in his job, and he is for permanent cows. It seems to us, however, as though some new kind of disease might carry off so many cattle that we should have to find sustenance and comfort (until the days of synthetic milk, if these come) in the more hardy goat. We have had many tender spots from and for goats; and we attribute the experience to the fact that goats are like some men we know in habit, manner and mind.

We lack also Mr. HILTNER's catholicity; we are not in agreement about all of the "God-made" foods, although, like him, we desire to please the canners because they have sense and engage in research with intelligence and understanding. It seems almost profane to call some natural foods "God-made." And we differ vigorously about the place of the chemist in the kitchen. The kitchen needs the chemist on the ground of economy, and the chemist needs the kitchen to give him a basis of art—the great art of cooking. In the

glorious days of Kingdom Come we expect to see, provided we are equipped with the ghostly eye, the kitchen of every chemist in his dining room and apart from the scullery. The chemist will cook his own dinners, and of all the men in town he will be the one most diligently sought after for his company. The girl that marries the chemist will be in luck, for then she can snub her dearest enemy by not inviting her to dinner. The London aldermen with their turtle soup and their turbot will suffer pangs of jealousy unless they can induce some distinguished chemist to volunteer to cook for them on Lord Mayor's Day. When the chemist enters the kitchen door he will find it *open sesame* to any class of society he desires. We know a chemist who cooks his own dinners, and so far as we are aware he is the most popular man in his home town.

Special Experts:

Charwomen and Chemists

IN A long article in the New York *Herald* of Feb. 27 on the 100,000 jobs, more or less, to be filled by President HARDING, there is a note to make chemists blush.

It states that "Government jobs are divided into four general classes: Those filled by the President with Senatorial approval, those filled by the President and one of the executive officials without Senatorial approval, those within the civil service list, and those carried on the rolls because of special fitness for the work to which they are assigned but without regard to the civil service—for example, certain groups of chemists and special experts and charwomen and laborers."

It sounds almost Russian; modern Russian. We heard the other day of a gentleman of Moscow who had formerly held a post of great dignity and requiring special training and fitness. He now serves the Soviet State in a post that requires his special training and fitness but, of course, without the dignity. A place to live is assigned to him and his wife. Early in the morning he goes out, chops wood, brings it in and builds a fire, and his wife, who is delicate, cooks his breakfast. Rations are assigned to him which he brings home after the day's work. Servants are not. They are not allowed. The proletariat rules and it does not serve. Then the old gentleman gets theater tickets as often as it is right and proper for him to be amused. There is no buying or selling or even trading. The Soviet State provides what it holds to be good for everyone.

If this were a Soviet government, of course the priority in the *Herald's* list would have been changed. It would have dealt with charwomen and chemists instead of the other way about. That would provide alphabetical sequence too, and it is possible and even likely that the charwomen outrank the chemists in point of age and length of service.

The whole thing is democratic, but we might as well fess up and tell the world that when it comes to training and fitness we think people are different and that they do not grade alike. Between mopping up a floor and the manipulation of delicate apparatus with the necessary thought as to what such apparatus shall do, we think we can see a difference. We do not like the word physicist; we agree with the late Lord KELVIN that the only real physicist is a siphon of soda water. But we haven't a better word at hand to indicate the men who should be classed with chemists rather than charwomen, and perhaps physicists are, in the eyes of government, "special experts."

Successful Chemical

Research in Anæsthesia

IN A paper recently presented before the American Oil Chemists Society, Dr. CHARLES BASKERVILLE, head of the department of chemistry of the College of the City of New York, pointed out a new use for edible oils in surgery.

It is well known that the vapors of ether or chloroform, when inhaled, produce the condition known as anæsthesia. This action is contingent upon the drug being taken up by the blood through the capillaries of the lungs. Exclusion of air produces asphyxiation, so that care must be observed to employ the proper mixture of ether with air to provide muscular relaxation and unconsciousness to pain—but no more. The process is a severe tax upon the patient, it chokes him and afterward nauseates him, and he dreads it.

The circulation of the blood takes place through numerous channels around the intestines, the stomach, indeed the whole alimentary tract as well as in the lungs, and numerous unsuccessful efforts have been made to administer ether or chloroform in the lower bowel by means of an enema. But ether boils at 34.6 deg., while the normal body temperature is 37. The lungs proceed to exhale ether almost immediately, but the dose is taken too fast and the subject may be asphyxiated. Little progress was made until Dr. J. T. GWATHMEY of New York conceived the idea of using the solubility of ether in oils and administering such a solution as an enema. Dr. BASKERVILLE has been working in collaboration with Dr. GWATHMEY for several years, and the result is a series of oil-ether solutions with the rates of evaporations determined and controlled. Various vegetable and mineral oils are used. After many experiments with animals the method of oil-ether enema was applied to persons and the result is a record of nearly 30,000 operations every one of which was successful from the patient's point of view. A short time after the enema is begun, ether is evolved from the patient's breath, but usually before he is aware of the odor of the anæsthetic, a gentle sleep has intervened.

Since an enema is often administered before an operation, there is no occasion to tell him that it is imminent. There is no occasion to tell him even which enema is made with the oil-ether solution, and thus the whole horrible dread of the thing is avoided. When the patient awakes there is no nausea, no retching; he is all bandaged, and the surgical business is finished.

In the army abroad when wounds of soldiers had to be re-dressed at the front and base hospitals, the men suffered tortures. Dr. GWATHMEY harked back to his investigations with Dr. BASKERVILLE on oil-ether colonic anæsthesia. He was reminded also of the rapid-fire action of ether when taken as an intoxicant in Ireland and by "Piccadilly Willies" in London. So he prepared an "oil-ether cocktail" in which the British army surgeons joined him. "The initial auto-human experiment," says Dr. BASKERVILLE, "was a success." Two thousand wounded soldiers after that were given such "cocktails" prior to dressing their serious wounds. The soldiers enjoyed the first exhilaration, dropped asleep, and three hours later awoke refreshed and all unconscious that their wounds had been completely examined and re-dressed. Some of our own surgeons since returning have availed themselves of the method in civilian practice in dressings after operations.

Readers' Views and Comments

Who Is a Chemist?

To the Editor of Chemical & Metallurgical Engineering

SIR:—Any man who has been fortunate enough to receive chemical training and who has even martyred himself in the cause of science will not be so presumptuous as to boast that he is trained to meet a multiplicity of problems. That the real chemist differs from the craftsman in that his mind is trained to meet a multiplicity of problems is undoubtedly true if we properly interpret multiplicity. The word as it appears in the subject editorial seems rather broad and perhaps more inclusive than is desired or can be verified in the cold world of facts.

This age of specialization renders constant application to the study of one field imperative to the man who would attain success. The expert metallurgical chemist would find himself entirely incompetent to be consulted on a problem in sugar refining. A chemist proficient in the science of distilled liquors would find himself wandering aimlessly if confronted with a mountain of oil shale. Thus it seems that multiplicity is not the proper word. Perhaps its scope in the explanation should be restricted.

The task of educating the public in a chemical way and to such an extent that the service and necessity of chemistry will be appreciated involves something besides the certification and legalization of the profession. Perhaps the chemical ignorance of the public is due to reluctance on the part of the men who are competent to come forward with an educational program. The fact is that the men who have given their lives to the pursuit of the subject are not prone to proclaim their proficiency from the housetops.

Lawyers and doctors are legalized, and rightly so. Are we to believe that the public has become aware of the necessity and service of the lawyer because of the legalization of the profession? The people caused the legalization of the profession by demanding protection from professional quacks. The people realize the danger underlying the employment of incompetents. The danger incident to the practices of unscrupulous "chemical experts" is not appreciated because the public has not the knowledge necessary to differentiate between their "merits" and demerits.

It has been through legislation arising from the demand of the people for protection that we know "who is a lawyer." The question "Who is a chemist?" will not be satisfactorily answered until the public realizes the need for a new protection.

Worcester, Mass.

G. C. MCCORMICK.

To the Editor of Chemical & Metallurgical Engineering

SIR:—Some time ago you asked this question in an editorial, and stated that it has not been answered yet. May I submit my suggestion as to this most important matter?

Chemistry today, both as a pure science and in its practical application, has come to the front in everyday life, in national development as well as in the welfare of mankind in general, to such an extent that it forms the broad foundation on which every future progress

of civilization will rest. This pre-eminent position of the chemical art is, however, not yet recognized by the general public, and this goal can be reached only by systematically educating and training the youth during school life in the all-important fundamentals of chemistry. This requires introduction of a correspondingly reformed school curriculum in grammar and high schools, as I had already outlined eight years ago in a special treatise on this subject, which found due recognition by high authority.

In the meantime it is of greatest importance, in regard to the high level of the chemical profession having been reached today, to determine who is its true and able representative—i.e., who is a real chemist. The word "chemist" must involve first of all a broad fundamental knowledge and training in the pure science of chemistry, on which rests the higher art of its practical application and its eminent cultural influence. Any man or woman is a chemist who possesses such a professional education along the science of chemistry that he or she is able to understand and to follow up with sufficient knowledge and clear vision every progress and problem within the realm of the chemical profession, be it in pure science or in its practical applications.

From the viewpoint of this definition, a man who practices chemical analysis from a routine standpoint only, without deeper knowledge of the scientific fundamentals of his art of chemistry in general, may be called an analyst, or better still a chemical analyst, but not a chemist, not even an analytical chemist. The latter is a chemist in its broader and higher sense, who makes chemical analysis his specialty. A chemical engineer is not a chemist, but rather an engineer with some chemical knowledge. An engineering chemist is a chemist who has some knowledge of engineering work as applied in industry. An electrochemist is a chemist with sufficient knowledge in electricity. A metallurgist without a broad general scientific knowledge and training in chemistry is not a chemist—if so, he may be called a metallurgical chemist. In this way any chemist may become a specialist in some chemical branch line and express his position accordingly.

The main point is that not everybody is a chemist who practices chemistry in some way or other with more or less skill; he may be a chemical worker of some kind, but not a chemist. The word "chemist" must become an exclusive title of high standard and meaning, according to the growing influence of chemistry and its art in cultural, economic and social life.

As soon as the question "Who is a chemist?" is satisfactorily solved the next important task would be to create an "American Chemists' Institute," whose membership and purpose would differ from the American Chemical Society essentially in the following points:

1. Only recognized chemists are admitted as members.
2. The main purpose of the new institute should consist in recording every achieved progress as well as any prospective new problem in pure and applied chemistry, thereby becoming the guiding authority along research for every individual worker. Publishing annual symposiums on all respective subjects.
3. Through special publications and lectures giving instruction and information to the general public re-

garding the influence of chemistry's progress on home and public life.

4. Establishing a universal library embracing every branch of chemistry, as a center for reference work.

5. Exercising influence to bring chemistry into the forefront of school education as being of fundamental importance for both sexes, especially in regard to health, hygiene and efficiency, constituting a national problem of the first order.

There are, of course, several other tasks which could be included in such a new organization, which, however, may be easily fixed and worked out after the fundamental statutes are determined.

J. PERINO.

Sewickley, Pa.

Plantation Rubber and the Testing of Rubber

To the Editor of Chemical & Metallurgical Engineering

SIR:—May I be permitted to comment on the review, in your issue of Jan. 5, of my book on rubber?

(1) Your reviewer's statement that I have "omitted all mention of the valuable papers on rubber which have appeared in CHEMICAL & METALLURGICAL ENGINEERING during the past five years" would seem to indicate that he has not read the book with much attention. In fact, mention is made of all such papers in which are reported original work bearing on the aspects of rubber discussed in the book, the paper by Kratz and Flower (CHEM. & MET. ENG., vol. 20, p. 417) being treated particularly fully. I may add that, so far from having failed to recognize the value of the papers on rubber which have appeared in CHEM. & MET., I have always found A. H. King's articles on various aspects of rubber technology to be of great interest and value.

(2) "The literature references," says Dr. Dannerth, "are for the most part English and Dutch, although one finds casual references to the work of Kratz, Flower, Tuttle and Cranor in the United States." The implication that I have paid a disproportionate amount of attention to the work on rubber, relevant to the aspects discussed, which has been performed in certain countries and have neglected that performed elsewhere, particularly in the United States, is, I venture to assert, not in accord with the facts. Your reviewer refers to the bibliography "in which the author has discovered [*sic*] 350 names of writers on rubber topics." Now an examination of these names shows that actually there are fewer names of English and Dutch than of French and German writers (approximately 130 and 170 respectively in the two groups). Further, nine pages in all are devoted to work published by Kratz; Tuttle's papers have been on matters of chemical analysis with which the book is not extensively concerned; Cranor's paper was published as late as December, 1919, when the book was in the press; and reference is made to an earlier-received private communication from Mr. Cranor. All other published work conducted in the United States which bears on the subjects treated, such as the work of Spence, Wormeley and the Bureau of Standards, is discussed fully.

(3) Dr. Dannerth's complaint that "all reference to synthetic rubber has been carefully deleted [*sic*] from the book" strike me as captious, not to say unreasonable, since the title of the volume, "Plantation Rubber and the Testing of Rubber," would, one imagines, hardly convey the expectation that synthetic rubber was within its scope.

(4) Your reviewer confesses that "a great deal of material on the physics and physical chemistry of rubber has in the volume been published in book form

for the first time," and yet he concludes that the book "will probably be of greater value to university men than to rubber manufacturers." Can it be that he fails to appreciate the importance for rubber technology of scientific investigations into the physics and physical chemistry of rubber? I would venture to commend to him an article on "Future Rubber Research" by A. H. King in CHEMICAL & METALLURGICAL ENGINEERING for Sept. 8, 1920, and the following excerpt, quoted in my book, from an editorial in CHEMICAL & METALLURGICAL ENGINEERING for June 15, 1919: "The rubber industry of today can learn a profitable lesson from a comparison of present conditions in the iron and steel industry with those of the 'good old days' before the spread of technical knowledge."

G. STAFFORD WHITBY.

Montreal, Canada.

Ownership of Oil-Yielding Shales in New Brunswick

To the Editor of Chemical & Metallurgical Engineering

SIR:—The world-wide importance of an increased supply of hydrocarbon oils makes it very necessary that no person or group of persons shall be allowed, for the furtherance of their own plans and schemes, to make incorrect claims or statements, without the same being contradicted and their falsity made evident.

For some years a conspiracy would seem to have existed in a certain province of Canada, by which certain persons have endeavored to make capitalists believe that they or their friends owned or controlled all the oil-yielding shales of that province. These claims have to my knowledge been made in London, England, and in New York. Because of these claims being persisted in, especially in New York, I wrote as follows to the Hon. James Domville, a Senator of Canada, who resides in the Province of New Brunswick and who has an intimate knowledge of the affairs of that province, particularly as regards oil shales, of which he was one of the first New Brunswickers to recognize the importance. My letter was as follows:

DEAR SENATOR: Lately, when in New York, I was credibly informed that certain parties were claiming that they and their friends owned all the oil-yielding shale deposits in the Province of New Brunswick.

As I have the honor of representing owners of certain New Brunswick shale deposits, and as you are known to be largely interested in other New Brunswick shale deposits, I have considered it my duty to call your attention to this claim, the making of which has done and is doing grave injury to your province.

The Senator replied:

DEAR SIMPSON: I have to thank you for calling my attention to the claims you inform me are being made as to the ownership of the Province of New Brunswick oil-yielding shale deposits.

As you know, I have been interested for over ten years in the Albert mines, a shale property in this province. I have authorized no one to make any claim such as that mentioned by you.

This is not the first time that similar claims have been made by unauthorized or irresponsible parties. The Province of New Brunswick Legislature passed an act on March 26, 1910, entitled "An act to amend 'an act to incorporate the Albertite Oilite & Cannel Coal Co., Ltd.,' " being 1 Edward VII, Chapter 79, page 300. By this act, The New Brunswick Petroleum Co., Ltd, which in 1907 had been granted certain privileges, had those privileges curtailed, *vide* clause 1, which states, "Under the said lease to the New Brunswick Petroleum Co., Ltd., no interest in bituminous shales and Albertite was granted to said company."

I am, yours faithfully,

JAMES DOMVILLE.

In the interest of the nascent oil shale industry, may I ask you to make public this correspondence.

Ottawa, Canada.

LOUIS SIMPSON.

British Chemical Industry

From Our London Correspondent

LONDON, Feb. 15, 1921

AT THE time of writing, the tone of the chemical industry and of chemical markets is one of incipient optimism and cheerfulness and it is generally expected in well-informed circles that there will be a partial revival of trade and industry by June of this year. It is not considered that the removal of the excess profits duty will have any appreciable influence in this connection, the mischief due to its prolonged retention having already been discounted. Most factories are at present working only three or four days per week, the export trade is still very depressed, and in consequence prices are still slightly in favor of buyers. Considerable quantities of caustic potash are now arriving from Germany and, the demand being purely nominal, the market is overstocked.

Considerable friction and dissatisfaction have arisen on account of the peculiar attitude of the large chemical and dyestuffs organizations in regard to export trade. During the war, when supplies were strictly rationed, it was possible to acquiesce in the stipulation that the destination of the goods should be declared, but apparently the manufacturers, having now established their agents and distributing systems in foreign countries, are anxious to continue this inquisition for their own ends, and the result is a state of semi-revolt on the part of the merchants. In several cases recently the merchant has actually obtained the order for the goods from his foreign customer and was refused supplies by the manufacturer solely in order to protect the latter's agents. As a result, several important orders have been placed in Germany and elsewhere and were therefore lost to the home manufacturer on account of what is generally considered as a short-sighted policy. The attention of the government has been called to the situation.

PROGRESS IN DIRECT FUEL SAVING

The campaign for increased efficiency in the use of fuels has gradually spent itself and there is less activity in the installation of coal- and labor-saving devices for the boiler plants of the country. On the other hand, considerable attention has been given to the recovery of washed coke and breeze from industrial ashes and to the froth flotation of coal. A flotation plant to deal with about 1,000 tons per day of coking coal is to be erected at the Skinningrove Iron Works, on the northeast coast, the process used for metallurgical work being suitably modified under the auspices of Minerals Separation, Ltd. It is stated that about 1 lb. of reagent is required per ton of coal treated and that apart from the removal of dirt and ashes, considerable economies are to be expected on account of increased output of the coke-oven plant and improved quality of coke. The gas companies are vitally concerned in the success of the process, particularly on account of the very high percentage of dirt and stone sold to them by the mines along with the coal during the last few years. In view of the high freight rates which are still prevalent, it is expected that considerable net economies will result from the extended use of this process. On the other hand, the large quantity of inert products supplied with present-day industrial coal has greatly increased the carbon con-

tent of the ashes from boiler plant, which may be 10 to 20 per cent or more by weight. The Fuel Recovery Syndicate is now developing the Lioud process for treating ashes, the usual size of plant dealing with about ten tons per hour and the cost being about 10s. per ton of recovered washed coke or breeze. Two plants are already at work in this country and a large number in France.

PROPOSED FORMATION OF BRITISH ENGINEERS' CLUB

The example set by the Chemical Industry Club is apparently to be followed by the formation of a similar organization for engineers, and curiously enough the provisional committee also includes representatives of the chemical industry like Max Muspratt, Mr. Woolcock, M. P., and Sir Robert Hadfield. The general feeling is that a club of this kind will not prove a success at the present time unless the subscription is sufficiently low to bring it also within the reach of the younger members of the profession. The idea of a central home and club for all engineering societies has often been mooted, but could not come to fruition on account of the existing and very adequate buildings of the leading societies.

FINE CHEMICALS AND DYESTUFFS

The views outlined in my last article have been confirmed by an official statement just issued by the Association of British Chemical Manufacturers, which predicts the collapse of the industry unless a bill complementary to the dyestuffs act is passed. No final decision has as yet been reached in regard to the proposed key industries bill, but it is quite certain that heavy chemicals will not be included and fine chemicals will probably be restricted mainly to pharmaceutical products. On the other hand, there seems to be so much opposition and uncertainty that it is by no means impossible that the fine chemical industry will be left to work out its own salvation.

CHEMICAL PUBLICATIONS AND GENERAL NOTES

Considerable discussion and some amusement has resulted from the proposals submitted by the Federal Council for Pure and Applied Chemistry for the publication of chemical literature. To some extent the suggestions made follow the lines of the corresponding American journals, but it is suggested that the various societies should establish a joint weekly journal practically on the same lines as CHEMICAL & METALLURGICAL ENGINEERING. It is refreshing to notice the intense keenness which is being displayed in regard to the value of such a journal as regards advertising revenue, but it is felt that until the societies concerned can make up their minds to abandon control by committees in favor of sound and commercial journalism, a weekly journal of this kind will meet with little support, particularly as the public is already well served by several trade papers. There is also the fear that advertising revenue will seriously diminish in the near future, partly on account of the removal of the excess profits duty and partly on account of industrial depression.

The first volume of the new edition of Thorpe's Dictionary of Applied Chemistry has just appeared and is to be followed by six or seven additional volumes to complete the series.

The Kelvin gold medal has been awarded to Dr. W. C. Unwin, F.R.S.

American Ceramic Society, Annual Meeting

Assembled at the Birthplace of the Society, the Members Hold Scientific Fest — Papers Show Need for Enlarged Technical Control of Processes and Widened Scope of Industrial Activity—
Results of Original Research Made Public—Abstracts of Papers

THE twenty-third annual meeting of the American Ceramic Society was held at the Deshler Hotel, Columbus, Ohio, Feb. 21 to 24. Significant in its location, near the largest ceramic industries of America, inspired by the presence of Edward Orton, Jr., dean of American ceramists and virtually the father of the society, who was surrounded by many distinguished senior ceramists, the meeting held far more than the usual amount of spirit and morale manifest on like occasions.

The society is one where every member is the other fellow's friend. The smoker on Monday night and the informal dance and banquet on Tuesday evening were more like functions of an intimate social organization than perfunctory affairs of the national technical society. The emotions of the banquet assembly were varied from laughter at W. D. Gates' description of sweaters for keeping interurban engines warm to tears at the touching tribute paid to Ernest Mayer by Toastmaster Orton. The special entertainment for the ladies and the visits to industrial plants in the vicinity displayed hard work and good judgment on the part of the local committee. The visit to Edward Orton's cone factory, the Bureau of Mines ceramic station and the university was like a pilgrimage to an old shrine.

With old traditions of art commingled with ideals for the science and industry of the future, it is little wonder that the meeting was a success for every member and division.

Business Meetings

Officers elected for 1921 were as follows: F. K. Pence, president; F. B. Ortman, vice-president; R. K. Hirsh, treasurer; R. M. Howe, trustee; E. W. Washburn, editor of the *Journal*.

The glass division has been invited to tour industries in England by the English society. The executive committee is considering the appointment of a full-time secretary. Arrangements are made for preparing abstracts of ceramic literature in co-operation with the American Chemical Society.

The American Ceramic Society has voted to join the Federated American Engineering Societies, if financial arrangements can be made.

Edward Orton made an eloquent plea that proper steps be taken to perpetuate the name of Ernest Mayer by suitable memorial, and a committee of five was appointed to work out details.

PRESIDENTIAL ADDRESS

R. H. Minton's presidential address on "Some Problems to Be Solved" revealed a masterful grasp of the situation existing in the ceramic industries today and was referred to a special committee for careful analysis and disposition in the form of instructions to the divisions of the society. It is abstracted in part in the following paragraphs:

With oxygen, silica and alumina forming 85 per cent by weight of the elements of the earth, we can conceive the magnitude of the foundations of our work. Secret methods are no barrier to technical competition. The future problems are chemical and physical on one hand and mechanical and human on the other. Scientists must solve our general problems, involving fundamental laws affecting drying and firing, heat transmission and heat losses, problems of combustion and kiln construction, kinds of fuel and control of processes.

The glass manufacturer needs knowledge of chemical reactions and physics of heat-treatment. Silica brick, quartz glass and porcelain industries need technical advice. Research into the chemical composition and properties of glazes is needed. More must be learned of the relation between glazes and frits and the solubilities of lead glazes. Specifications are needed for refractories.

Other problems are the disintegration of clay products by weathering, the dunting of sanitary and terra cotta bodies, the failure of refractories under load and the improvement of electrical porcelains. Plasticity of clays is also a most important subject. The mechanical and organization problems are vital engineering subjects. Standardization of methods and products is badly needed.

Research and development in many lines must come. For our purposes chemistry and physics are the most important. We must co-operate with and support government bureaus. Economic co-operation in market development, both foreign and domestic, must come. We should solve the employment situation. It is the function of the American Ceramic Society to promote all these interests in the clay industries.

Enamels Division

FISH SCALING

The Causes and Control of Fish Scaling of Sheet Steel Enamels, by R. R. Danielson and W. H. Souder. The U. S. Bureau of Standards conducted an extended investigation with simple gray ware enamels and commercial formulas. These were applied to 20-gage steel and the effects noted on variations in firing, thermal expansion of enamels, annealing composition of steel and mechanical treatment of steel.

The fundamental cause of fish scaling lies in the difference of coefficients of expansion of enamels and steel, that for steel being higher than for enamels, so that the latter is under compressive strain. The factors influencing this phenomenon are composition of enamel, overfiring, with consequent volatilization of part of contents, and lack of annealing the enameled ware, which is glass and must be so treated. Secondarily, fish scaling is influenced by the physical condition of the metal, elastic strength of the glass, underfiring and cleanliness of metal surface.

It may be remedied by adjusting the enamel coefficient

of expansion to fit that of steel—i.e., by decreasing its boric acid content; by changing composition to increase strength, and by treatment of metal to give best adhesion, as by cold-rolling, etc., and correct preparation of ware in cleaning process. This paper was accompanied by numerous charts and curves to substantiate the findings.

John S. Grainer followed with a plea for further scientific investigation and increased technical control of the industry, reviewing conditions where secrecy and unwillingness to co-operate on the part of the practical enameler have stifled progress. He attributed fish scaling to overfiring, poor composition and poor furnace construction and spoke highly of the excellent work done by the Bureau of Standards. An explanation of fish scaling was also undertaken by J. F. Bardbush, and the three papers are a distinct addition to the literature.

COPPER ENAMELS

Copper enamels were covered in two papers. A preliminary report of work being carried on by B. T. Sweely stated that with an arsenic content of 0.1 equivalent As_2O_3 in an enamel of one type applied by the dry method the following relations held true: (1) Increase of silica with RO , arsenic and boric constant, increases tendency to fracture, increases refractoriness and does not affect opacity and luster. (2) Increase of boric acid above 0.2 equivalent causes enamels to matt. (3) Increase of K_2O at expense of PbO causes enamels to flow better and to mature at lower temperature, increases solubility and decreases tendency to fracture. (4) High-lead enamels are opaque, but do not flow well and attack the copper.

The following limits were recommended:

$$\left. \begin{array}{l} 0.3-0.6 \text{ KNaO} \\ 0.7-0.4 \text{ PbO} \end{array} \right\} \begin{array}{l} 0.05-0.15 \text{ As}_2\text{O}_3 \\ 0-0.2 \text{ B}_2\text{O}_3 \\ 1.3-1.8 \text{ SiO}_2 \end{array}$$

R. R. Danielson followed with an outline of his investigations on twenty white enamels for copper. While the number of investigations was small, he offered the following results: (1) Correct smelting is extremely important, slow air cooling of frit is preferable to water quenching and repeated smelts promote opacity and eliminate gas. (2) Certain reducing atmosphere in the furnace eliminates copper oxidation. (3) Slight changes in composition have a decided effect on resultant properties. (4) Sodium oxide promotes glass but reduces opacity. (5) Lead oxide promotes fusibility without materially reducing opacity. (6) Cryolite is not desirable, as it tends to promote matt finish. (7) Keep B_2O_3 content low. (8) Arsenic is an excellent substitute for tin oxide.

Two of the formulas showed best for watch dials and three others for thermometer scales, sign letters, etc.

SOLUBILITY OF ENAMELS IN ACIDS

Solubility of enamels in acids as related to the composition was discussed in an exhaustive paper by Homer F. Staley. The question is important in the manufacture of chemical ware used in the many industries. The various materials affect the acid resistance in the following order, the most advantageous being named first: Al_2O_3 , cryolite, Na_2O , PbO , BaO , Li_2O , MgO , CaF_2 , ZnO , SrO , CaO and B_2O_3 .

When substituted one for another in equal percentage amounts, various oxides and minerals affected the resistance of enamels to the action of boiling 20 per cent hydrochloric acid in the following order, the most

favorable being named first: Al_2O_3 , MgO , CaF_2 , ZnO , SrO , CaO and B_2O_3 . The first five are especially desirable, while the remainder are undesirable. The relative effect of the materials used in the experiments was the same with various base enamel compositions. When substituted one for another ZrO_2 , TiO_2 and SiO_2 affected the resistance in the order named. The favorable action on acid resistance conferred by ZrO_2 is offset by a tendency to produce excessive chipping. Rutile gives less chipping than either zirconia or silica and greater acid resistance than silica.

WET PROCESS ENAMELS FOR CAST IRON

R. R. Danielson gave the results of preliminary work at the Bureau of Standards in developing wet process enamels for cast iron. This information was of particular value to many manufacturers, especially producers of stove parts. The subject hinges on the development of a suitable ground coat. Refractory ground coat showed greater freedom from pinholing. A medium amount of raw material in mill additions is desirable, since high contents give rise to flaking and small amounts give rise to pinholing in the cover enamel. Clay is a better mill addition than flint or feldspar. The composition of the frit portion is more important than mill additions. Dry process ground coats are not necessarily suitable for the wet process. It is desirable to continue the study of this subject.

FIRING ENAMELS

A. Malinovsky's paper dealt with the melting of enamels in rotary furnaces as compared with the ordinary reverberatory type, the former showing more uniform product, freedom from contamination by rabble irons and furnace linings, lower losses through adhesion to walls and lower fuel consumption. He described the construction and operation of a U. S. Smelting Furnace Co. furnace with lantern slides.

L. E. Barringer gave a treatise on the application of electric heat to vitreous enameling, with particular reference to the furnace developed by the General Electric Co. This most recent addition to the art is attracting considerable attention in the enameling industries.

B. T. Sweely gave notes on the acid resistance of enameled cooking utensils as affected by the position of firing. The under surfaces of pieces as placed in the ovens are more resistant to citric and acetic acids than the upper sides. The inner surfaces of enameled vessels may be made more resistant to acids of the kitchen by firing in an inverted position.

Refractories Division

MOLDS FOR MAGNESITE, CHROME AND SILICA BRICK

Erling E. Ayars described at length the best types of molds for making magnesite, chrome and silica brick. Slip molds are used for silica brick. Chrome and magnesite brick are made largely by machinery and a machine is now being developed for pressing out silica straights. Special shapes will eventually be eliminated from coke-oven construction and only 9 in. straights employed.

TESTING COKE-OVEN REFRACTORIES

F. A. Harvey offered a complete report on the methods of testing coke-oven refractories together with specifications for them. The paper was the result of several years' intensive work on the subject in con-

nection with the ovens of the Semet-Solvay Co. The proper testing of refractory materials requires a clear understanding of conditions both ordinary and extraordinary which the materials must meet in service. The tests must then be made for size, warpage, ring, load and vitrification; reheating to 1,450, 1,350 or 1,200 deg. C. as required; fusion point; bulk density, apparent density, true density and porosity; bending and load; crushing and modulus of rupture, spalling, fineness, plasticity and heat conductivity.

All silica brick and shapes must pass the 1,200 deg. C. reheating test and show not more than 1.6 per cent average permanent linear expansion. For regenerator checks up to 2 per cent can be allowed. Lime content should not be specified until more complete data on the effect of lime are available. Alumina should not exceed 1.65 per cent. For fineness of grind 97 per cent of material should pass a $\frac{1}{4}$ -in. mesh screen. All class 1 silica brick should have a modulus of rupture of not less than 500 lb. and a cold crushing strength of not less than 1,600 lb. per sq.in. Class 2 silica brick should have a modulus of rupture of not less than 350 lb. and cold crushing strength of not less than 800 lb. per sq.in. Class 1 brick should be used in bench walls, corbels and oven linings. Shapes should not have a variation in dimensions greater than $\frac{1}{16}$ in. per ft. for brick under 12 in. and $\frac{1}{8}$ in. per ft. for larger pieces. Visual inspection and hammer tests should eliminate cracked and badly warped pieces.

Clay brick in the reheating tests should not show a swelling greater than 1 per cent nor a shrinkage greater than 1.6 per cent. Bending tests should not show greater than $\frac{3}{8}$ in. for 1,450 deg. C. heat and $\frac{1}{4}$ in. for 1,350 and 1,200 deg. C. heats. Dimensions should not vary more than $\frac{1}{8}$ in. for standard sizes under 12 in. nor more than $\frac{1}{16}$ in. per ft. for sizes over 12 in. Statement must be made as to whether brick is hand or machine made.

Silica cement must have fusion point as high as cone 27, must all pass 30-mesh screen and must survive the pail test. It must contain not over 25 per cent plastic clay.

Fireclay ("A" quality) should spread easily and smoothly with trowel, pass 14-mesh and 95 per cent pass a 20-mesh screen, and fuse not lower than cone 28. "B" quality may fuse as low as cone 20.

ZIRCONIA CEMENTS

Mark Sheppard's paper on zirconia cements brought out the fact that crude zirconia with high shrinkage and impurities could not be bonded with clay to make a satisfactory cement. When a part of the crude zirconia, however, was partly replaced by pure zirconia, the purified material having lower shrinkage, a cement could be formed. When this was applied as a wet wash to a bung on malleable furnaces, an increase of 25 per cent was secured in the number of heats run before replacement.

HEAT-TREATMENT OF SILICA BRICK IN THE CROWN OF A TUNNEL KILN

A. A. Klein in discussing the heat-treatment of a silica brick in the crown of a tunnel kiln stated that after the heating it contained no quartzite, low amount of tridymite and nearly 100 per cent cristoballite where the previous composition had been equal parts of each.

This is evidence that all quartzite tends to change over to cristoballite on heating.

J. W. Hepplewhite proposed a departure in the method of measuring actual thermal conductivity of refractories by bringing both sides of brick to a high temperature and measuring the heated air delivered from a chamber on the cooler side. Some discussion followed his description of the apparatus and suggestions were made as to methods of overcoming difficulties encountered in performance.

W. Henry Grant has found little information available as to the major cause of failure of firebrick in oil-burning furnaces. The brick do not burn but disintegrate. A dense fine grind made into hard-burned firebrick has been found to give best service.

R. M. Howe in tests conducted at the Mellon Institute with a flint clay firebrick in which the plastic clay bond was kept constant and various amounts of gannister were added, displacing the flint clay, found that the addition of gannister increased the resistance to spalling at intermediate temperatures. At higher temperatures no advantage was discovered and at the lower limiting temperature for firebrick a disadvantage was encountered in the tendency to lower the melting point as the mix approached the eutectic for alumina and silica.

Glass Division

TRAINING OF THE GLASSWORKS CHEMIST

Alexander Silverman outlined a suggested college course for the training of the glassworks chemist, with a first year course to include general inorganic chemistry, mathematics, English, German and some general work in the factory. Second year should include advanced inorganic chemistry, advanced physics, mathematics, German or French, quantitative and qualitative analysis and factory work. The third year should embrace physical chemistry, quantitative analysis, mineralogy, pyrometry, microscopy, organic chemistry and laboratory work in the factory. The final year's work should include clays and refractories, glass technology, ceramic calculations, engineering laboratory, electrical engineering and factory management.

Some think the glass chemist is so specialized there is no need for him in the industry, but the training suggested coupled with practical experience will develop a man to become an important factor in industrial development.

COMPOSITION OF BARIUM GLASS

R. J. Montgomery gave the result of research in the composition of optical glasses whose properties are dominated by the barium oxide content. The batch is more complex than that of lead glasses, which have a three-component system of alkali, lead and silica, while barium glasses have a second acid (B_2O_3) introduced together with Al_2O_3 as well as more complicated RO, containing zinc and calcium in addition to alkali and barium.

There are no simple relations between composition and optical properties, and the relations as observed in the charts must be expressed in the most general terms. Deductions were made on BaO versus optical properties, B_2O_3 and SiO_2 versus optical properties, SiO_2 versus BaO and SiO_2 versus alkali. The proportioning of the RO bases, the Al_2O_3 , ZnO and alkali contents was discussed. Each particular glass is a problem in itself and the details cannot be covered in a general paper.

DISSOLVED GASES IN GLASS

E. W. Washburn gave an exhaustive report of investigation of dissolved gases in glass, which in addition to appearing in the *Journal* of the American Ceramic Society will shortly be issued as Bulletin 118 (1921) by the University of Illinois Engineering Experiment Station. The work was begun in 1917 and is just completed. The results to date lead to the conclusion that all varieties of glass in the finished state contain dissolved gases. The amount of this dissolved gas is sufficient to cause the glass to effervesce violently if the pressure upon it be suddenly reduced while in a fluid condition. The amount and composition of the dissolved gas varies greatly with the type of glass and the detail of the melting and fining procedures. In three types of industrial glass examined, the volume of the dissolved gases, measured under standard conditions, varied from 0.2 to two times the volume of the glass itself. Carbon dioxide, oxygen and nitrogen were found in various amounts in the gas.

THE OPERATION OF LEERS

C. E. Frazier spoke on the essentials of proper annealing of glass articles from a practical standpoint. The factors involved are the shape, weight, temperature at which the glass is worked and whether the article is blown or machine made. The strains created in the latter will be proportional to the difference in temperature between the plunger mold and the glass. The annealing temperature varies from 800 to 1,100 deg. F. and the time from 45 min. to 1 hr. 20 min. Proper annealing involves correct mold design, working temperature, temperature annealing chamber, soaking time and a gradual cooling on removal from annealing chamber. Comparisons were made of the open, muffled and continuous leer.

Heavy Clay Products

This division was organized with Ross C. Purdy chairman. The scope of activity will include common brick, drain tile, facebrick, sewer tile and other fields involving the heavier ceramic industries. The discussion centered on the co-operative movement with the various national associations of these products. A. V. Bleininger reported the work as carried out by the ceramic committee of the National Research Council. The hollow tile producers are also inclined to join. Joint conferences have been held by the executive committees of all these associations and all approved the plan for each association to appropriate \$10,000 a year for two years to establish a fund for research and have recommended it back for approval by each association. The formation of this division for the work will greatly increase the American Ceramic Society's membership.

The Art Division

Under the chairmanship of Frederick H. Rhead of Zanesville, Ohio, the new division giving art a definite place in the society was formed. The following papers were presented at the close of the business session:

"The Mutual Relations of Art and Technology in the Ceramic Industry," Leon V. Solon, New York City; "Relationship of the Artist to the Manufacturer," Conrad Dressler, Cleveland, Ohio; "Some Suggestions for Research in Commercial Decorative Processes," Frederick H. Rhead, Zanesville, Ohio; "Ability of Variable Glaze Compositions to Take Vapor Lustres,"

Ray T. Watkins, Columbus, Ohio; "Nickel Oxide in Glazes," J. D. Whitmer, Zanesville, Ohio; "A Study of Crystalline Glazes," Hobart N. Kraner, Columbus, Ohio.

Kilns

As in previous years, the general session included a symposium on kilns directed by R. H. Minton, which was attended by members from all branches of the society.

DATA ON A DRESSLER KILN

F. H. Riddle gave some real data on a Dressler kiln which had been in operation seven months at cone 18. The condition of the structure at the end of the period was classed as a temporary delay and not a failure. Many have been skeptical about the success of tunnel kilns above cone 11. Cone 20 has been reached in the case at hand. The structure is 300 ft. long with silica brick arch in the hot zone (40 ft. long) and the remainder firebrick. Photographs showed the rise in this arch due to greatest heat, 2,678 deg. F., was 1 $\frac{3}{4}$ in. The flue boxes were replaced with carborundum brick. The mortar stood up well, but reacted with the carborundum to break the latter down. Where no binders were used the carborundum stood up well.

Examination of the silica brick in the hot zone (2,400 deg. F.) showed that the edges next to the heat were completely converted to tridymite and the outside edges crystoballite. There was no difference in expansion between the two parts of the brick. Electric porcelain can be burned in the tunnel kiln.

DESCRIPTION OF A UNIQUE KILN

C. B. Harrop spoke on the construction of two of his kilns installed at the Mt. Clemens Pottery Co., Mt. Clemens, Mich. The installation was unique in that two kilns were placed end to end for bisque and glaze burning. The former is 325 ft. long operating at cone 10 and the latter 273 ft. long at cone 5. They are burning white ware in this open-fired, hand-stoked type. The ashes are automatically removed. The firebox has an enlarged throat and the walls of the main chamber are sloped in at the top to produce even distribution of heat.

The coal burned is Elkhorn Kentucky grade and burns one dozen bisque for every 1.22 lb., against 7.8 lb. consumed in periodic kilns.

COMPARTMENT KILN FOR CLAY PRODUCTS

W. D. Richardson gave a paper on the adaptability of the compartment kiln for clay products. Attention to fuel saving is becoming important. The tunnel kiln has been the dream of potters for a long time. In the old experiments with this type it was found that the only installations that could not be inspected were those that failed. The latest compartment kiln development can be adapted to any type of ware where gas is employed for heating. No saggers are required to protect ware. It saves from 50 to 60 per cent of fuel over the periodic kiln, is compact and adaptable to plant conditions, requires no ash handling, has better burn control, uniform product, low repair costs, and a wider range of practical utility than any other type.

THE SHAW COMPARTMENT KILN

R. H. Minton spoke on the Shaw compartment kiln, stating that these are used widely in England, while the tunnel kiln is popular in Germany. The former compares favorably with the tunnel kilns for fuel economy and is more adaptable to existing plants.

Investigations of the Chemical Literature—I

A Survey of the Field of Chemical Literature and of the Various Kinds of Searches or Investigations—Library Research—Use of Card Index Catalogs, Shelf Lists and General Reference Works*

By FRANK E. BARROWS†

THE chemical literature is the storehouse of the available published information of chemical science and chemical industry. It is most extensive, both in the wide range of subjects which it includes and in the long period of time over which it extends. Investigations of this literature are often required. Proper investigation requires a familiarity on the part of the investigator with the various sources of information and with the facilities available for using them. The importance of proper training and guidance in making investigations of the chemical literature is not as generally recognized as it should be.

The present paper is a contribution to the general subject of the chemical literature and its investigation, and includes a discussion of the use of library facilities and general reference works, and of the searching of the periodical and other literature.

The Field of Chemical Literature

PERIODICALS

The number of current periodicals systematically examined for *Chemical Abstracts*, according to the list published in 1918, was 789. Bolton, in his "Select Bibliography of Chemistry," published in 1893, lists 436 periodicals, while in his "Catalogue of Scientific and Technical Periodicals, 1665-1895," published in 1897, he gives the following numbers of periodicals as relating to certain branches of chemistry: General chemistry, 154; pharmaceutical chemistry, 30; physiological chemistry, 6; technical chemistry, 94; dyeing and printing, 21; illuminating gas, 30; iron industry, 33; ceramics and glass, 32; metallurgy, 44; mining, 165; oils, fats, soap, etc., 22; sugar, 43; tanning and leather, 11; wines and spirits, 48. Even as early as 1848 Gmelin, in vol. 1 of his "Hand-Book of Chemistry," gives a list of 77 chemical periodicals of earlier date.

OTHER LITERATURE

In addition to the periodical literature the field of chemical literature also includes the patent literature, the text book literature, and the numerous histories, hand-books, dictionaries, encyclopædias, technologies, pamphlets, bulletins, monographs, dissertations, public documents, trade catalogs, reviews, indexes, bibliographies and other books and publications which relate, in whole or in part, to chemical science or to chemical industry.

VARIOUS FIELDS OF CHEMISTRY

In the general field of the chemical literature are numerous branches or subdivisions, including:

Agricultural chemistry, analytical chemistry, apparatus, biochemistry, ceramics, cement, colloidal chemistry,

dyestuffs and dyeing, electrochemistry, explosives, fermentation, fertilizers, foods, fuels, gas manufacture, glass manufacture, general inorganic chemistry, leather, metallurgy, mineralogical chemistry, oils and fats, general organic chemistry, paints and varnishes, paper making, perfumes, petroleum oils, pharmaceutical and medical chemistry, photography, physical chemistry, plastics, resins, rubber, sanitation, soap, sugar, textiles, theoretical chemistry, water, and wood distillation.

This list might be elaborated or abbreviated, depending upon the particular standpoint from which the field is considered.

Some of the chemical periodicals are of a general character and embrace many of these branches; others relate to certain branches only. The chemical literature, other than the periodical literature, is likewise in part of a general character and in part specialized and limited to certain subjects or branches.

It is apparent that the chemical literature is of a most extensive character, both in the wide range of subjects which it includes and the long period of time over which it extends.

Various Kinds of Searches or Investigations

Searches or investigations of the chemical literature, of a more or less comprehensive character, may be made from various standpoints—e.g., by the research chemist, to familiarize himself with the available published information along the lines of his research; by the student, as a part of his studies or research; by the writer or author who, in his articles or publications, desires to give credit to the work of others, or to review the prior literature along the lines of his own publication; by the bibliographer, as the basis of his bibliography; by the manufacturer, to obtain information of interest along the lines of his manufacture or along new lines of development; by the patent investigator, in connection with questions relating to the novelty and patentability of inventions, and the validity and infringement of patents, etc.

It will be evident that the character and scope of the search or investigation will vary, depending upon the particular object the searcher has in view.

The value of any search or investigation of a comprehensive character will depend on its thoroughness and completeness, and this will in turn depend upon the facilities available for making the search and upon the ability and training of the searcher in making use of these facilities.

Libraries

The making of any comprehensive investigation necessarily requires that there shall be available a library containing the chemical literature properly classified and accessible for examination.

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Libraries of this character will be found in the larger cities and in many of the colleges, technical schools and universities, although the extent of the chemical literature, both book and periodical, will vary greatly in different libraries.

For many purposes the libraries of Washington offer facilities not elsewhere available. The Library of Congress is an excellent field of search because of its extensive number of publications and its card index catalog, and particularly if permission be obtained to examine the classified works in the stacks of the library. For making searches through the patent literature, both United States and foreign, the library of the Patent Office offers facilities nowhere else available in this country. The Smithsonian and Surgeon-General's libraries as well as those of the Geological Survey, Bureau of Mines and Department of Agriculture are likewise of special value in their respective fields.

Many of the public libraries of the larger cities, as well as libraries such as the John Crerar Library of Chicago, the Franklin Institute Library of Philadelphia and the Chemists' Club and Engineering Societies libraries of New York, also afford excellent fields of search.

In addition to these public libraries and libraries which are generally open to the public there are many private and special libraries, of associations, societies, corporations or individuals, which may contain valuable special collections along certain lines.

The importance and value of proper library service is well illustrated by the fact that at the annual meeting of the American Chemical Society at Buffalo (May 7 to 11, 1919), the program included a "Symposium on Library Service in Industrial Plants," with twelve different papers.¹

The publication, *Special Libraries*, of the Special Libraries Association contains much that is of interest from the general standpoint of library investigations, bibliographies, etc., and is to be recommended to those interested in such subjects.

In making use of a library's facilities the searcher may proceed in various ways—i.e., with the card index catalog, with the classified books on the shelves of the library, with the general reference works or with the periodical literature.

CARD INDEX CATALOGS

Every library of consequence has its card index catalog of the books and publications on the shelves of the library. The librarian is taught that "in any library the card catalog is the main bibliographical tool for that particular library" and that "good cataloging is the basis of all satisfactory service to the public."

In using the card index catalog the searcher will naturally look under the same general or special subjects or headings as in using the various indexes of chemical publications, although it may be necessary to look under more general, rather than or in addition to specific, subjects. After obtaining lists of the publications of the library along the lines in which he is interested he may have the publications brought to him, or he may in many libraries go to the shelves where the books themselves are classified.

Some libraries have special rooms where the more important scientific and technical periodicals and books are separately arranged for convenience of use. Thus in the New York Public Library publications relat-

ing to science and technology will be found in four adjacent rooms. Chemistry periodicals and books are in Room 118, physics, mathematics, geology, mining and metallurgy in Room 115, engineering periodicals in Room 117, engineering, patents, electricity, textiles and related subjects in Room 121. A single card index catalog serves as a guide to all the material in this division.

Again, certain libraries have special card index catalogs. The Patent Office at Washington has an extensive card index of the chemical literature, with a formula classification of organic chemical compounds similar to that of Richter's "Lexikon."

Some libraries also include in their card index catalogs reference to leading papers appearing in the current technical and scientific periodicals. The Engineering Library and Public Library of New York include references of this character.

In many fields of chemistry there are special books or monographs devoted to particular subjects and sometimes containing copious references to the patent and periodical literature. A search or investigation may be very materially shortened if such a work is found devoted to the particular subject of the investigation. These works will usually be referred to in the card index catalogs.

SHELF LISTS

From the card index catalog of the library the searcher can ascertain the classes where the particular books in which he is interested are classified. He may find that some of the books are in one class, some in another, still others in a third, and so on. If it is permissible to go to the shelves or stacks of the library he may find in these same classes still other books of interest which he did not find from the card index.

Information about the classification and arrangement of the books on the shelves, and even about books and publications relating to the particular field of the investigation, may frequently be obtained from the librarian or assistant in charge.

It is useful to keep in mind that both the Dewey decimal system of classification and that of the Library of Congress provide for the separate classification of science and technology. Thus in the Library of Congress classification Class Q relates to science and Class T to technology. Chemistry is classified in Class QD; chemical technology in Class TP. Agricultural chemistry is separately classified in Class S (agriculture); medical and pharmaceutical chemistry in Class R (medicine); physiological chemistry in Class QP (science); mineral industries, including metallurgy, fuels, etc., in Class TN (technology), etc. Some publications relating to chemical subjects are also classified in the class of economics (Class H), while others may be found in sets of Government publications or among series of bulletins or publications of universities, etc., and separately classified for that reason. For a complete search of the library's facilities, accordingly, it is important to use both the card index catalog and the shelf lists relating to the particular subjects of the investigation.

General Reference Works

For some purposes it is more profitable to begin with the general reference works, which will be found in considerable number in all of the larger and more important libraries, than with the card index catalog or the classified shelf lists. These general works include dictionaries, hand-books, encyclopædias, technologies,

¹See *J. Ind. Eng. Chem.*, vol. 11, pp. 578-589, June, 1919.

bibliographies, indexes of various kinds, etc., and are often separately classified from the rest of the chemical literature.

Some of these reference works will themselves be found to contain a great deal of information on many different subjects, particularly in the case of dictionaries and technologies, and some of the hand-books and encyclopædias; others will be found to consist mainly of indexes or bibliographies which direct the investigator to the periodical literature for further information. Sometimes reference works such as Beilstein or Richter, in organic chemistry, or Gmelin-Kraut or Abegg, in inorganic chemistry, will be the best place to start in making the investigation.

Some of the general reference works that may be used to advantage in making investigations are briefly referred to below. This list does not purport to be at all complete, but is intended rather as illustrative.

DICTIONARIES

Thorpe's "Dictionary of Applied Chemistry," published 1912-1913, in five volumes, is one of the best known and most valuable of the chemical dictionaries. It contains many valuable monographs and numerous references to the original literature.

Watt's "Dictionary of Chemistry," published 1892-1894, in four volumes, is an older but in some respects an even more valuable work.

Wurtz's "Dictionnaire de Chimie Pure et Appliquée," in three volumes, published in 1874, with its First Supplement, in two volumes, and its Second Supplement, in seven volumes (published 1892-1908), is another valuable reference work, and contains numerous references to the original literature.

ENCYCLOPÆDIAS

Freymy's "Encyclopédie Chimique," in ninety-three volumes, published 1882-1890, with an index volume (Table Alphabétique des Matières) published in 1899, is an elaborate work, but not as valuable as its size would indicate.

Ullmann's "Enzyklopädie der technischen Chemie," still incomplete, is a valuable work. Eight volumes are now available.

HAND-BOOKS

Gmelin's "Hand-Book of Chemistry" was translated by Watts, and published by the Cavendish Society, in eighteen volumes, the first six of which relate to inorganic chemistry and the last twelve to organic chemistry. The first volume was published in 1848, the eighteenth volume in 1871. A separate index volume was published in 1872. Seventy-seven periodicals are listed in the beginning of the first volume. The original German work of Gmelin was published in seven volumes, three relating to inorganic chemistry and four to organic chemistry.

This publication is one of the best and most valuable of the early reference works, and it contains, in digest or abstract form, reference to most of the important chemical literature prior to the middle of the Nineteenth Century.

There is a tendency among students and among some chemists to consider that the main strides in the advance of chemical knowledge have been within the last few years, but reference to Gmelin's Hand-Book shows that far more information was available half a century ago, both in inorganic and organic chemistry, than is commonly appreciated.

Perhaps the most elaborate and exhaustive digest of inorganic chemistry is Gmelin-Kraut's "Handbuch der anorganischen Chemie." This hand-book follows the same general plan as the earlier hand-books by Gmelin, giving a bibliography at the beginning of each subject and a discussion of the properties, methods of preparation and commercial methods of manufacture of the various metals and of their various compounds. About 170 periodicals are listed in the introductory portion of the first volume. The work is still incomplete, but the volumes which have been published and the fields which they cover, are indicated by the following table:

Vol. 1, Pt. 1, published 1907, 888 pages. Oxygen, Hydrogen, Helium, Argon, Neon, Krypton, Xenon, Nitrogen, Sulphur, Selenium.

Vol. 1, Pt. 2, published 1909, 441 pages. Fluorine, Chlorine, Bromine, Iodine.

Vol. 1, Pt. 3, published 1911, 907 pages. Phosphorus, Boron, Carbon.

Vol. 2, Pt. 1, published 1906, 512 pages. Potassium, Rubidium, Calcium, Lithium, Sodium.

Vol. 2, Pt. 2, published 1909, 726 pages. Barium, Strontium, Calcium, Magnesium, Glucinum, Aluminum.

Vol. 3, Pt. 1, published 1912, 1568 pages. Titanium, Silicon, Chromium, Tungsten, Molybdenum, Uranium.

Vol. 3, Pt. 2, published 1908, 1135 pages. Radio-active material (Uranium, Thorium, Radium, Polonium, Radio-Tellurium, Radio-active Lead, Actinium and Emanium, etc.), Vanadium, Manganese, Arsenic, Antimony, Tellurium, Bismuth.

Vol. 4, Pt. 1, published 1911, 1056 pages. Zinc, Cadmium, Indium, Gallium, Germanium, Tin, Thallium.

Vol. 5, Pt. 1, published 1909, 1595 pages. Nickel, Cobalt, Copper.

Vol. 5, Pt. 2, published 1914, 1752 pages. Silver, Gold, Mercury.

Vol. 5, Pt. 3, published 1915, 992 pages. Platinum.

The unpublished volumes of this Hand-book are as follows:

Vol. 4, Pt. 2, Lead, Iron.

Vol. 5, Pt. 4, Palladium, Rhodium, Iridium, Ruthenium, Osmium.

Vol. 6, Zirconium, Thorium, Tantalum, Niobium, Cerium, Lanthanum, Didymium, Neodymium, Praseodymium, Yttrium, Ytternium, Scandium, Erbium, Terbium.

OTHER HAND-BOOKS AND TREATISES

Abegg's "Handbuch der anorganischen Chemie," published 1905-1920, is another standard reference work on inorganic chemistry, and is perhaps better known than Gmelin-Kraut, although it also is incomplete.

Dammer's "Handbuch der anorganischen Chemie" is of similar character, though of earlier date.

Dammer's "Handbuch der Chemischen Technologie," 5 volumes, published 1895-1898, supplemented by "Chemische Technologie der Neuzeit," 3 volumes, 1910-1911, is a valuable survey of applied chemistry.

Roscoe and Schorlemmer's "Treatise of Chemistry," in English, and Moissan's "Traite der Chimie Minérale," in French, are also useful reference works.

GENERAL REFERENCE WORKS, ORGANIC CHEMISTRY

The most valuable work in the field of organic chemistry for use as a digest or reference work is Beilstein's "Handbuch der Organischen Chemie." Every organic chemist who has occasion to make investigations of the literature should be well acquainted with it.

The third edition was published in four volumes, from 1893 to 1899; the four supplemental volumes in 1901 to 1906; the supplemental volumes (Ergänzungsbände) following the same general plan as the original volumes. The fifth supplemental volume or index volume was also published in 1906. The scope of the work will be indicated from the following:

Vol. 1, published 1893, Fatty Series.

Vol. 2, published 1896, Aromatic Series: Hydrocarbons, Phenols, Alcohols, Acids.

Vol. 3, published 1897, Aromatic Series: Aldehydes, Ketones, Quinones, Camphor Products, Terpenes, Etheral Oils, Resins and Balsams, Glucosides, Bitter and Indifferent Substances, Dyestuffs, Tanning Material, Furan Series (Thiophenbodies), Alkaloids.

Vol. 4, published 1899, Aromatic Series, Bases Azoxy-, Azo-, Hydrazo-, Diazo-, Diazoamino-Derivatives, Albuminates, Phosphorus-, Antimony-, Arsenic-, Bismuth-Compounds, Boron and Silicon Compounds. Metallo-Organic Compounds.

Each volume is provided with an index, but these are superseded by the supplementary Index Volume 5, which gives an elaborate name index of the various compounds of organic chemistry described in the entire work.

Beilstein is supplemented by Richter's "Lexikon der Kohlenstoff-Verbindungen," in four parts, published in 1910-1912. This book is a collective index to the third edition of Beilstein and also contains numerous other literature references covering the period up to and including 1909.

A fourth edition of Beilstein, to consist of fifteen volumes, is being prepared by Bernard Prager and Paul Jacobson.² The volumes which have appeared to date are:

Vol. 1, published 1918, Acyclic Hydrocarbons, Hydroxy- and Carbonyl-Compounds.

Vol. 2, published 1920, Acyclic Carboxylic Acids.

Vol. 3, published 1921, Hydroxy- and Carbonyl-Carboxylic Acids.

This fourth edition is to include the literature up to the end of the year 1909.

Subsequent to 1909, Stelzner's "Literatur-Register der Organischen Chemie" covers the literature of organic chemistry for the period of 1910-1911 (vol. 1) and 1912-1913 (vol. 2).

Another index which should be mentioned in this connection is the card index catalog of the Patent Office at Washington. This catalog, so far as it relates to organic chemistry, has a system of classification by formula very similar to that of Richter's "Lexikon." This card index is not, of course, available except at Washington. It has been compiled under the direction of Dr. Edwin A. Hill, of the Classification Division of the Patent Office, and its character and scope are described in articles by Dr. Hill appearing in the *Journal of the American Chemical Society*, vol. 2, year 1900, pages 478-494; vol. 29, year 1907, pages 936-941; and vol. 34, year 1912, pages 416-418. It is also described in Appendix K of the report of the investigation of the United States Patent Office made by the President's Commission on Economy and Efficiency in 1912 (House of Representatives Document 1100, Sixty-Second Congress, Third Session).

BOLTON—SELECT BIBLIOGRAPHY OF CHEMISTRY

Another important work of a bibliographical character is the "Select Bibliography of Chemistry," by Henry C. Bolton, published by the Smithsonian Institution (Smithsonian Miscellaneous Collection Nos. 850, 1170 and 1253).

The first volume of this bibliography was published in 1893 and covers the period from 1492 to 1892. The first supplement, published in 1899, covers the period from 1492 to 1897, and includes works omitted from the first volume, together with those appearing up to the end of the year 1897. The character of this bibliography will be apparent from the following quotations from the preface of the first volume:

An attempt has been made in the following pages to collect the titles of the principal books on chemistry

published in Europe and America from the rise of the literature to the close of the year 1892. The term chemistry is taken in its fullest significance, and the Bibliography will be found to contain books in every department of chemical literature, pure and applied;

* * * * *

The Bibliography is confined, however, to independent works and their translations, and does not, as a rule, include Academic Dissertations (which are so numerous as to require a special catalogue), nor so-called "reprints" or "separates" (Separate-Abdrücke); of the latter only a few score are ordinarily printed and they must be regarded as belonging to periodicals. No attempt has been made to index the voluminous literature of periodicals except in the section of Biography as noted below.

* * * * *

To facilitate reference the work is divided into seven sections: I, Bibliography; II, Dictionaries; III, History; IV, Biography; V, Chemistry, pure and applied; VI, Alchemy, VII, Periodicals.

Altogether the first volume contains about twelve thousand titles, while the first supplement has fifty-five hundred more, making more than 17,500 in all. Of these titles 273 of the first volume and 95 of the supplement relate to bibliographies, while 327 of the first volume and 84 of the supplement relate to dictionaries and tables.

The third volume of this "Select Bibliography of Chemistry," by Bolton, relates to "Academic Dissertations." The dissertations are indexed under the authors' names, but the book is also provided with a subject-matter index. The nature of the work will be apparent from the following extracts from page 3:

This bibliography is not an index to the chemical dissertations that have appeared in periodicals, but a list of those that have been printed independently. When compiling the list of titles I was fortunate in securing permission to make copies of the card catalogues of two large collections of dissertations on chemistry, those in University Library, Strassburg, and those in the library of the United States Geological Survey, Washington City. I had also the opportunity of cataloguing several thousand dissertations deposited by the Smithsonian Institution in the Library of Congress; the latter were chiefly of German origin.

* * * * *

For the convenience of residents of the United States the dissertations found in the libraries of the Geological Survey and of the Smithsonian Institution are indicated by the letters "G. S." and "S. I." respectively.

CATALOG OF SCIENTIFIC PAPERS

This work, which is still incomplete, has been compiled and published by the Royal Society of London. It has properly been referred to as the most comprehensive index to general science ever attempted. The first six volumes, published 1867-1872, cover the period from 1800 to 1863. In the preface of vol. 1, it is said:

This catalog is intended to serve as an index to the titles and dates of scientific papers contained in the Transactions of societies, journals and other periodical works which have been published from the beginning of the present century to the end of the year 1863.

In the introduction of this same volume the subject-matter of the catalog is discussed in part as follows:

The following catalog is intended to contain the title of every scientific memoir which appears in the various Transactions and Proceedings of scientific societies, and in the scientific journals published within the time which it comprehends; with the reference, the date, the author's name and the number of pages in the memoir.

* * * * *

A list of the works indexed, nearly fourteen hundred in number, arranged alphabetically according to the contraction employed in the catalog, will be found at the end of the introduction.

* * * * *

The titles are arranged alphabetically according to

²For a discussion of the arrangement of compounds in this new edition see "Classifying Organic Compounds by the Prager-Jacobson System," by Donald W. MacArdle, *CHEM & MET. ENG.*, vol. 22, p. 256, Feb. 11, 1920.

the authors' names, the arrangement under the head of any one author being chronological.

The second series of the catalog, vols. 7 and 8, published 1877-1879, covers the period from 1864 to 1873. The third series, in three volumes (9 to 11), published 1891-1896, covers the period from 1874 to 1893. A supplementary volume, vol. 12, published in 1902, contains additional papers published between 1800 and 1883.

The papers of this supplementary volume were taken from more than 350 added periodicals, so that, with the nearly 1,400 periodicals indexed in the first volume, and with the 130 more added in vol. 6, the total number of periodicals indexed in the "Catalog of Scientific Papers" up to 1883 is between eighteen and nineteen hundred.

The fourth series of the catalog covers the period from 1884 to 1900. Vols. 13 to 16, for about half of the papers of the series, have so far been published, although their publication is of comparatively recent date (1914-1918). The remaining volumes are yet to appear.

When the catalog is completed, it will consist of an author catalog and a subject index covering the entire period from 1800 to 1900. That is, the volumes of the author catalog are to be supplemented by index volumes of subject-matter covering the entire period from 1800 to 1900. The subject indexes are to be issued separately for each of the seventeen sciences dealt with in the "International Catalog of Scientific Literature," and will be arranged in accordance with the schedules of the International Catalog. The index volumes of "Pure Mathematics, Mechanics and Physics" have thus far been published. Unfortunately the index volume for chemistry is not yet available. Until this volume is available, the "Catalog of Scientific Papers" cannot be readily searched, except as an author index. However, for investigating the various papers of any given author between the dates 1800 and 1900, the catalog undoubtedly furnishes the most complete and comprehensive single index available. When the subject-matter index volumes are likewise available, it will then be the most complete and one of the most valuable indexes of the chemical literature of the nineteenth century.

INTERNATIONAL CATALOG OF SCIENTIFIC LITERATURE

Beginning with the year 1901, the "International Catalog of Scientific Literature" was published as a continuation of the "Catalog of Scientific Papers" of the Royal Society of London, and it now appears annually, in seventeen volumes, for each of the seventeen sciences dealt with. These sciences or branches which are included in the catalog are as follows:

- A. Mathematics.
- B. Mechanics.
- C. Physics.
- D. Chemistry.
- E. Astronomy.
- F. Meteorology (including Terrestrial Magnetism).
- G. Mineralogy (including Petrology and Crystallography).
- H. Geology.
- J. Geography (Mathematical and Physical).
- K. Palæontology.
- L. General Biology.
- M. Botany.
- N. Zoology.
- O. Human Anatomy.
- P. Physical Anthropology.
- Q. Physiology (including experimental Psychology, Pharmacology and experimental Pathology).
- R. Bacteriology.

In the list of the journals, published as a separate volume in 1903, the surprising number of 4,673 journals is listed from twenty-five different countries. Germany leads with 1,308, France is second with 919, the

United States third with 539, and the United Kingdom fourth with 455, while Russia is fifth with 397.

It is, of course, evident that the field covered by the international catalog, as well as that covered by the "Catalog of Scientific Papers," is much broader than chemistry, but inasmuch as a separate volume appears annually for each science, the consideration of the portion of the catalog relating to chemistry does not involve a consideration of the portions of the catalog relating to other sciences. The "International Catalog" is one of the most valuable indexes of the chemical literature for the period which it covers (since 1900).

REPERTORIUM DER TECHNISCHEN JOURNAL LITERATUR

This work goes back to 1823, was edited by Schubarth for the volume covering the period 1823 to 1853, and by Kerl for the two volumes covering the periods 1854 to 1868 and 1869 to 1873. Beginning 1874 it appeared annually, and since 1877 it has been published by the German patent office. Prior to 1879 it was known as the "Repertorium der Technischen Literatur"; since 1879 it has been known as the "Repertorium der Technischen Journal Literatur."

It has had an author index since 1897 in addition to the subject index which it has always contained. The last volume of the "Repertorium" was published in 1908.

The general arrangement of the "Repertorium" is alphabetical, by subjects, and it contains reference to a large number of the leading articles appearing both in the German and in other periodicals for the current year. The field covered includes much that has no relation to chemistry and metallurgy, but it is nevertheless a valuable index for use in searches of the chemical and metallurgical literature. It is of course equally valuable in other fields than chemistry.

THE INDUSTRIAL ARTS INDEX

This index is published by the H. W. Wilson Co., 958-964 University Ave., New York. The plan of the index is set forth by the publishers in the following language:

The Industrial Arts Index is an indexing service to eighty-one technical journals which have been selected by our subscribers as the leaders in their respective fields. It reaches you in magazine form (instead of loose cards) ten times a year. The entries are arranged alphabetically by subject and repeated under place names when necessary. Every article of importance in these eighty-one magazines is indexed under as many subject headings as will bring out all points of interest, and cross-references direct to the searcher of allied subjects in other parts of the alphabet.

The rate for this service is based on the number of periodicals indexed for which you subscribe.

Annual volumes of the index have been published since 1912.

This index is not comparable with *Chemical Abstracts*, either in the scope of the field covered or in the detailed information which it gives, but it is nevertheless a useful index for many purposes, and one with which the searcher should be familiar. It includes much that is of general interest which is outside the field of chemical literature.

MINING WORLD INDEX

The "Mining World Index" of current literature was published from 1912 through 1916 by the Mining World Co. of Chicago. It was edited by the editor of the *Mining and Engineering World* and was published as "An International Bibliography of Mining and the Mining Sciences, compiled and revised semi-annually from the

index of the World's Current Literature, appearing weekly in *Mining and Engineering World*."

This index is of more particular interest to those making investigations of the mining and metallurgical literature, for the period which the index covers (i.e., 1912 to 1916).

ENGINEERING INDEX

The "Engineering Index" is an index which is likewise of more particular interest in connection with technical and engineering subjects, but it will nevertheless in some cases be found useful in those branches of applied chemistry which are included within its scope. Four volumes of the index cover the period from 1884 to 1905, and annual indexes have since been published. In 1906 the index covered about 250 technical and engineering journals in six different languages, about one-fourth of the periodicals indexed being in languages other than English.

Part II will be published in a subsequent issue.

British Report on Use of Tidal Power

In its third interim report to the President of the [government] Board of Trade the Water Power Resources Committee—of which Sir John Snell is chairman—deals solely with the question of utilizing the tides for power purposes. Its object is to urge the need of a more detailed technical inquiry into the subject than the committee itself is in a position to undertake. Of the tidal power schemes brought to its notice the greater number show no recognition of the very serious technical difficulties involved in harnessing the tides, and few have been worked out in detail. The committee has, however, had under consideration two tidal power schemes for the Severn Estuary, which, although preliminary, were based on investigation of the actual conditions of the site and were accompanied by estimates of cost.

The possibility of utilizing the tides of the Severn may almost be regarded as a test question; the tidal amplitude is large, the configuration of the estuary is well suited to the purpose; the physical characteristics of the land in the vicinity are such as to facilitate the construction of a high-level storage reservoir; and the adjoining industrial district is one in which the power requirements are already large, and the power supply is likely to be absorbed completely for industrial purposes.

PRELIMINARY EXAMINATION MADE

As a safeguard against undue optimism, the committee thought it desirable to carry out an independent preliminary examination of the subject on broad lines. A subcommittee consisting of Sir Philip Dawson and Prof. A. H. Gibson was constituted for this purpose. This subcommittee approached several of the leading firms of manufacturers of turbines and electric generators throughout the world with the object of obtaining particulars concerning low-head and variable-head turbines and electric generators suitable for tidal power schemes to enable it to frame an estimate of the possibility of utilizing the tides of the Severn. The results of the investigations which have been carried out support the view that energy can be generated and utilized at a favorable rate.

After giving careful consideration to the views expressed by the subcommittee the main committee finds that while on the information before it it is not in a

position to recommend the Severn scheme as a practical proposition, it is in unanimous agreement that the plan certainly cannot be dismissed as impracticable, and that further and more detailed technical inquiry into the subject of tidal power is amply justified and should be initiated without delay.

The utilization of tidal power involves the solution of many complex problems, and though the committee is of the opinion that a prima facie case has been made out for the Severn scheme, it must be pointed out that before a final pronouncement is possible a further investigation of a number of physical and technical questions—some of general interest and some peculiar to the conditions of the Severn—must be made.

SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

The conclusions arrived at are:

The difficulties to be overcome in harnessing the tides are so bound up with local conditions that it is essential that the general question of tidal power should be approached with reference to actual conditions obtaining at the same particular locality.

The technical information available in regard to the possibility of utilizing the tides in the Severn for the generation of power is not sufficiently precise to enable the committee to express a final opinion on the schemes which have been brought before it.

Preliminary estimates indicate, however, that if the Severn tides were used energy could be generated and utilized at a favorable rate, and that the power obtainable throughout an industrial day of ten hours would be of the order of 260,000 kw. and the consequent saving of coal would be from one and one-fourth to two and one-half million tons annually.

The committee recommends that:

The Board of Trade, in consultation with the Minister of Transport, should set up a special technical commission, consisting mainly of expert engineers and persons of scientific attainments, to investigate the possibility, from a commercial standpoint, of utilizing the tides for power purposes.

The inquiry should be pursued with special reference to the Severn Estuary; the commission should prepare a preliminary design and reasonably detailed estimates of cost of a tidal power scheme for that estuary, taking into consideration the desirability of making provision for road, railway and shipping facilities suited to the requirements and possibilities of the adjoining district.

The commission should have regard to any interests likely to be detrimentally affected and should consider and report upon the steps which might be taken to prevent or mitigate injury to any interest.

United States Sugar Production, 1920

According to a preliminary estimate made by the Department of Agriculture, beet sugar production in 1920 exceeded the former record crop of 1915 by 27 per cent and reached the figure of 2,219,200,000 lb. Production of cane sugar is estimated to have been 385,974,000 lb., so the total estimated sugar crop for United States was 2,605,174,000 lb. This was 15 per cent above record sugar production in 1916 and 53 per cent above 1919.

The sugar produced within the United States amounts to about one-quarter of the total consumption, which is estimated as 9,750,000,000 lb. for 1920, equivalent to 92 lb. per capita.

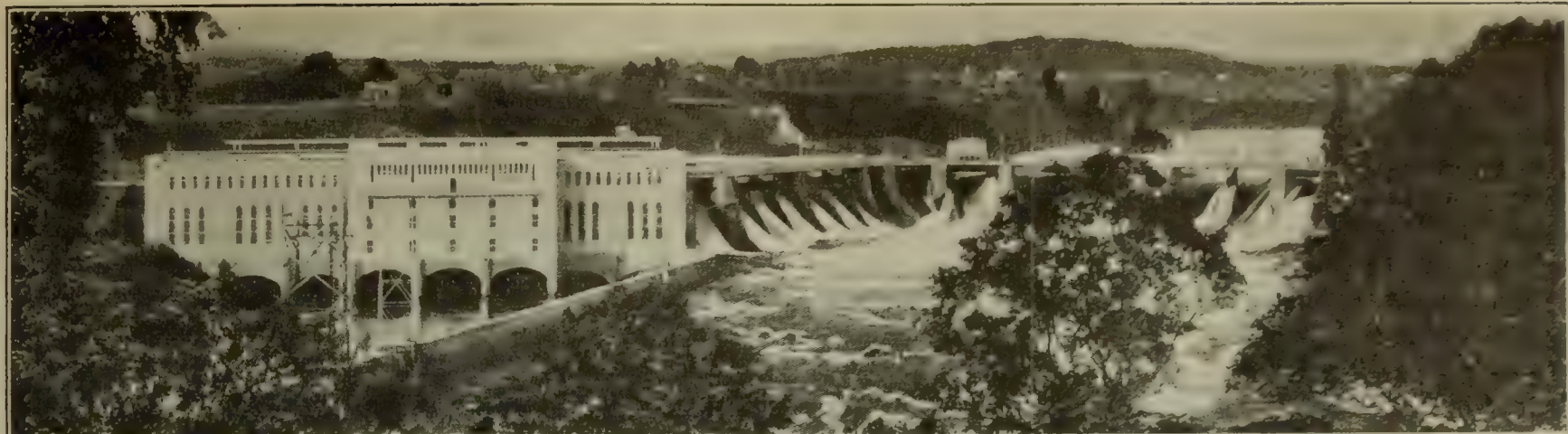


FIG. 1. BULLERFORSN ELECTRIC POWER PLANT
Mounted for 24,000 hp. normal and 30,000 hp. maximal load.

Electric Smelting of Pig Iron at Domnarfvet, Sweden

Early Operation at the Domnarfvet Iron Works and Conditions Leading to the Adoption of Electric Furnaces—Possibilities of Using Non-Charcoal Reducing Agents and Pit Instead of Shaft Furnaces Are Still in the Research Stage

BY BARON GERARD DE GEER
Manager, Domnarfvet Steel Works

STORA Kopparbergs Bergslags Aktiebolag, the company owning the Domnarfvet Iron Works, is the oldest in Sweden and most probably one of the oldest in the world. It has been estimated that the company was established about 1225, and there are still certain documents in existence, photographs of one of them being given in Fig. 2, setting forth special rights which had been granted the company by Swedish kings in the thirteenth century. At first, the smelting of copper at the Falun mine ("Stora Kopparberget," or the great copper mountain) was the main source of revenue, but during the following centuries iron and steel were also produced in increasing quantities. This industry was, as was the case with the iron industry of Sweden in general, based on the production of high-quality materials and was carried on at a great number of small plants. When railways had been built and the transportation conditions completely changed, these small places were concentrated to a large and more up-to-date plant, the Domnarfvet Iron Works.

EARLY OPERATIONS AT DOMNARFVET

This plant was built at the intersection of the Dal River and the railway which connects the works with its iron ores, as well as with Gothenburg, the most important harbor for import and export in Sweden. Wood required for making charcoal is transported in rafts on the Dal River, around the upper course of which the company's extensive forests are situated. Also power is obtained from the Dal River, which not far from Domnarfvet forms several important waterfalls (Fig. 1).

To begin with, the plant, in the same way as its predecessors, was intended for the manufacture of high-quality materials for export, but later the production was changed to ordinary iron for domestic consumption. There were several reasons for this. As Sweden became an industrial country, the demand for ordinary iron had increased and as certain grades were

protected by tariff, the conditions for domestic manufacture became more favorable. Moreover, it had become possible to use high-phosphorus ores in the basic steel processes invented at the end of the last century. Stora Kopparbergs Bergslags Aktiebolag is the owner of great deposits of very rich and suitably situated ore of this kind, which had heretofore been regarded as nearly valueless. Domnarfvet was therefore rebuilt, with the object in view to enter the domestic market and also to utilize the company's cheap high-phosphorus ores.

A basic bessemer plant was built with four 10-ton converters, and also a basic open-hearth plant with four 25- to 35-ton furnaces as shown on the plan, Fig. 3. As it was not possible to produce the required amount of pig iron in the original charcoal blast furnaces, these

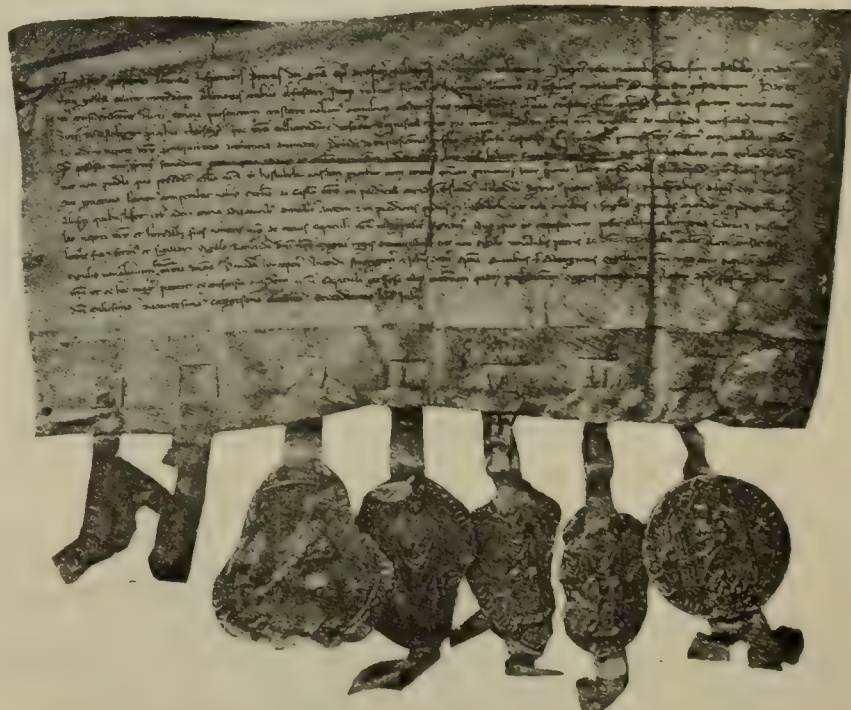


FIG. 2. THE OLDEST ORIGINAL PURCHASE DEED
CONCERNING STORA KOPPARBERGET
Issued by the bishop Peter Elofsson, June 16, 1288, and relating to one-eighth of the company.

were rebuilt for operation with coke. Coke had to be imported from England or Germany, and was always of a poor quality on account of the long transportation and the frequent loading and unloading. We were equipped with reversing cogging mill, rail and shape mill, sheet and tin plate mills, wire mills and various merchant mills. With this equipment, the capacity of the plant was about 100,000 tons rolled products per year.

It soon became evident that this output was far too small and in nowise corresponded either to the selling possibilities or to the modern demand for mass production. When contemplating further construction, however, the question of obtaining fuel became vital. The plant had cheap ore and power, but the expensive and inferior coke was a real handicap in the competition with the imported iron. At this time (about 1910), electric pig iron smelting began to give commercial promise, so the company decided to postpone its new construction until it had been shown whether the increased requirement of pig iron could not be met by producing it with electric heat. This was thought to be well within the range of possibility, as the company could develop cheaply about 160,000 kw.

In order to decide this question, one 3,000-kw. shaft furnace of the Electrometals type and one 9,000-kw. Helfenstein furnace were built at Domnarfvet. The latter was a modified ferrosilicon furnace without a shaft. At about the same time the widely reported tests at Trollhättan were made with an Electrometals furnace, in which experiments all the iron works of Sweden were financially interested. After a few years' experimenting, it became evident that electric pig iron could easily compete with the Swedish high quality iron produced with charcoal, but not with ordinary iron produced in large quantities and that shaft furnaces were the most suitable, open furnaces being not as economical, as for instance when producing ferro-alloys.

On account of these facts Stora Kopparbergs Bergslags decided in 1914 to continue producing chiefly coke pig iron at Domnarfvet, and to build immediately a modern blast furnace with a daily capacity of about 500 tons. This was to be followed later by another similar blast furnace, and eventually also by coke ovens. At the same time it was, however, decided that the electric production of pig iron should not be discontinued, but kept up and further developed, as far as the supply of cheap power warranted. As the flow of water in the Dal River is considerably above normal during five or six months of the year, power can be obtained during this period at a very low price. The manufacture of steel would still be based on the basic bessemer process and the open-hearth plant was to be increased in capacity to take care of the increased amount of scrap. In these plans, the possibility of refining the basic bessemer metal in electric steel furnaces to improve its quality was also considered.

COKE SHORTAGE DRIVES PLANT TO ELECTRIC FURNACES

Construction of the new coke blast furnace was started immediately and at the same time some extensions were made to the melting and rolling shops to enable them to handle the increased quantity of iron. At this time, however, the world war broke out and upset all the calculations. The price of coke rose to an undreamed-of height, and at times it was impossible to obtain coke at all. As a matter of fact since 1917 the purchase price of one ton of coke has been higher than the cost to produce one ton of electric pig iron. To continue producing coke pig iron under such conditions was evidently impossible. At first we tried to mix coke and charcoal, but after a while the coke furnaces had to be shut down. Domnarfvet came to be in a very precarious condition, as it was impossible to obtain the pig iron required to keep the plant in operation. Still

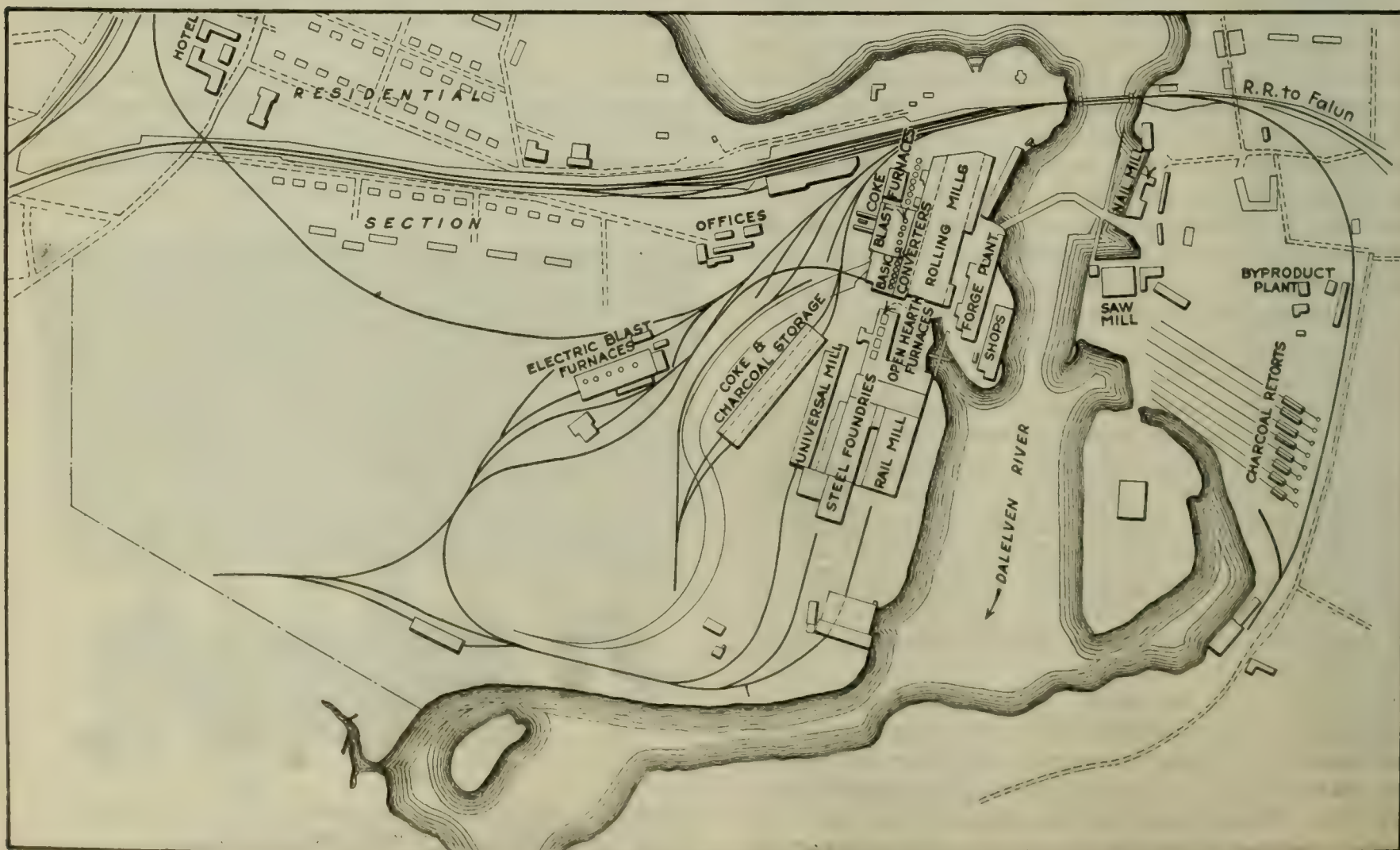


FIG. 3. MAP OF DOMNARFVET STEEL WORKS

worse, the conclusion of peace and conditions following this did not improve the situation. There is no open market for coal and coke in Europe and everything indicates a permanent high price of coke.

Through these changed conditions the situation as regards coke iron and electric pig iron has become such as to give the latter a decided advantage. The only road open for Domnarfvet, not considering the alternative of shutting down completely, was to increase the production of electric pig iron. The construction of the new coke blast furnace, the foundations, storage yards and machinery of which were already finished, had to be stopped, and the installation of the electric furnaces hastened instead. However, water power must also be developed, which requires considerable time and capital.

In order to be able to increase the ingot production sooner, it has also been decided to install electric steel furnaces for melting cold scrap. Such a furnace, of 10 tons capacity, was finished in 1920 and two more were put in course of construction.

The electric pig iron process differs from the ordinary process, as is well known, in that the fuel required to heat and melt the charge is substituted by electric energy. In an electric pig iron furnace, only that quantity of charcoal is charged as is required for the reduction of the ore. As no air is blown in, the combustion of the carbon must be effected by means of the oxygen in the ore. The differences in design and operation between a blast furnace and an electric pig iron furnace are due to these conditions.

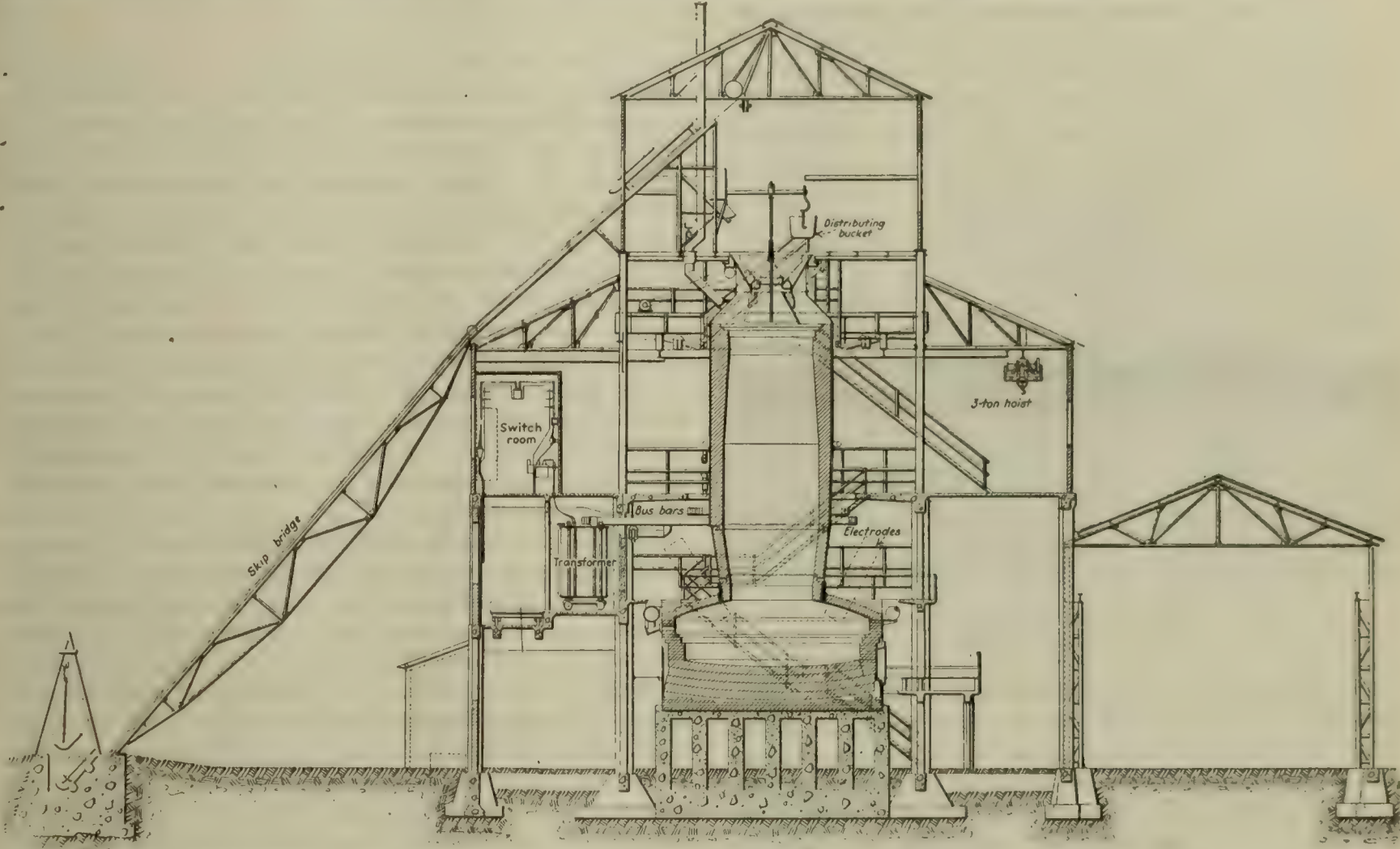


FIG. 4. CROSS-SECTION OF ELECTRIC PIG-IRON FURNACE PLANT

At the present time, six electric pig iron furnaces are built or are in the course of construction. The year of construction, type and capacity are given below:

Assuming an output of 3.6 tons pig iron per kw-yr., the capacity of the Electrometals furnaces would correspond to an output of about 80,000 tons per year. Such

Year	Type	Condition	Nominal Capacity of Transformers,*	
			Kw.	
1911	Electrometals		3,000	
1912	Helfenstein	Not operating in 1920.	9,000	
1915	Electrometals		5,500	
1918	Electrometals		4,000	
1919	Electrometals		4,500	
1920	Electrometals	Building in 1920.	5,000	
			31,000	

* Variation in these figures as quoted in the literature at various times and places is due to using figures purporting either the maximum or average input into the furnace, measured at different points.

an output, however, cannot be attained, as the supply of water allows full load only during certain periods.

A regulation of the drainage system of the Dal River by storing the water in the spring and autumn floods in the lakes to bring about a more uniform supply of power has already been started.

Fig. 4 shows furnace No. 4 at Domnarfvet. The upper part is similar to a blast furnace, but the lower part consists of a large crucible, the walls of which are connected with the shaft by means of a circular roof. Through this roof four, six or eight electrodes are inserted; they have a diameter of 600 to 700 mm. Gas is taken off at the top under the charging platform, cleaned in the usual manner, and part of it is blown into the furnace again through openings, as shown in the drawing, between the electrodes and immediately under the roof. A certain quantity of gas is therefore always circulating in the furnace.

The gas circulation is of very great importance for the proper operation of the furnace and attempts to dispense with it have failed. The gas cools the roof, thereby increasing its life, and also distributes the heat and the chemical reactions more evenly between the hearth and the shaft. The evolution of gas in an electric furnace is naturally considerably less than in a blast furnace, where about three times as large a quantity of carbon is burnt. The heat carried by the gas from the hearth up the shaft, as well as its ability

to perform the chemical reactions, will therefore be less. This is counterbalanced by blowing gas into the furnace. The carbon dioxide of this gas is immediately split up, forming carbon monoxide, which rises up in the shaft again unites with oxygen of the ore.

PRECAUTIONS FOR SUCCESSFUL OPERATION

In connection with an electric pig iron furnace, there are several factors which must be taken into consideration, but which are of no consequence in a blast furnace. The operation is very sensitive and requires careful attention, a fact perhaps better illustrated by a short account of some of the more common operating troubles.

It is of the utmost importance that the amount of carbon charged is carefully adjusted to the oxygen in the ore. If too much carbon is charged, the excess can not be burned, but accumulates in the hearth, causing "hot runs" with their accompanying troubles. If, on the other hand, insufficient carbon is charged, the reduction will be incomplete. The slag will be dark with a high



FIG. 1. DOMNARFVET STEEL WORKS
THE IRON TAPPING PIT

content of iron and the furnace will run cold. Disturbances of the state of equilibrium between carbon and oxygen may be caused either by variations in the composition of the charge or, which is more common, by variations in the carbon dioxide content of the gas. The ratio $\text{CO}_2 : \text{CO}$ is, as in a blast furnace, influenced by several factors, as for instance the temperature, the pressure, the size of the charcoal, etc. Assuming that the run is otherwise satisfactory, if this ratio is changed so that CO_2 is increased, there will be an excess of carbon burned up in the hearth. The amount of carbon charged is the same, but a certain part of this carbon will unite with more oxygen than before, and consequently a residue of carbon is obtained which cannot be burned. By accumulations of carbon in the hearth, the space required for the reactions becomes smaller, the temperature increases, and the rate of melting decreases. This causes the CO_2 content to increase still more and conditions become still worse. Finally, the zone of reaction will come up close to the shaft and the energy put into the furnace will not cover the losses. The furnace will then come to a standstill.

If for some reason the ratio $\text{CO}_2 : \text{CO}$ is changed so that CO_2 is decreased, the conditions will be just the opposite. The rate of melting will increase, the pig iron will become cold, and the slag will be very unsatisfactory. Also in this case a minor disturbance will show a tendency to multiply itself, due to the fact that the increased rate of melting causes the percentage of CO_2 to decrease still more.

The problem of overcoming these troubles presented a good deal of difficulty at the start. This was particularly the case with hot runs with an excess of carbon in the hearth. To decrease the carbon or to increase the ore, as would be done in a blast furnace, proved to be ineffective. It was difficult to make the proper adjustment, and, through the decreased rate of melting, it took a long time before any change in the charge could make itself felt in the hearth. Frequently it was only a temporary disturbance which caused the trouble, and if the charge was changed permanently, it might cause the furnace to change from one extremity to the other. While adjusting the operation in this way, the equilibrium of the furnace proved to be very unstable and during long periods hot runs might change to cold runs and vice versa, with excess or want of carbon in the hearth.

The simplest way to correct hot runs for instance would be to charge a certain quantity of ore directly into the hearth, corresponding to the excess of carbon. It has also been suggested to combat it by sprinkling water on the charge through the gas intakes. Both these methods have been tried, but they are difficult of application. It has been found that the best way to restore equilibrium between carbon and oxygen is to add only one or two charges of ore or charcoal without making any permanent change in the burden. This is changed only when the furnace shows a decided tendency to run hot or cold. It would of course be better to prevent the disturbances altogether, and it is advisable to observe carefully the composition of the gas and at the first sign of departure from normal limits make the necessary adjustments.

Another peculiarity with the electric shaft furnace is the difficulty of regulating the temperature of the pig iron when the furnace is running normally. An increase in the amperage does not increase the temperature of the iron tapped, but only increases the rate of melting. It is true that an increase of carbon in the charge will make hotter iron, but at the same time, due to excess carbon in the hearth, it will cause grave disturbances. It seems that pig iron attains only that temperature which is necessary for the reactions in the hearth to take place. The superheating desirable to avoid losses in runners and skulls during tapping and transportation of the iron is often very difficult to obtain.

OPERATING DATA

In the accompanying table is a tabulation of analyses of raw materials and products at the electric furnaces at Domnarfvet together with some operating data.

The ore is taken from Grangesberg deposits and is a mixture of magnetite and specular hematite. Phosphorus analyzes about 1 per cent, somewhat too low to obtain the desired content of phosphorus in the pig iron. Some apatite is therefore generally added, also some manganese ore or slag high in manganese to raise the manganese content. As the ore, as well as the charcoal, is practically free from sulphur, and the silica content of the ore is relatively low, only a small amount of limestone is needed as addition to the charge in order to obtain the desired composition of the slag, which in turn is used for the manufacture of cement.

Gas from electric furnaces is considerably richer than ordinary blast-furnace gas and is an appreciable item on the credit side of the electric furnace account. The excess of gas has been estimated at 400 to 600 cu. m. per ton of pig iron. At Domnarfvet it is used for burn-

OPERATING DATA AT DOMNARFVET

Iron Ore		Slag	
Fe ₂ O ₃	64.96 (Fe = 61.49)		
Fe ₂ O ₄	20.64		
FeO.....		0.87 (Fe = 0.68)	
MnO.....	0.19	0.96	
MgO.....	1.79	12.57	
CaO.....	4.00	38.83	
Al ₂ O ₃	2.00	12.06	
SiO ₂	4.20	32.82	
P ₂ O ₅	2.40 (P = 1.05)	0.64	
Pig Iron		Gas	
C.....	3.6-4.0%	CO ₂	25%
Si.....	0.5%	CO.....	65%
Mn.....	0.75%	H.....	8.5%
S.....	0.02-0.015%	N.....	1.5%
P.....	1.8-2.15%		
Materials required per ton of pig iron:			
Iron ore, kg.....		1,720	
Limestone, kg.....		60	
Charcoal, kg.....		370	
Power, kw.-hr.....		2,400	
Electrodes, kg.....		8	

ing limestone or, mixed with producer gas, in open-hearth furnaces. On account of its high content of carbon monoxide, this gas is very poisonous and great care must be exercised to guard against leaks in the tanks and piping.

NON-CHARCOAL REDUCING AGENTS

A question which is of vital importance for the future of the electric pig iron furnaces is the possibility of using some other reducing agent than charcoal. If the electric iron industry at Domnarfvet is to be further developed, its maximum capacity will be determined by the supply of charcoal, not of power, since supply of the former will give out sooner than the supply of the latter. On account of the much increased demand for paper and paper pulp, the competition for wood for making charcoal has become very active. The prices threaten to increase so as to make the manufacture of charcoal prohibitive and the charcoal ovens will soon be run only on wood refuse.

If the utility of the electric pig iron process in Sweden is to be limited by the amount of charcoal available, it will be so much more circumscribed in other countries which have a large supply of water power but lack charcoal. Other reducing agents which may be considered are coke and anthracite.

Tests with coke have been made at Domnarfvet. It was shown that a mixture of coke and charcoal, with 50 per cent of each, could be used without causing trouble, but when a higher percentage of coke, or coke alone was used, the results obtained were poor. The output decreased considerably and the power consumption per ton of pig iron increased. This fact may be explained by the comparatively low electric resistance and high density of coke as compared with charcoal, resulting in decreased velocity of reaction. Another inconvenience consisted in the tendency of the coke to graphitize at the high temperature prevailing around the arcs. Graphitized coke reacts only very slowly with the oxygen in the ore. Hot runs, with accompanying evils, became on account of this still worse, as once an excess of carbon was obtained it was difficult to burn. Actual tests with coke at the Domnarfvet electric furnaces have definitely proved this fact, that the troubles on account of hot runs were considerably greater when running with coke than with charcoal.

With this exception, there were no technical difficulties in connection with operation with coke, but our economical results were poor on account of the lowered production and the increased power consumption. To



FIG. 6. DOMNARFVET STEEL WORKS
Houses for Workmen

pronounce the Electrometals furnaces as unsuitable for operation with coke or anthracite on account of these tests would be incorrect. Domnarfvet furnaces were designed in view of operation with charcoal exclusively and it is evident that operation with coke requires a somewhat different design, as is the case with blast furnaces. What this difference is is not yet determined, at least not on the basis of actual tests. An answer to this question will doubtless be had in the near future, as it is said that plans to try out coke are maturing at several places.

PIT VERSUS SHAFT FURNACES

Another interesting question in connection with electric smelting of ore is the possibility of using simpler and cheaper furnaces than the relatively complicated shaft furnaces, such as the open furnace of about the same type that is used for making ferrosilicon. Although tests with this kind of furnace considerably antedated the tests with shaft furnaces, these latter furnaces have been successfully developed, while the open furnaces have not yet passed the experimental stage. It might be justly asked why pig iron cannot be made in an open furnace as well as ferrosilicon, which is more difficult to reduce. The answer is that technically there is no difficulty in making iron in an open furnace, but economically it is more advantageous to make it in a shaft furnace. Under normal conditions—i.e., with low fuel prices—the difference in the cost of production between blast-furnace iron and electric pig iron is so small that only a very small difference in favor of the former will make the latter impossible. In an open furnace, the consumption of charcoal and power are both greater than in a shaft furnace. The lower temperature of the escaping gases and their higher CO₂ content mean a more effective utilization of power as well as of charcoal. In addition, the excess gas may be used for generating power or heat, something which is done at all large electric pig iron plants. Against these advantages, the open furnace can show a lower cost of installation and possibly a certain adaptation for a variation in the grade of iron produced. Such a furnace may for instance without any difficulty be made to produce pig iron instead of ferrosilicon. However, the possibilities may be of great practical importance in isolated cases.

Domnarfvet is probably one of the few plants where both types of furnaces have been run at the same time on a large scale. The tests were decidedly in favor of the shaft furnaces, and future installations would on that basis probably be made along the same general lines.

Interconversion Tables and Chart for Units of Volume and Weight, and Energy

c 1 1 1 2 3 4 5 6 7 8 9 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100															
MULTIPLY BY															
TO CONVERT FROM	To Cu. in.	To Cu. Ft.	To Cu. Yd.	To Fl. Oz.	To Pint	To Quart	To Gallon	To Grain	To Oz. Troy	To Oz. Av.	To Lb. Troy	To Lb. Av.	To CC. or G.	To Ltr. or Kg.	To Cu. M.
Cu. in.	1.00000	.035787	.02143	.554112	.034632	.017316	.004329	252.891	.526857	.578037	.043905	.036127	16.3871	.016387	.01639
Cu. Ft.	1728.00	1.00000	.037037	957.505	59.8442	29.9221	7.48052	436996	910.408	998.848	75.8674	62.4280	28316.9	28.3169	.028317
Cu. Yd.	46656.0	27.0000	1.00000	25852.6	1615.79	807.896	201.974	117990	24581.0	26968.9	2048.42	1685.56	764556	764.556	.764556
Fl. Oz.	1.80469	.001044	.03868	1.00000	.062500	.031250	.007813	456.390	.950813	1.04318	.079234	.065199	29.5736	.029573	.02957
Pint	28.8750	.016710	.06189	16.0000	1.00000	.500000	.125000	7302.23	15.2130	16.6908	1.26775	1.04318	473.177	.473177	.04732
Quart	57.7500	.033420	.001238	32.0000	2.00000	1.00000	.250000	1460.45	30.4260	33.3816	2.53550	2.08635	946.354	.946354	.09463
Gallon	231.000	.133681	.004951	128.000	8.00000	4.00000	1.00000	58417.9	121.704	133.527	10.1420	8.34541	3785.42	3.78542	.003785
Grain	.003954	.02288	.08475	.002191	.01369	.06850	.01712	1.00000	.002083	.002286	.01736	.01428	.064799	.06479	.06479
Oz. Troy	1.89805	.001098	.04068	1.05173	.065733	.032867	.008217	480.000	1.00000	1.09714	.083333	.068571	31.1035	.031104	.03110
Oz. Av.	1.72999	.001001	.03708	.958608	.059913	.029957	.007489	437.500	.911457	1.00000	.075255	.062500	28.3495	.028350	.02835
Lb. Troy	22.7766	.013181	.04882	12.6208	.788800	.394400	.098600	5760.00	12.0000	13.1657	1.00000	.822857	373.242	.373242	.03732
Lb. Av.	27.6799	.016018	.05933	15.3378	.958611	.479306	.119826	7000.00	14.5833	16.0000	1.21528	1.00000	453.593	.453593	.04536
CC or Gram	.061024	.03531	.01308	.033814	.002113	.001057	.02642	15.4323	.032151	.035274	.002679	.002205	1.00000	.001000	.000001
Liter or Keg.	61.0237	.035315	.001308	33.8140	2.11337	1.05669	.264172	15432.3	32.1507	35.2739	2.67923	2.20462	1000.00	1.00000	.001000
Cu. M.	61023.7	35.3146	1.30795	33814.0	2113.37	1056.69	264.172	154320	32150.7	35273.9	2679.23	2204.62	1000000	1000.00	1.00000
Note. The small subnumeral following a zero indicates that the zero is to be taken that number of times; thus, .01428 is equivalent to .0001428.															
Values used in constructing table: 1 lb. av. = 453.5926 g. 1 lb. av. = 7000 grains.															
1 inch = 2.540001 cm. ∴ 1 gal. = 8.34541 lb. ∴ 1 gallon = 58417.87 grains.															
∴ 1 cu. in. = 16,387083 cc. = 16.387083 g H ₂ O at 4°C. ∴ 1 lb. av. = 27.679886 cu. in. H ₂ O at 4°C. 231 cu. in. = 1 gallon = 3785.4162 g.															
4°C. = 39°F.															
A 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100															
MULTIPLY BY															
TO CONVERT FROM	B. T. U.	P. C. U.	Cal.	Ft. Lbs.	Ft. Tons.	Kg. M.	HP Hrs.	KW Hrs.	Joules	Lbs. C	Lbs. H ₂ O				
B. T. U.	1.00000	.555556	.251996	778.000	.389001	107.563	.03929	.02931	1055.20	.06876	.001031				
P. C. U.	1.80000	1.00000	45.3593	1400.40	.700202	193.613	.07072	.05276	1899.36	.01238	.001855				
Calories	3.96832	2.20462	1.00000	3091.36	1.54368	426.844	.001559	.001163	4187.37	.02729	.004089				
Ft. Lbs.	.001285	.07141	.03239	1.00000	.000500	.138255	.05050	.03767	1.35625	.078840	.01325				
Ft. Tons	2.57069	1.42816	.647804	2000.00	1.00000	276.511	.001010	.07535	2712.59	.01768	.002649				
Kg. M.	.009297	.005165	.002343	7.23301	.003617	1.00000	.03653	.02725	9.81009	.06394	.09580				
HP Hrs.	2544.99	.141388	641.327	1980000	.990.004	273747	1.00000	.746000	2685473	.175044	2.62261				
KW Hrs.	3411.57	1895.32	859.702	2654200	1327.10	366959	1.34041	1.00000	3599889	.234648	3.51562				
Joules	.09477	.05265	.02388	.737311	.03687	.101937	.03724	.02778	1.00000	.06518	.09766				
Lbs. C.	14544.0	8080.00	3665.03	113150	5657.63	1564396	5.71434	4.26285	153470	1.00000	14.9876				
Lbs. H ₂ O	970.400	539.111	244.537	754971	377.487	104379	.381270	.284424	1023966	.066744	1.00000				
"P. C. U." refers to the "pound-centigrade unit." The ton used is 2000 pounds. "Lbs. C" refers to pounds of carbon oxidized, 100% efficiency equivalent to the corresponding number of heat units. "Lbs H ₂ O" refers to pounds of water evaporated at 100°C. = 212°F. at 100% efficiency															
C1 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100															

By the use of the foregoing table¹ about 330 inter-conversions among twenty-six of the standard engineering units of measure can be directly estimated from the alignment chart to three significant figures or calculated by simple multiplication to six figures. The multiplier factor given in the table is located on the center scale "A" giving the point which when aligned with any number point on "C1" determines the product on

"C." Imperfections in the scale due to lack of precision in printing should be checked at intervals along "A" scale by actual division of "C" by "C1," the lines being left out so that the reader can do this. A line scratched on a transparent celluloid triangle gives the best medium for making alignments.

When volume and weight interconversions are given, water is the medium the calculations are based upon. By the introduction of specific gravity factors the medium can be changed, giving the weight of any volume of any material, etc.

¹Compiled by and published by the courtesy of the engineering staff of the du Pont company.

Extraction of Juice From the Sugar Beet

Brief Outline of Modern Practice in the Beet-Sugar Refinery—Fluming and Washing—
Design of Equipment—Diffusion Cell and Battery—Effect of
Temperature on Purity

BY WALLACE MONTGOMERY

THE advances made in chemical engineering during the past few years have not been adopted as readily by sugar manufacturers as by other industrial concerns. They have recently awakened to the fact, which is made evident by their increased rate of production as compared with earlier years. The harvesting season being short, the factories are forced to lie idle for many months of the year. This fostered the tendency on the part of the owners to be conservative regarding changes unless thoroughly proved of value.

The manner of harvesting and transporting beets has changed considerably, but there is still unlimited opportunity for improvements. The manufacturing operations proper have to deal with the beet after it has been delivered into the storage bins, and the resulting products from the working up of the beet.

The beets are flumed into the factory by water from the tail pipes of condensers, the amount of which water should not be less than 950 to 1,000 per cent on beets handled. A larger quantity insures an adequate supply of beets at all times. The fluming of the beets is beneficial in that much of the adhering particles of the dirt is removed, also trash and tops are separated. There is some water absorption during the time the beets enter the water until they are taken up in elevator to scales. This has been found to vary with the temperature of the water and the class of beet, though 0.2 per cent is an approximate figure. The beets pass over separators to remove rocks or any foreign substance.

BEET WATER

A drawing of one type of equipment for removing the beets from the flume and placing them in the washer is shown in Fig. 1. The wheel revolves and picks up the beets, allowing them to drop into the washer, from which they are worked toward the farther end by paddles, a continual stream of water flowing through the washer at all times. From the washer the beets pass over a picking table or series of rolls as in this particular case, these rolls being set just far enough apart to keep the beets moving but allowing any small pieces or tailings to drop through to a separator directly below.

For a number of years the tailings and broken pieces of the beets removed from the picker were either thrown away or used as feed for hogs. At present it is the usual practice to work them up along with the

whole beets. The quantity of tailings will vary greatly, as also will the sugar content. A specific case in which the author conducted a test over practically an entire campaign gave the following results:

	Per Cent
Tailings on beets worked.....	0.2
Sugar in tailings.....	7.40
Apparent purity.....	80.00

Scrolls are also used in elevating beets from flume to pickers or washer, and one large American factory uses an air lift successfully.

From the rolls or picking table the beets are discharged into an elevator and are then carried up to the top floor of the factory, where they are discharged into a hopper and through some form of scales where the weight for the factory control is obtained. The checking of the scales is very important, as a slight error here throws off the entire results throughout the house.

From the scales the beets drop into a hopper and feed into the cutters, where they are sliced into V-shaped slices called cossettes. The cossettes enter the diffusion cells, where the first important step in sugar manufacture takes place—the extraction of the sugar in the cossettes by diffusion—and the handling of the diffusion juice calls for continuous control and care to prevent unnecessary losses and to keep the unavoidable losses within reasonable limits.

Fig. 2 shows the construction of a diffusion cell.

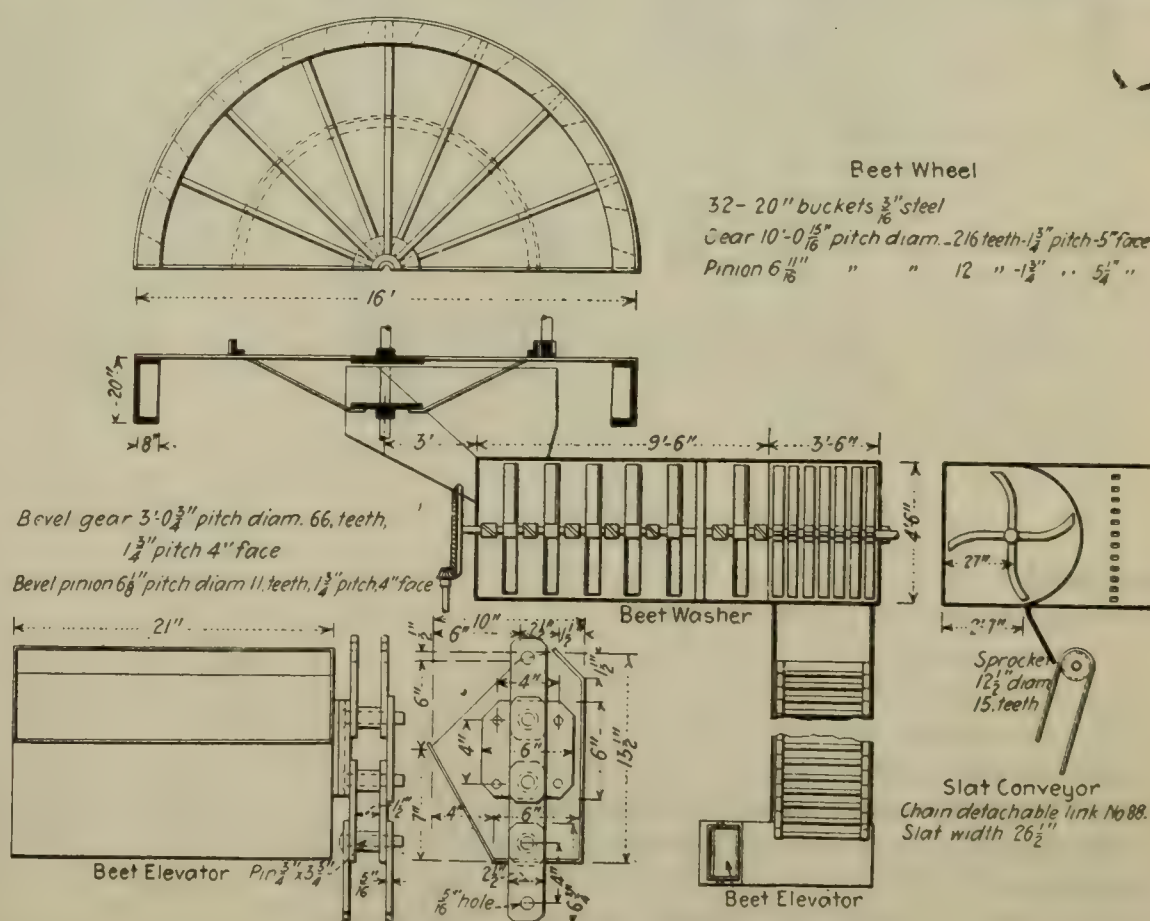


FIG. 1. BEET WHEEL WASHER AND ELEVATOR

These cells are arranged either circularly or in a straight line, known as circular battery and straight battery. Both have advantages, though in economy of space and ease of manipulation a circular battery is to be preferred.

There are a number of processes and methods of diffusion. That of Naudet has recently attracted most attention. Fig. 3 shows a Naudet battery in plan.

The losses taking place at the batteries may be calculated from the following data obtained from the laboratory where analyses are being made continuously upon all products.

	Per Cent
Sucrose in beets.....	18.50
Purity (apparent).....	84.00
Battery Losses:	Per Cent on Beets
Sugar in pulp.....	0.16
Sugar in pulp water	0.05
Total known loss	0.21
Total sugar entering house = 18.50 — 0.21 = 18.29 per cent	
Giving a battery extraction of 98.86 per cent of suger in beets and a loss of 1.14 per cent of sugar in beets.	
Assuming the analysis of the diffusion juice to be:	
Brix, deg.	14.00
Per cent sucrose	11.69
Apparent purity, per cent	83.50
Ash, per cent	0.62
Then the total solids entering house would be	
$18.29 \times \frac{100}{83.50} = 21.91$ per cent on beets	
Non-sugars entering house are:	
$21.91 - 18.29 = 3.62$ per cent on beets	
Organic non-sugars are:	
$3.62 - 0.62 = 3.00$ per cent on beets	

THE PERCENTAGE DRAFT

The percentage draft or amount of juice drawn from the diffusion battery varies from 125 to 160 per cent on

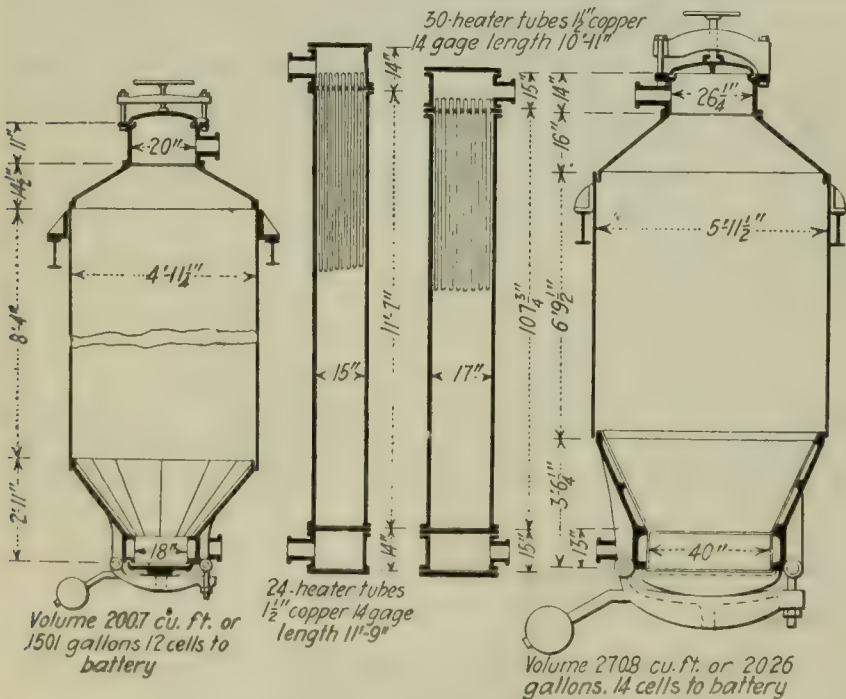


FIG. 2. DIFFUSION CELLS

beets and in some cases may be even higher. From our previous calculation the draft would be

$\frac{18.29}{11.69} \times 100 = 156.5$ per cent

The percentage draft is held at a point where the losses are the lowest and the juice still of sufficient density to not require excessive evaporation.

The amount of steam necessary for diffusion varies considerably, due to the temperature of battery water, temperature of beets and temperature of juice drawn. Usually 2.5 to 5.5 per cent on beets worked will suffice.

To calculate the time of diffusion or the average time one cell remains in circulation we must know the total number of cells made each twelve hours and the number of cells over which circulation is carried, assuming that on a 14-cell battery 100 cells were made in twelve hours and the circulation carried over twelve cells.

Then time of diffusion = $\frac{14}{100} \times 12 = 1.68$, or 1 hour 41 min.

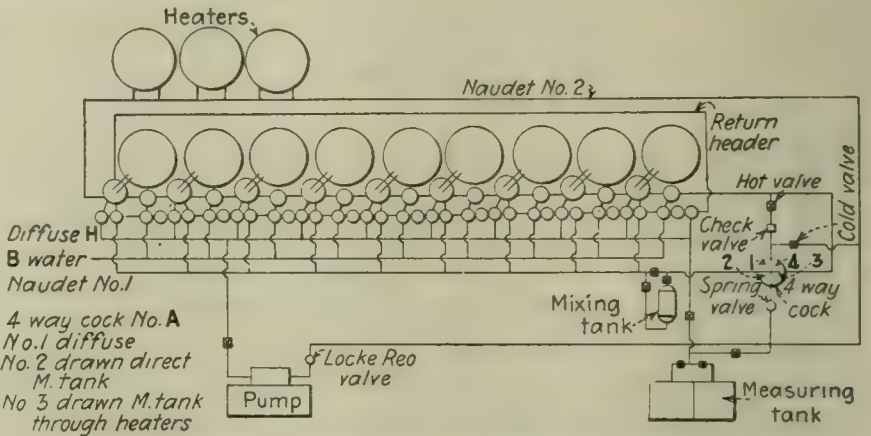


FIG. 3. PLAN OF NAUDET BATTERY

By per cent fill in battery is understood the pounds of beets per each 100-lb. capacity of the cell space of water.

Assuming cell capacity to be 200 cu.ft., or 56.6 hectoliters,
Number of cells worked 170
Tons beets worked 600
Cell capacity, 200 cu.ft. $\times$ 62.3 = 12,460 lb. water
Tons beets per cell = $\frac{600}{170} = 7,040$ lb.
Percentage fill = $\frac{7,040}{12,460} = 56.5$ per cent

TEMPERATURE AND PURITY OF PRODUCT

The varying purity and sugar per cent in the different cells is shown by Fig. 4. This varies, of course, but under ordinary conditions the curve is approximately the same. The figures above the curve denote the temperature of each cell, and those below indicate thr percentage of sucrose in each cell at the time samples were taken.

The regulation of temperature is of the utmost importance and in no case should it exceed 97 deg. C. The beets will to a certain extent determine what temperatures may be carried, because with a well-matured beet high temperature causes the pulp to become mushy and very hard to dump from the cells. With firm beets not quite ripe higher temperatures may be carried,

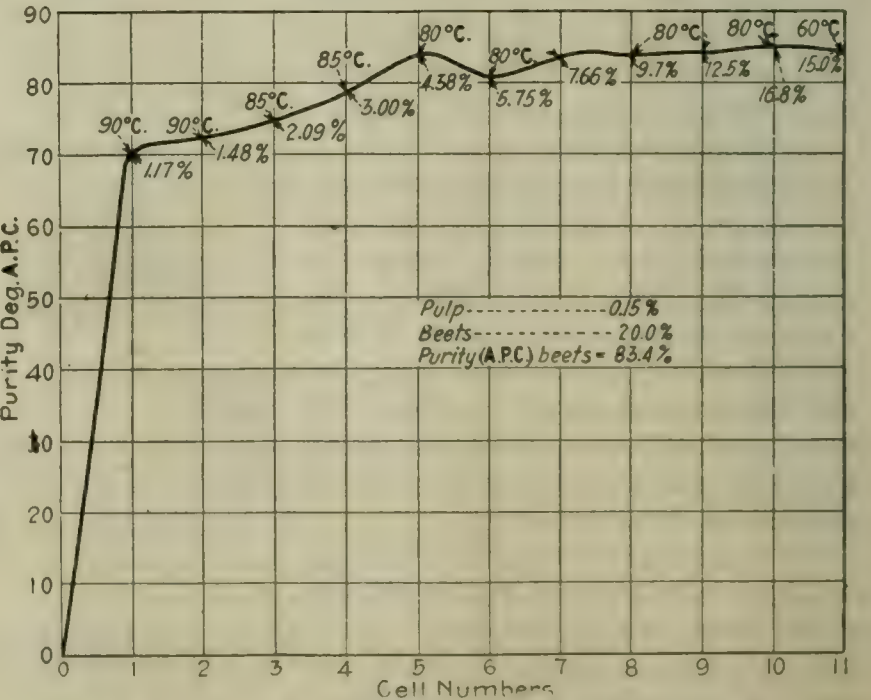


FIG. 4. CURVE SHOWING VARYING PURITIES OF BATTERY

though the amount of gums freed from the pulp is very detrimental to the further working up of juice and so offsets any gain in extraction.

The pulp of diffused cossettes is 80 per cent by weight on beets worked, while waste, the water remaining in the cell at time of discharging, amounts to 150 per cent on the weight of the beets. The discharging of the exhausted cossettes in nearly all modern factories is done by mechanical means, the bottom door being operated by hydraulic pressure governed by an operator above. Fig. 2 shows an old type door operated by hand, which in closing and locking properly takes too much time. One of the most ingenious improvements relating to the battery is the water inflated gasket for bottom of cell doors. This consists of a heavy circular rubber tube on the same order as an inner tube for automobile tires. When the door is to be opened the pressure is released from the gasket. After closing the door again, the gasket is inflated, thereby making a tight joint and preventing leakage from the cell bottom, the door and bottom of cell being grooved to receive this gasket. No

attention is required, only examination occasionally. The pulp and waste water are removed from battery pit by centrifugal pumps and sent to a silo, where the water drains off and the pulp remains to be used as cattle feed, or else it is sent directly to the drying department, where it passes through a press or series of presses. It is then dried in large rotary driers heated by steam or hot gases obtained from furnaces in which oil is burned.

The pulp, as it enters the drier is of the following composition:

	Per Cent
Moisture	93.0 — 95.0
Sucrose	0.32 — 0.45

After passing through the presses the moisture is about 83 to 85 per cent, and from the driers ready for sacking contains only 11.5 to 12.5 per cent moisture, and about 32 to 35 per cent will pass through a 10-mesh sieve. The pulp contains about 0.50 to 0.55 per cent sugar.

Union Sugar Co.,
Betteravia, Cal.

Heat of Dissociation of Iron Pyrites

BY HEIHACHI KAMURA

THE object of this investigation was to find the heat absorbed in the decomposition of iron pyrites, FeS_2 , into FeS and sulphur vapor. Previous attempts to measure this calorimetrically had not succeeded, and up to the present the heat of formation of pyrites from FeS and sulphur vapor is unknown.

Following the suggestion of Dr. J. W. Richards, the author measured the decomposition pressures at which sulphur vapor is given off by iron pyrites at different temperatures, with the object of finding the decomposition pressure curve, and thence deducing thermodynamically the heat absorbed in the decomposition.

Temperatures were measured by a platinum-iridium thermocouple. Pressures were measured directly upon a mercury pressure gage.

The experimental results are contained in the accompanying diagrams. Fig. 1 is the plot of the pressure in millimeters of mercury against the temperature in degrees C.¹

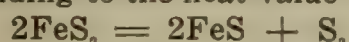
Fig. 2 is a plot of the results showing logarithm of the pressure against the reciprocal of the absolute temperature. It will be seen that they conform reasonably well to a straight line relation between these quantities.

Fig. 3 shows the plot of the same observations extended to zero value of $\frac{1}{T}$, in order to illustrate the relation in its entirety, corresponding to

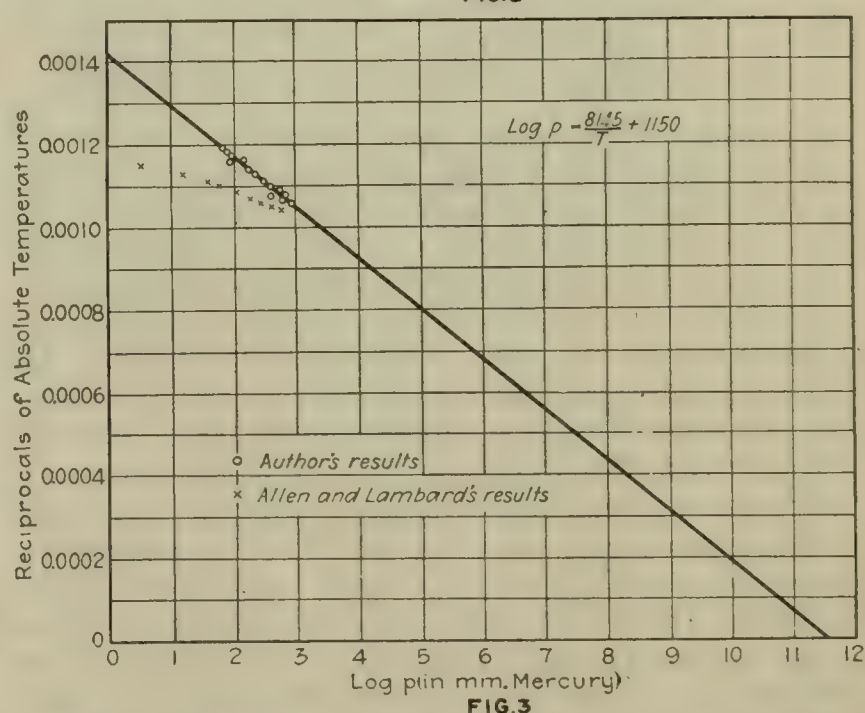
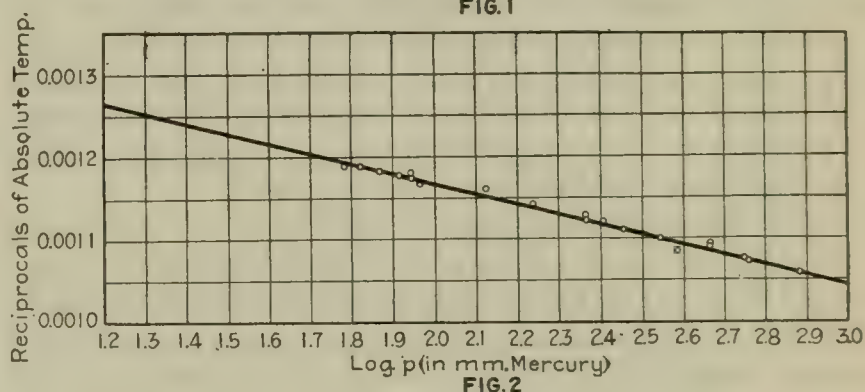
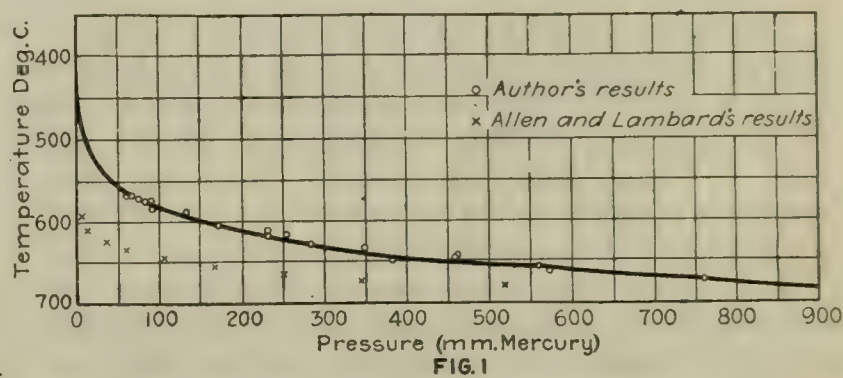
$$\log p = -\frac{8145}{T} + 11.50$$

which is the formula deducible from my experimental data.

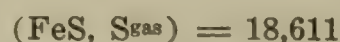
The constant 11.50 in the above equation corresponds fairly well with that obtained for other similar decomposition pressure equations, there being a tendency for this value to lie between 9 and 12 for all decomposition pressures. The thermodynamic discussion of this formula makes Q , the heat of decomposition per molecular volume of sulphur vapor formed, $4.57 \times 8,145 = 37,223$, corresponding to the heat value of the equation



¹The results of similar experiments recorded by Messrs. Allen and Lombard in the *American Journal of Science*, 1917, vol. 43, p. 175, are shown for comparison.



We can, therefore, write the value of the heat absorbed per atom of sulphur or, rather, conversely, the heat evolved in the combination expressed thermochemically as follows:



Metallurgical Department,
Lehigh University.

Who Is Entitled to Inventions?

BY CHESLA C. SHERLOCK

INVENTIONS and the right to ownership in them have caused a good deal of litigation in our courts. The question of ownership in an invention must be determined before the right to the patent can be thoroughly established. And it is because of the value of the patent monopoly that the question of ownership is so bitterly contested before the courts.

The patent laws contemplated that the actual inventor of the new appliance should be the sole person entitled to the letters patent, and the law is so worded. It was not contemplated that the ownership could be vested in anyone but the actual inventor, especially in the earlier days of our patent history. But of later years it became apparent that persons other than the actual inventor might have a legitimate interest in the ownership of the fruits of his skill or inventive genius.

RIGHTS OF INVENTOR WHEN HE IS HIRED TO WORK ON INVENTION

The most common case is where an employer hires one of an inventive turn of mind on a stipulated salary to work on some appliance or invention for the benefit of the employer's trade or business. If the inventor fails to bring forth the desired invention, then the employer is the loser in the salary paid to the employee during his period of experimentation.

But suppose that the employed inventor does, in fact, succeed in bringing forth the invention which the employer has asked for? Suppose that the employer has paid him the stipulated salary, but that when the invention is a success the inventor claims that the invention belongs to him solely and he refuses to assign the patent rights or the ownership in it to the employer? What are the rights of the respective parties?

This is a question which has been so thoroughly threshed out by the courts that the principles are generally accepted as being settled. It will not be necessary for us to cite cases, unless someone comes forward and wants them to substantiate the principles here announced as to the rights of the respective parties.

COURTS SEEK TO PROTECT ACTUAL INVENTOR

The courts will make every effort to preserve the rights in the invention in the actual inventor. This does not mean that they will seek to ignore existing agreements or contracts or fail to take into consideration all the facts and circumstances surrounding each case.

The point is that the actual inventor is the one to be protected in all cases consistent with justice. He is the one for whom the whole theory of patent rights and privileges was first promulgated; he is the one to be favored and secured in any rights in danger.

But where an employer has expressly contracted with an inventor prior to the invention of a given appliance, method or machine, upon the express understanding that any rights which the inventor may have in the invention are to become the sole property of such employer in consideration of the stipulated salary, then the courts will take cognizance of this agreement and the right of ownership in the invention rests in the employer. This is practically the only case in which the employer of an inventor can step in and acquire any rights in the invention. And it is well to mark this fact.

Take a case where an employee, not expressly employed

to perfect an invention, does bring forth an invention having commercial value. Does the employer have a right to share in the ownership on the theory that the employee learned things of advantage or used the knowledge and skill obtained on the employer's time in perfecting his invention?

EMPLOYER HAS NO RIGHT IN EMPLOYEE'S INVENTION EXCEPT BY SPECIAL PRIOR CONTRACT

It is the general rule that the employer has no right in the inventions of an employee unless they have expressly contracted concerning said invention. Employees are not deprived of their rights to an invention merely because they happen to be in the employ of another at the time they perfect their patentable ideas. To recognize any such rule would serve to defeat the very purpose for which the patent privileges were originally granted under the Constitution.

Inventions arising casually out of an employee's association with an employer, then, are not subject to any property rights vesting in the employer. The only instance where an employer can secure an interest in an invention perfected by an employee is for him to enter into a valid contract which grants him such right *prior* to the perfection of said invention, or an assignment of the rights in the patent subsequent to it.

CONTRACT MUST BE WRITTEN AND ENFORCEABLE, NOT A MERE UNDERSTANDING

It is well to pause right here and make it plain that this agreement must be in the form of a contract which can be enforced in the courts. A mere mutual understanding that the employer is to have all rights or a share in the ownership of an invention which the employee is to bring forth is not sufficient to confer that right upon the employer. The presumption in such a case would be against the employer and in favor of the actual inventor.

The contract must be a written agreement and, as such, enforceable at law. This means that it must be for a valid consideration, made by proper parties and for a lawful object. Failing in this, the employer will only be the loser and there is no redress for the wrongs he suffers.

If the employee has permitted his employer to use the invention, the law presumes that the employee or inventor has granted a license to such employer for the use of said invention. And this license or right to use will continue even after the employee-inventor has left the employment of the original employer.

Indigo in the Dutch East Indies

Indigo is grown on about forty estates in Java, as well as by the natives. The estate indigo contains from 60 to 80 per cent of indigotine. The native product averages only $\frac{1}{4}$ to 1 per cent of indigotine, and is for the greater part used in the island, principally for battiking, while the overproduction usually finds a market in Singapore. Before the war most of the dry indigo went direct to the Netherlands and the wet product to Singapore. In 1917 Japan entered the market for both the wet and dry product, and in the following two years took the bulk of the dry product. During 1920 Singapore was an important market for the product. The United States bought a small quantity of dry indigo in 1917, increasing its purchases in the following year, but has since been out of the market.

Cobalt Brasses*

Cobalt in Brass Acts Much Like Nickel in Brass, Despite Their Different Influence on Steel—Of All the Elements Investigated, Cobalt Is Unique in Possessing a Variable Coefficient of Equivalence

By LEON GUILLET

THE following study was made with the view of comparing the rôle of cobalt with that of nickel in Cu:Zn alloys, as presented in *CHEMICAL & METALLURGICAL ENGINEERING*, vol. 24, p. 261.

It is first necessary to give the binary diagrams of Cu:Ni, Cu:Co, Zn:Ni and Zn:Co. According to the most recent works the constitution of these different alloys are:

COPPER: NICKEL

This is a classical diagram and according to Guertler and Tammann¹ is as shown in Fig. 1. The liquidus is formed of a single branch of a curve without maximum or minimum and the solidus consists of a single branch located slightly below. Two lines representing the magnetic transformation can be noted below 320 deg. C., but no other change appears in the solid. Magnetic transformation point is rapidly lowered as the copper content is increased, varying from 330 deg. C. (626 deg. F.) to 0 deg. C. (32 deg. F.), the copper being respectively 0 and 48 per cent.

COPPER: COBALT

The copper:cobalt diagram (Fig. 2) is quite different,² approaching that for copper:iron. The liquidus indicates a transition point near pure copper. The upper branch of the liquidus is quite irregular and all alloys containing up to 80 per cent of copper melt above 1,300 deg. C. (2,375 deg. F.). The solidus is formed by a branch starting at the fusion point of cobalt (1,490 deg. C., or 2,714 deg. F.) and reaching the horizontal line corresponding to the transition point (1,110 deg. C., or 1,850 deg. F.) at a point where the copper content of the solid solution is 12 per cent. A short curved branch also starts on the transition horizontal at copper 97 per cent and ends at the melting point of pure copper.

Immediately below the solidus, in the neighborhood of pure cobalt is found a solid solution between β non-magnetic cobalt and copper (constituent I). In the neighborhood of pure copper, a zone of small extent locates a non-magnetic copper:cobalt solution (constituent II). A zone of far greater extent below the horizontal part of the solidus consists of a heterogeneous mixture of constituents I and II. But the non-magnetic solid solution becomes magnetic at higher temperatures. We therefore have various transformation lines as follows: Cobalt loses its magnetism at 1,159 deg. C. (2,118 deg. F.). This transformation point in constituent I is lowered to about 1,050 deg. C. (1,920 deg. F.). After this transformation the alloys contain a constituent III which is simply solid solution I, consisting of copper in cobalt, become magnetic. There is

also a very small zone of constituents I + III. At the extreme right of the diagram, the non-magnetic solid solution II becomes magnetic at temperatures which are approximately determined as shown by region IV.

The horizontal line at 1,050 deg. C. (1,920 deg. F.) separates mixtures of solutions I and II from mixtures of zones III + II, and the horizontal line at 955 deg. C. (1,751 deg. F.) separates the latter from a zone consisting of a mixture of solutions III + IV. It is to be noted that in the last region both solid solutions are magnetic, in the next above only the cobalt-rich solution is magnetic, and in the zone just below the solidus neither constituent is magnetic.

ZINC: NICKEL

Equilibrium in the zinc:nickel system has been studied by Tagel³ despite difficulties caused by volatilization of the zinc. Researches were made first on alloys containing up to 24 per cent nickel, but the diagram shown in Fig. 3 has subsequently been completed. The liquidus, starting from the melting point of nickel, is

³Z. anorg. allgem. Chem., vol. 57, p. 34; *Revue de Métallurgie*, vol. 4, p. 781; vol. 5, p. 413.

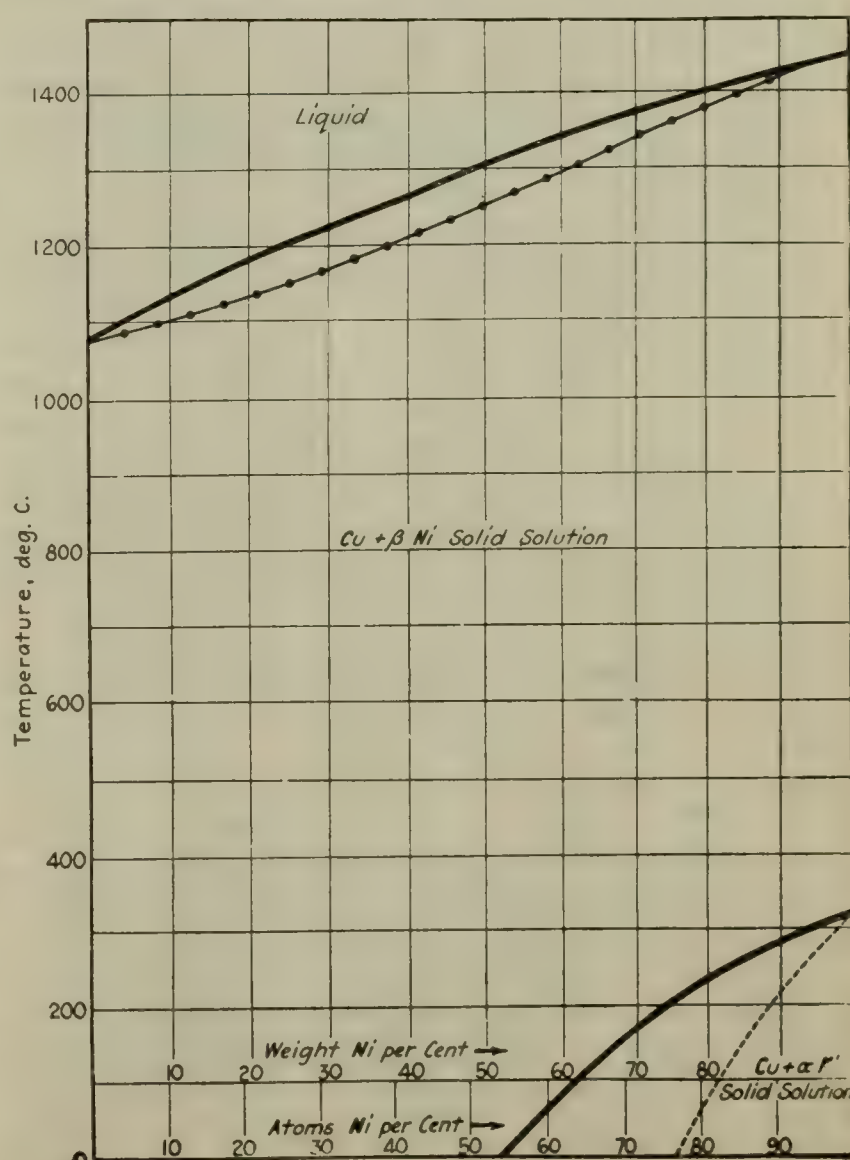


FIG. 1. BINARY DIAGRAM COPPER: NICKEL ALLOY

*From *Revue de Métallurgie*, vol. 17, No. 7, p. 494 (1920).

¹Z. anorg. allgem. Chem., vol. 52, p. 25 (1907).

²Salmen, Z. anorg. allgem. Chem., vol. 57, p. 1 (1908).

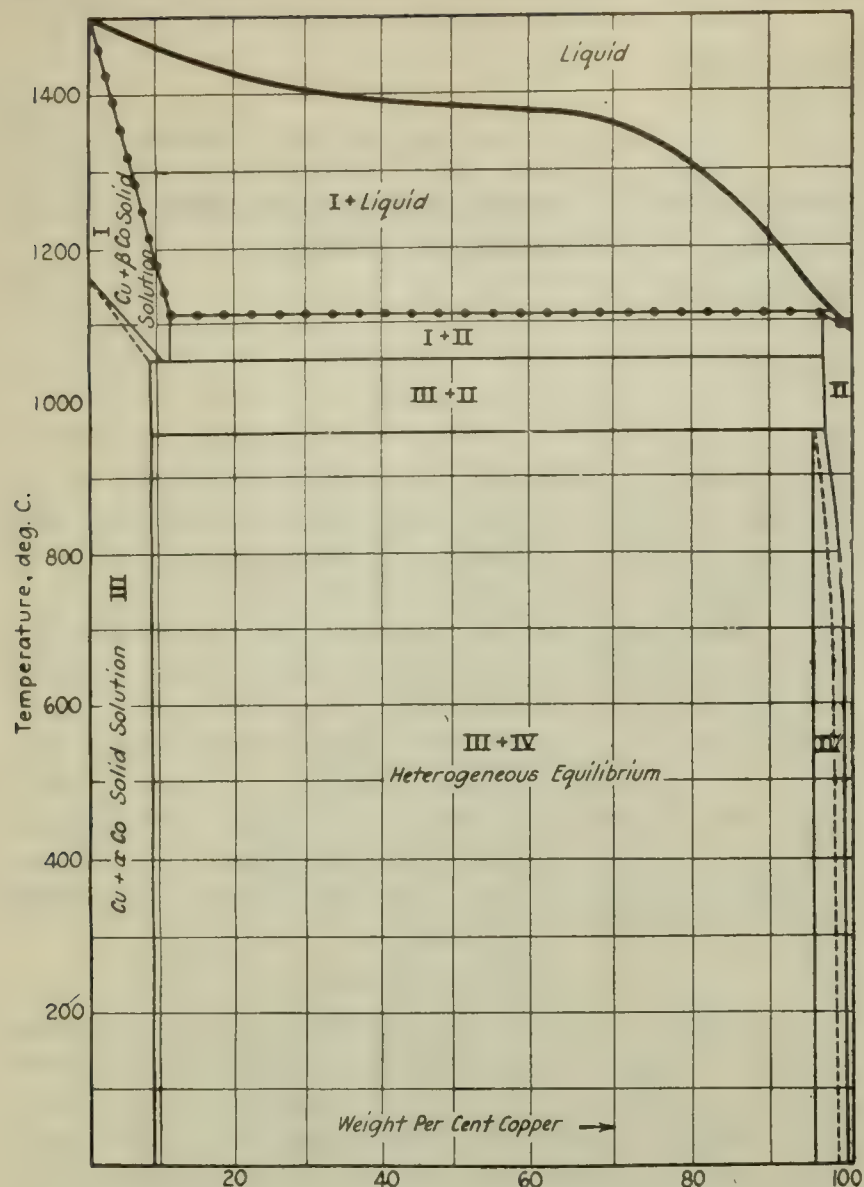


FIG. 2. BINARY DIAGRAM COPPER: COBALT ALLOY

lowered rapidly and shows a transition point at about 54 per cent zinc and 1,035 deg. C. (1,895 deg. F.), a eutectic at 870 deg. C. (1,598 deg. F.) and 73 per cent zinc and the maximum corresponding to the compound NiZn_2 fusing at 876 deg. C. (1,609 deg. F.). Beyond this maximum the liquidus drops rapidly to the melting point of zinc (419 deg. C., or 786 deg. F.).

The solidus is formed of a line starting from the melting point of pure nickel and ends in the transition horizontal at 35 per cent zinc. A new oblique line starts at approximately the transition point on the liquidus. This branch reaches the eutectic horizontal at 61 per cent zinc and this horizontal extends a little distance beyond the eutectic point. The solidus is then formed of two curved branches reaching the maximum on the liquidus at the compound NiZn_2 , the right hand being extremely steep, reaching horizontal at the melting point of zinc, following this horizontal to the end of the diagram.

The conformation of liquidus and solidus indicates the existence of: Region I, a solid solution of zinc in β nickel. Region V, a solid solution below the transition horizontal, and which may be due to a suppositious compound, NiZn . Region VII, the solid solution of NiZn_2 . A first eutectic between constituents V and VII. A second eutectic between pure β zinc and the solution containing compound NiZn_2 . (Zone VII + β Zn.)

Study of the diagram also shows other transformation points, some of which are very interesting.

At the nickel side the magnetic transformation in the solid solution is depressed until for 20 per cent nickel it does not occur above ordinary temperature. Constituent II is therefore a solid solution of zinc in magnetic nickel. At the zinc side the transformation takes place

at a constant temperature (360 deg. C., or 680 deg. F.) because the zinc retains its identity in alloys containing as high as 10 per cent nickel. The solid solution V forms a eutectoid with 59 per cent zinc at 655 deg. C. (1,211 deg. F.) between solid solution VII and constituent VI (compound NiZn). This is a good example of a chemical compound formed during the decomposition of a solid solution.

ZINC: COBALT

Zinc: cobalt has been studied by Lew Konja' as far as alloys containing 40 per cent cobalt. This portion of the diagram (Fig. 4) is very similar to the similar end of the zinc: nickel diagram (Fig. 3).

The liquidus starts from pure zinc and rises rapidly. Higher than 20 per cent cobalt the diagram could not be traced with precision. The solidus consists of a horizontal line at 414 deg. C. (777 deg. F.) starting from 87 per cent Zn and reaching over nearly to pure zinc. It would seem that the eutectic does not correspond to exactly pure zinc, but is an alloy containing about 0.5 per cent cobalt.

Constituent I is the pure β zinc; the eutectic would be formed of β zinc and a constituent III, a poorly defined zinc: cobalt solid solution. Zone III + β Zn separated by the horizontal line at 360 deg. C. from zone III + α Zn do not differ except by the allotropic state of the zinc.

To summarize:

Copper: nickel alloys are formed of a single solid solution, which is non-magnetic or magnetic depending upon the content of nickel.

Copper: cobalt alloys are composed of two conjugate

¹Z. anorg. allgem. Chem., vol. 59, p. 293 (1908).

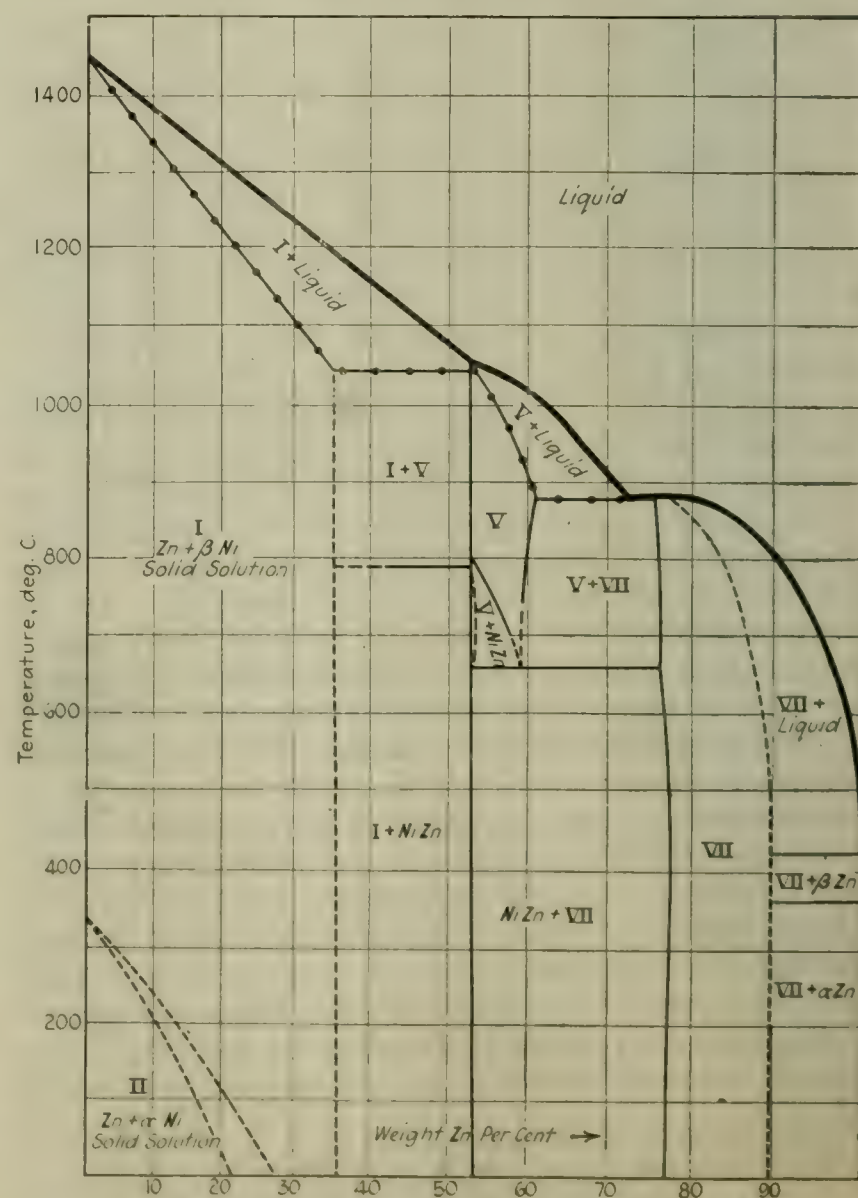


FIG. 3. BINARY DIAGRAM ZINC: NICKEL ALLOY

solid solutions varying somewhat in composition, both of which exist in the magnetic and non-magnetic forms at the proper temperatures.

Zinc:nickel alloys exist in solid solutions extending from pure nickel to 50 per cent zinc. Nickel appears to be insoluble in zinc, however. There are also two compounds, NiZn and NiZn₃, the last one appearing in solid solution in nearly all the zinc-rich alloys.

Zinc:cobalt alloys. The constitution is known only in the neighborhood of pure zinc; they are formed of pure zinc and of an imperfectly understood solid solution, as summarized in Fig. 4.

ALLOYS TESTED

In the study of cobalt brasses, the tests have been made under the same conditions as for nickel brasses.⁵

Table I shows the composition of the alloys tested. Three series were studied containing respectively about 70, 60 and 55 per cent copper, the cobalt increasing in

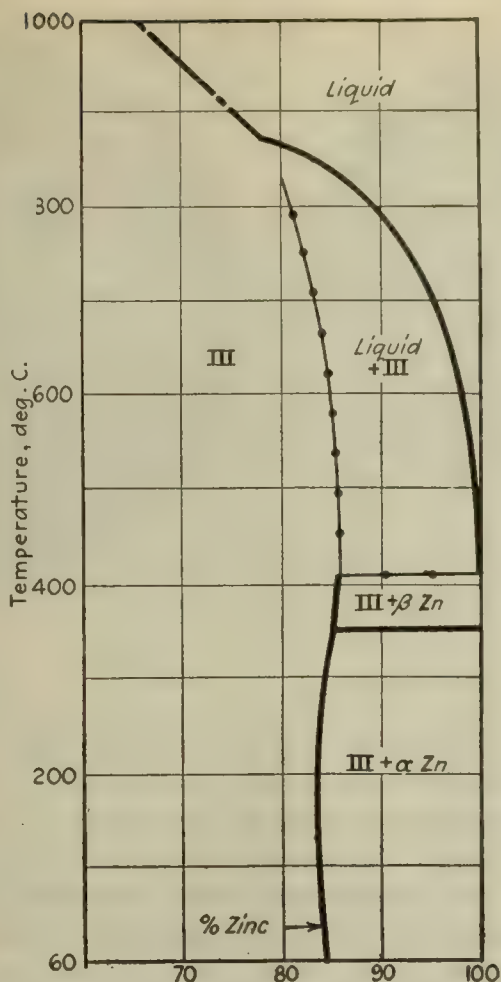


FIG. 4. BINARY DIAGRAM
ZINC: COBALT ALLOY

Fig. 5 shows the macrographs of the above three alloys at full size after etching with boiling 20 per cent ammonia persulphate solution. It is evident that the presence of cobalt has a considerable influence on the grain size.

Series B.—Brass with 60.34 Cu, 0.64 Co is formed $\alpha + \beta$ constituents. Its fictitious composition (61 per cent) as shown in the microscope is a little higher than the real. Alloy 60.50 Cu, 2.27 Co possesses a structure analogous to the above, but its fictitious composition is even higher, being around 62 per cent. Brass containing 60.48 Cu, 4.81 Co shows but little β , but has a little of a special constituent apparently the same as found in the brass 70.76 Cu, 4.35 Co of Series A (Fig. 6).

Calculating the coefficient of equivalence⁶ for cobalt from these data, disregarding the last sample, which contains a constituent other than the normal solid solutions found in brasses, it is found that the value of t varies between -0.7 and -0.1 .

Macrographs of this series again show that cobalt has a very great influence on the grain size.

Micrographs Figs. 7 and 8 (magnified 74 diameters) show the structure of these alloys.

Series C.—The three alloys with about 55 per cent copper are formed of α and β solutions, none presenting any special constituent, as may be seen in Figs. 9, 10 and 11. But it is apparent that they all present very different fictitious compositions, determination of which will serve for calculating the coefficient of equivalence t for cobalt.

Alloy 55.46 Cu, 0.78 Co has a fictitious composition of

⁶See CHEM. & MET. ENG., vol. 24, p. 177.

TABLE I. COMPOSITION OF COBALT BRASSES INVESTIGATED

No.	Analysis Wished			Analysis Obtained					Shock Tests		
	Cu	Co	Zn	Cu	Co	Zn	Fe	Pb	Total	Angle	Hard- ness
Series A	1	70	1	29	70.20	0.72	28.96	0.07	tr.	99.99	44
	2	70	2	28	70.28	1.94	27.66	0.07	tr.	99.95	76
	3	70	5	25	70.76	4.35	24.79	0.07	tr.	99.97	82
Series B	4	60	1	39	60.34	0.64	38.86	0.07	tr.	99.91	72
	5	60	2	38	60.50	2.27	37.05	0.07	tr.	99.99	71
	6	60	5	35	60.48	4.81	34.62	0.08	tr.	99.99	107
Series C	7	55	1	44	55.46	0.78	43.66	0.08	tr.	99.98	138
	8	55	2	43	55.63	2.42	41.86	0.07	tr.	99.98	104
	9	55	3	40	55.46	4.98	39.45	0.08	tr.	99.97	125

each series from 0.5 to 5 per cent. In reality the figure given for cobalt represents the sum of nickel plus cobalt, since the composition of the cobalt used in making up the alloys was 93.13 Co, 0.78 Ni, 0.90 Si, 0.17 Cu, 1.61 Fe.

MICROGRAPHIC AND MACROGRAPHIC EXAMINATION

Series A.—The alloy 70.2 Cu, 0.72 Co is formed by a single solid solution in relatively coarse crystals. It can be admitted *a priori* that it is the α solution of brasses. Alloy 70.28 Cu, 1.94 Co is also formed of a single solid solution; but with the same rate of cooling, the crystals are of much smaller dimensions than the former. Alloy 70.76 Cu, 4.35 Co (Fig. 6) contains two constituents, a solid solution whose elements are much smaller than either of the preceding, and a star-like special constituent which looks very much like one of the solid solutions in the binary copper: cobalt system.

⁵CHEM. & MET. ENG., vol. 24, p. 261.

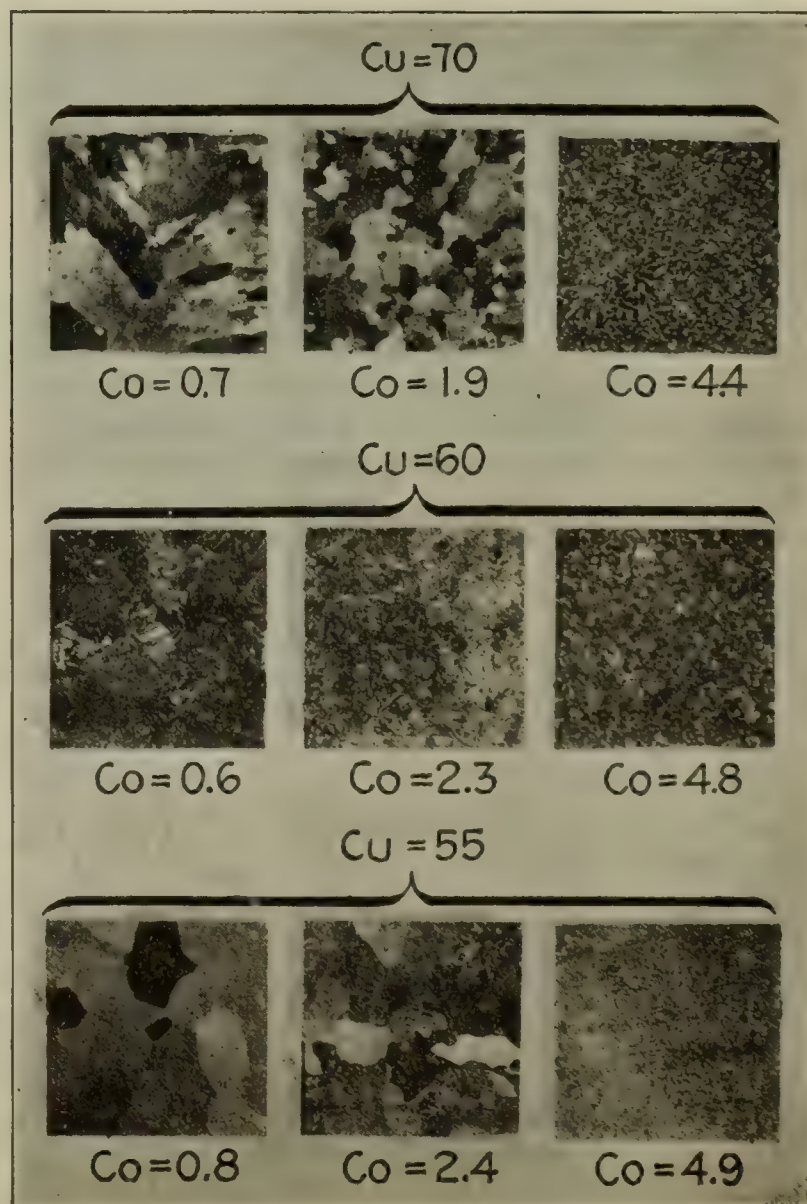


FIG. 5. MACROGRAPHS OF COBALT BRASSES



Fig. 6. 70.76 Cu, 4.35 Co brass.

FIG. 6 TO 8 (ALL $\times 55$)
Fig. 7. 60.5 Cu, 2.27 Co brass

Fig. 8. 60.5 Cu, 4.81 Co brass.

56.5 Cu, that of the alloy 55.63 Cu, 2.42 Co is 59 Cu, and that of the alloy 55.46 Cu, 4.98 Co is approximately 61 Cu. The coefficient of equivalence calculated from these values is respectively

$$t = -1.5, t = -1.4, t = -0.9.$$

Macrographs again show clearly that the grains become smaller as cobalt increases.

It is to be noted that there is an important variation in the coefficient of equivalence of cobalt for variations in the composition of the alloy under examination, the values of t varying between -0.1 and -1.5 . It would seem that the nearer the alloy approaches the point where the special constituent appears—i.e., to the

The tests for the mechanical properties of cobalt brasses have been made under conditions similar to those used for the nickel brasses,⁷ only cast samples being tested. The results obtained are tabulated in Table II.

The results are often irregular (notably alloy No. 2 under tension) but some interesting conclusions may be drawn.

Thus: Series C (alloys Nos. 7, 8 and 9) clearly show the relation between the fictitious composition and the

TABLE III. TRANSFORMATION POINTS OF COBALT BRASSES

Alloys Tested		Fictitious Composition	Transformation Points		Maximum Temperature Attained
Cu	Co		On Heating	On Cooling	
70.76	4.35	d + special constituent	?	?	875
60.34	0.64	61	455—790	750—455	860
60.48	4.81	a + special constituent	?	?	850
55.46	0.78	56.5	460	455	845
55.46	4.98	61	470—815	790—400	860

TABLE II. MECHANICAL PROPERTIES OF COBALT BRASSES

No.	Composition		Tension Tests			ρ
	Cu	Co	Ultimate Strength	Elongation	Contraction in Area	
1	70.20	0.72	31,000	57.0	...	17.1
2	70.28	1.94	32,100	22.0	42.2	12.5
3	70.76	4.35	47,900	51.0	62.2	15.3
4	60.34	0.64	46,600	49.0	57.5	13.1
5	60.50	2.27	44,300	57.0	54.6	11.5
6	60.48	4.81	47,400	38.0	37.7	7.5
7	55.46	0.78	53,600	16.0	30.7	9.0
8	55.63	2.42	57,700	32.0	38.9	11.2
9	55.46	4.98	63,400	39.0	54.6	14.0

saturation limit in cobalt of the α and β constituents—the smaller the coefficient. It is worthy of remark that cobalt is the only element yet known which possesses a variable coefficient of equivalence.

mechanical properties. The strength and the elongation increase simultaneously.

Alloy No. 6 (high-cobalt) shows a very appreciable decrease in elongation, a fact which is not observed for alloy No. 3, although both these products contain a little of a special constituent.

MAGNETISM AND TRANSITION POINTS

Determinations by a magnetized needle indicate that brasses containing 0.70 per cent cobalt are non-magnetic, but brasses with 2, 4 and 5 per cent cobalt are clearly

⁷See CHEM. & MET. ENG., vol. 24, p. 261.



Fig. 9. 55.4 Cu, 0.78 Co brass.

FIGS. 9 TO 11 (ALL $\times 55$)
Fig. 10. 55.6 Cu, 2.42 Co brass.

Fig. 11. 55.46 Cu, 4.98 Co brass.

magnetic, the magnetism increasing with the increase in cobalt.

Transformation points have been determined with a Saladin-Le Chatelier apparatus and the results tabulated in Table III. The tests show that:

Cobalt brasses have transformation points which correspond approximately to those of ordinary brasses having real compositions equal to the fictitious compositions of the alloys considered.

Alloys having equal fictitious compositions have different transformation points, since the presence of cobalt slightly raises these temperatures. This is brought out by comparing the results on samples Nos. 2 and 5.

Microscopic observation failed to resolve the β constituent in any of the cobalt brasses studied.

CONCLUSIONS

Cobalt enters into solid solution in one or both of the normal constituents of the Cu:Zn alloys and creates a

fictitious composition which is greater than the real composition.

The coefficient of equivalence of cobalt varies between wide limits, from -0.1 to -1.5 , whereas that of nickel⁸ is approximately -1.3 .

A special constituent is isolated as the cobalt content increases, and the more readily for brasses of lower copper content. Only traces of this constituent were noted in the samples studied, so that it can be said that the alloy is not thereby altered extensively. It is to be noted, however, that the alloy 60 Cu, 4.8 Co has a considerably decreased elongation and resiliency.

Copper:cobalt solutions are much less extensive than those of copper:nickel.

Additions of cobalt are not of great industrial importance in the manufacture of brasses.

The rôle of cobalt approaches that of nickel in brasses, although these two metals have completely different effects in steels.

⁸See CHEM. & MET. ENG., vol. 24, p. 178.

The Manufacture of Nitric Acid

AT A MEETING of the Delaware Section, American Chemical Society, held Wednesday evening, Feb. 23, an address on "The Manufacture of Nitric Acid" was given by F. C. Zeisberg, manager of the elementary process section, E. I. du Pont de Nemours & Co.

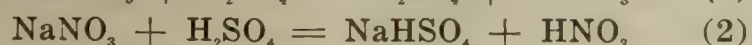
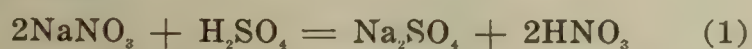
EARLY DEVELOPMENTS

In 778 A.D. Geber, an Arabian alchemist, obtained *aqua dissolutiva* from saltpeter, copper sulphate and alum. Because of its solvent properties, nitric acid was made on a semi-commercial scale even during the Middle Ages. Illustrations of the crude forms of apparatus will be found in a work by Lazarus Ercker published in 1580. The substitution of cast iron for earthenware retorts began between 1720 and 1759 and Chilean nitrate was first used as raw material in 1830. Until quite recently the horizontal cylindrical type of retort was extensively used in this country. The cast-iron cylinders were mounted in pairs in brick settings and the ends were closed with cast-iron plates or, in some cases, brickwork. A charge of 3,000 lb. of sodium nitrate was considered large.

In 1912 the du Pont company first installed the vertical or pot retorts.

REACTIONS INVOLVED IN MODERN PROCESS

Two equations are commonly used to express the formation of nitric acid from sodium nitrate and sulphuric acid:



It will be noticed that reaction 1 requires only one-half as much sulphuric acid as the second reaction. However, the saving in acid is offset by the fact that the residue left in the retort has such a high melting point as to make its removal a difficult and troublesome operation.

Experience has shown that an $\text{H}_2\text{SO}_4:\text{NaNO}_3$ ratio of 1:1 by weight gives the best results. The cake formed in this case contains both Na_2SO_4 and NaHSO_4 , and consequently has a melting point lower than that of either component. These relations may be summarized as follows:

	Ratio $\text{H}_2\text{SO}_4:\text{NaNO}_3$		Melting Point
	By Weight	Molar	of Residue, Deg. C.
Reaction 1.....	0.576	0.5	888
Reaction 2.....	1.15	1	186
Actual charging ratio.....	1	0.87	± 178

For successful operation the 1:1 ratio should be adhered to rather closely. A higher ratio causes the phenomenon of "pumping" (which if serious may drive part of the charge into the condenser) and increases the sulphuric acid cost but gives a stronger distillate and lower repair costs. On the other hand, a low ratio saves sulphuric acid, but repair costs are higher and the distillate is weaker due to decomposition of nitric acid at the high temperature necessary in this case.

RAW MATERIALS

Chilean nitrate as purchased has an average composition of 2.15 per cent H_2O , 1.70 per cent NaCl and 94.10 per cent NaNO_3 . It is dried to below 0.5 per cent H_2O so as to avoid unnecessary dilution of the distillate. The size of the nitrate particles is important, since very fine material tends to form cakes in the retort. These may break up later and react with almost explosive violence, or they may remain unacted upon and thus lower the yield.

Sulphuric acid recovered from spent mixed acid used for nitrating is found to work well, no matter how black and muddy. Even tank bottoms containing 30 to 40 per cent ferric sulphate have been used successfully. The strength of the acid is important, however, since very strong acid will dehydrate the HNO_3 according to the reaction:



The NO_2 passes through the condensers to the absorbers and later the water distills over, diluting the strong distillate. With dry NaNO_3 , 92.5 per cent H_2SO_4 gives the optimum strength of distillate.

DISTILLATION PHENOMENA

Curves plotted from the averaged data of ten runs with charges of 6,500 lb. NaNO_3 show many interesting phenomena. The strength of distillate is a little low at first due to water vapor and nitrosyl chloride, but soon rises to a maximum of about 97 per cent, after

which it falls off gradually. The rate of distillation increases to a prime of 18 lb. per minute about three hours after heat is applied and then decreases regularly. Soon after firing, the charge begins to foam and the foam depth increases until just before the end of the reaction, when the retort is practically full of foam. After reaching this point the foam drops abruptly and this serves as one of the best indications that the reaction is complete.

After the distillation has been in progress for about three hours the mushy charge sets to a solid pumice-like block which gradually melts again. This peculiarity has proved to be a most serious stumbling block for continuous processes which depend upon gravity flow.

The time required for a distillation cycle varies with the charge about as follows:

Charge Sodium Nitrate, Lb.	Single Shift, Hr.	Continuous, Hr.
4,000	7 to 8	...
5,000	9 to 10	...
6,000	10 to 12	...
7,000	12 to 14	12
9,000	Over 14	...

THE MODERN PLANT

A modern nitric acid plant includes: A battery of retorts connected in pairs to condensers provided, as a rule, with bleachers; absorption towers for the recovery of uncondensed vapors; a variety of accessory apparatus such as charging devices for nitrate and acid, storage system for the weak and strong cuts or mixing tanks if mixed acid is to be made.

RETORTS

Vertical cast-iron retorts are usually made with detachable hemispherical bottoms, although a recent bottom design is based upon the catenary of revolution, the theory being that this shape will give maximum strength. The retorts are set in brickwork and are heated directly by coal fires. The life of a retort is from 500 to 600 runs. Occasionally this is exceeded, as in the case of a retort at Repauno, which lasted 1,763 runs. During this time the thickness of the casting was reduced by erosion from 2 in. to about $\frac{1}{4}$ in. Most retorts fail through cracks developed by the heat. Patching prolongs the life about 100 runs.

CONDENSERS

Several types of condensers are in use. The improved Hart condenser consists of one or more stands each containing fourteen inclined 3-in. glass tubes connected to baffled headers so that the vapors make three passes. Each stand offers about 50 sq.ft. of condensing surface. Tube breakage is high—about 100 tubes per retort per year.

The Hough Duriron condenser is very open in construction and offers little resistance to gas flow. When operating intermittently in cold weather, water is likely to become trapped in the condenser and burst it in freezing.

S-bend condensers of 6-in. Duriron or fused silica pipe cooled by trickling water over the outside are very efficient.

A condenser described by F. Moore and J. A. Hall in U. S. Patent 986,846 of March 14, 1911, and used at the Shand plant of the Canadian Explosives Co. on Vancouver Island gives a distillate containing less than 0.1 per cent NO_2 . It consists of a tower containing a

large number of vertical tubes inside of which the condensing water circulates. The condensed acid passes countercurrent to the hot vapors through a packed section at the base of the tower which serves as a bleacher.

ABSORPTION SYSTEM

No condensers were used in the earlier systems, the nitric acid being distilled directly into sulphuric acid. This gives a mixed acid containing nitroso sulphuric acid, which is undesirable for certain nitrations. The first absorption towers using water were built at Hercules, Cal., from sewer tile filled with broken beer bottles. The acid which drained from the bottom of each tower was allowed to flow into a carboy and when this was full, it was carried upstairs by workmen and dumped into the top of the next.

Modern towers are constructed of chemical stoneware, six sections 30 in. in diameter by 30 in. high forming a typical tower. Coke, lump quartz or specially designed stoneware packing may be used to fill the tower. If of the dimensions given, 3,600 3-in. rings would be required. Finding a suitable construction material for the saucer in which the tower rests presents quite a problem. Volvic stone saturated with some bituminous material is only fairly satisfactory. The same may be said of Duriron. The du Pont company has obtained excellent service from Maine granite.

The reaction which takes place in the towers is the reverse of reaction 3. In order to get a strong acid it is necessary to have a series of towers, with water entering at the end of the series and flowing countercurrent to the gases. The acid collecting in each saucer flows to a distributing pot provided with two discharge openings leading to two stoneware pulsometers which operate by compressed air and insure a rapid circulation of acid in the tower. The distributing pots are interconnected so that as acid is formed it flows from one tower to the next toward the strong acid end. Baffles in the pots prevent water from passing through the whole series into the strong acid when the air is shut off from the pulsometers.

STORAGE AND TRANSPORTATION

Very strong nitric acid can be stored in lead-lined tanks, although there is considerable corrosion in the vapor space above the acid. Weak acid is best kept in stoneware pots, these being available in sizes up to 530 gal. Around the plant the acid is handled in pipe lines of chemical ware, glass or Duriron.

At best, however, the problem of handling the pure acid is a troublesome one. Since nitric acid is now used almost exclusively as mixed acid and since this can be handled easily in steel tanks and tank cars, steel circulating tanks are usually provided in which the nitric acid may be mixed with the required amount of sulphuric acid.

As indicated above, transportation of nitric acid is difficult except in the mixed form containing at least 12 to 13 per cent of H_2SO_4 . Glass carboys are used to quite an extent and for short distances chemical ware, glass or Duriron lines are satisfactory. In Germany and Norway, perfectly pure HNO_3 is transported in aluminum containers. Traces of H_2SO_4 , Cl_2 or NO_2 cause rapid corrosion.

YIELDS AND COSTS

From 94 per cent in 1900, the yield rose to 96.8 per cent in 1913 and—in spite of wartime demand for out-

put—to 97.6 per cent in 1918. At present it is nearly 99 per cent. In 1913, the production of 1,000 lb. HNO_3 required 265 lb. of coal and 1.9 men-hr. labor. Corresponding figures for 1918 are 222 lb. and 1.4 men-hr.

The normal cost of producing 100 lb. of nitric acid is distributed as shown in the accompanying table.

NORMAL COST PER 100 LB. HNO_3		
Labor.....	\$0.06	
Repair labor.....	0.06	
Retorts.....	0.08	
Supplies.....	0.05	
Fuel.....	0.03	
Power.....	0.03	
Overhead.....	0.18	
	\$0.49	
Less credit for nitercake.....	0.24	
Cost exclusive of raw materials.....		\$0.25
Sodium nitrate, 145 lb. @ 2.5c.....	\$3.63	
Sulphuric acid, 151 lb. @ 1c.....	1.51	
Cost of raw materials.....		\$5.14
Total cost.....		\$5.39

It will be noted that the raw material cost far exceeds all other items and that, consequently, increasing the yield 1 per cent would have as much effect in decreasing the cost as doubling the life of the retorts. Although similar relations exist in many other chemical processes, they are often lost sight of and much time is wasted in misdirected efforts to diminish costs.

PRODUCTION

Production statistics for the United States are as follows:

Year	HNO_3 Production, Short Tons
1904.....	59,000
1909.....	68,000
1914.....	79,000
1917.....	404,000
1918.....	634,000

Present production is somewhat above that of 1914. Normally the du Pont company makes one-third of the nitric acid produced in this country, but during the war the proportion rose to one-half.

OTHER PROCESSES

The Valentiner vacuum process proved to be a failure commercially. Recently the Buffalo Foundry & Machine Co. has devised a vacuum process which promises to be very efficient. The retort is provided with a powerful agitator and the sulphuric acid is added automatically. In this way foaming is reduced to a minimum in spite of the fact that distillation takes place in a vacuum (maintained by a special pump having a sulphuric acid piston to minimize corrosion). No absorption towers are used, the uncondensed vapors being absorbed in concentrated sulphuric acid which is subsequently used in the retort. As noted above, the continuous process fails owing to the solidification of the charge at one stage.

USES

Peace-time uses include: manufacture of chamber sulphuric acid, aqua regia, nitroglycerine, nitrobenzene, nitrocotton, fulminates and nitrates; pickling of copper, bronze and brass; parting of gold and silver; purification of silver; gilding bronze; photo-engraving; silk dyeing.

In war time it is used in making nitrocotton, nitroglycerine, trinitrotoluene, fulminates, ammonium nitrate and many other compounds.

Progress Report on Superpower Survey

THE Congress, in appropriating for the Geological Survey, June 5, 1920, provided for the survey of power production and distribution in the United States, including the study of methods for the further utilization of water power and the special investigation of the possible economy of fuel, labor and materials resulting from the use in the Boston-Washington industrial region of a comprehensive system for the generation and distribution of electricity to transportation lines and industries.

While the final report has not been completed, a progress report was submitted to the President on Feb. 24 by John Barton Payne, Secretary of the Interior, giving results thus far accomplished, with a brief statement of the scope of the investigation.

ENGINEERING STAFF AND ADVISORY BOARD

An organization was effected under the Geological Survey with offices for the engineering staff in New York City. The engineering staff includes William S. Murray, as chairman; Nathan C. Grover, the chief hydraulic engineer of the United States Geological Survey; Ozni P. Hood, chief mechanical engineer of the Bureau of Mines; Lorin E. Imlay, division engineer for the subjects of power and transmission; Henry W. Butler, division engineer for industries, and Cary T. Hutchinson, division engineer for railroads, with Henry Flood, Jr., engineer-secretary. The engineering staff has been aided by the hearty co-operation of an advisory board of business and professional men, who accepted appointments for this special service. Of this board Prof. Lester P. Breckenridge of Yale is chairman, and the various interests connected with this investigation are represented as follows: Magnus W. Alexander of Boston, representing the National Industrial Conference Board; Edward G. Buckland, vice-president New York, New Haven & Hartford R.R.; Charles L. Edgar, of the Boston Edison Co., representing the National Electric Light Association; Abraham T. Hardin, vice-president New York Central R.R.; Herbert Hoover, representing the mining industry; William Kelley, Lieutenant-Colonel, U. S. A.; Elisha Lee, vice-president Pennsylvania R.R.; Dr. Arthur D. Little of Boston, representing the electrochemical and byproducts industries; James H. McGraw, president McGraw-Hill Co., Inc., representing the technical press; John H. Pardee of New York, representing the American Electric Railway Association; Henry Cleveland Perkins of Washington, representing the mining industry, and Matthew S. Sloan, of the Brooklyn Edison Co., representing the National Electric Light Association.

Having in mind the object of the Superpower Survey, viz.: (1) allocation and amount of waste in labor, coal and other materials, due to the improper form of power generation and distribution within the Boston-Washington zone, and (2) recommendations regarding a regional power system by means of which these wastes may be eliminated, the superpower report naturally divides itself into three divisions: (1) Physical, (2) Legal, and (3) Financial.

PHYSICAL ASPECTS OF SURVEY

With regard to the physical aspect, the investigation has been concerned with the power necessary to (a)

railroads, (b) industries, (c) utilities, and (d) a system of centralized electric generation and transmission to supply their power requirements up to and including 1930.

RAILROADS

There are twenty class 1 railways included in the superpower zone. These are divided as follows: First track, 14,500 miles; second track, 6,500 miles; total trackage (including yards and sidings) 36,000 miles. There are a total of 10,000 steam locomotives, of which 44 per cent are freight, 29 per cent passenger and 27 per cent switching. The total annual railroad coal consumption for 1919 was 19,000,000 tons. Apparently one-third of this mileage can be economically electrified, including the greater part of double track mileage. Due to lack of traffic density upon the branch lines, these cannot be profitably electrified. This 33 per cent of mileage will carry more than 50 per cent of the traffic and by preferential arrangement of routes probably 60 per cent of the total traffic could be put over this mileage. Through the electrification of this mileage a fuel saving of 6,000,000 tons, or \$40,000,000 per annum, would be effected. Added to this saving will be \$50,000,000 annually as a difference in favor of electric versus steam engine repairs and maintenance.

The total unit cost of electrification will be approximately \$40,000 per mile of main line track, which with 12,600 miles to be electrified would cost \$500,000,000. In addition, yard and siding trackage would call for \$300,000,000, or a total of \$800,000,000. This sum will cover the necessary construction and equipment for the railways beginning with the electric substations and with the driving wheel of their electric motive power. The electrification outlined will displace approximately 7,000 steam locomotives, which at salvage value of \$22,500 each will credit the electrification estimate with approximately \$150,000,000, leaving a net investment of \$650,000,000 which taken in connection with the aforementioned savings of \$90,000,000 per annum would return approximately 14 per cent on the investment.

INDUSTRIES

There are approximately 50,000 industrial plants in the zone which either purchase or generate power. The Bureau of the Census is at present compiling the statistics of the 1919 Census of Manufactures. It is heartily co-operating with the Superpower Survey and will prepare, on a form made up by this Survey, the power and fuel statistics for the superpower zone, which will show the power and fuel requirements in the thirty-six major industries in the following classification of plants: Plants which do not use any power, plants using only steam power, plants purchasing electric power, plants not in these classes. In addition the plants will be classified as to size.

As soon as the tabulations are completed by the Bureau of the Census, the Survey in conjunction with experts in the various industries, will analyze and ascertain what possible fuel savings could have been made by the superpower system in 1919. From the data at hand, a saving of between six and eight million tons of coal is indicated.

In the anthracite coal mines of Pennsylvania, by means of electrification and the supply of superpower, a conservative estimate based on actual tests shows a saving of 6,500,000 gross tons of anthracite. The Survey is at present preparing estimates on the cost of completely electrifying the anthracite mines.

The data required of the Industrial Division will be ready by May 1, for assembly in its final form.

UTILITIES

A large saving of coal can be effected through the more efficient generation of power by the new superpower stations. The Survey finds that the average rate of coal consumption for present central station output is $2\frac{3}{4}$ lb. per kw.-hr. Power can be produced in the superpower system at an average rate of $1\frac{3}{4}$ lb. per kw.-hr. The present central station output of coal-generated power within the zone is 8,000,000,000 kw.-hr. Therefore 1 lb. saved per kw.-hr. will conserve 4,000,000 tons of coal annually.

ELECTRIC POWER GENERATION AND TRANSMISSION

The location of the large superpower stations and their attendant transmission lines is related to the establishment of load centers throughout the superpower zone to which power will be transmitted from them at minimum distance.

To date it is indicated that about twenty load centers will be established. Early in March sufficient data will be at hand to establish these load centers, after which the location of new superpower stations and their interlinking transmission systems can be promptly determined within the zone.

The development of power outside of but for transmission to the zone is being most carefully considered, having relation to the St. Lawrence River, other hydroelectric powers and the bituminous coal mines. It has been agreed among the experts of the country that 250,000 volts will be an acceptable voltage for the transmission of power from distances greater than 200 miles and at about half that value for the zone itself.

A conference with the coal authorities indicates that a fair figure to take for the average price of coal during the period 1919 was \$2.90 per ton at the mine, and during the period from that date to 1930, \$3.50 per ton.

With regard to water power for the zone, a summation of the possible outputs from the Potomac, Susquehanna, Delaware, St. Lawrence (American rights), Raquette and the Adirondack powers indicate that for an average year there will be available 12,000,000,000 kw.-hr., and for a minimum year 8,360,000,000 kw.-hr., the plant capacity being 2,300,000 kw. to furnish this amount of energy. It is of interest at this point to state that in 1930 the total power requirement in the superpower zone indicated by projected growth curves will be 48,000,000,000 kw.-hr., of which amount the superpower system could supply 36,000,000,000 kw.-hr. This, therefore, indicates that the water-power supply can be but from 20 to 25 per cent of the total. This fact forces the conclusion that most careful consideration must be given to the efficient development of power from coal.

The report will contain a chronology indicating time and location of superpower stations to be constructed in the order of their requirement, giving savings to be effected as their serial installation is made.

Through the unusual co-operation of the public utilities, the railways and the industries, the completion of the work will be, after May 1, substantially a matter of computation and tabulation.

The legislative and financial aspects of the survey include many important problems such as the formation of a corporation and the method of financing it. These will be considered in detail in the final report which is expected to be ready by June 30, 1921.

Current Events

in the Chemical and Metallurgical Industries

Plans for Annual Meeting of T.A.P.P.I.

Several reports of unusual interest and value will be presented at the annual meeting of the Technical Association of the Pulp and Paper Industry which opens at the Waldorf-Astoria Hotel, New York, on Tuesday, April 12.

PULVERIZED FUEL AND STEAM ECONOMY

The committee on heat, light and power is planning a symposium on powdered fuel and steam economy. The leading paper in the symposium will deal with certain definite conditions in steam plants, and discussion will afterward be centered on individual problems in different mills. The chairman of this committee is Howard S. Taylor, of the Management Engineering & Development Co., City National Bank Building, Dayton, Ohio.

An illustrated paper on waterwheel testing, based on the results of twenty years' experience in testing waterwheels in the grinder rooms of mills in the United States and Canada, will be presented by a New England expert who has developed a simple scheme of showing results and indicating methods of operating to insure maximum efficiency.

REPORT ON GROUNDWOOD PROCESS

The committee on groundwood, or mechanical pulp, headed by W. A. Munro, of the Wisconsin River Paper & Pulp Co., has conducted a searching investigation into the merits of the Hall process of grinding wood, and a most suggestive and valuable report has been compiled from communications made by users or licensees of the process. The subject has been investigated from three angles—that of the grinder room, of the paper machine room and of the press-room. The resistance of paper made from Hall process pulp to strain in turning the angle bars of big newspaper printing presses forms part of the study, the committee being in possession of several interesting letters from the press-rooms of the larger dailies.

PLANS FOR DYE INVESTIGATION

Ross Campbell, department of technical control, American Writing Paper Co., Holyoke, Mass., has been named by President Hatch to succeed Dr. Otto Kress as chairman of the committee on dyestuffs. One of the first tasks of this committee will be to check up the chapter on dyes in the vocational education textbook. The dyestuffs committee has some ambitious plans for reporting on the performance of different dyes under different conditions, their peculiarities, different combinations in which special dyes should or should not be used, etc.

INDIVIDUAL PAPERS IN PROSPECT

Among contributions to the session on scientific papers, one is promised from the Forest Products Laboratory dealing with a new method of pulping in which the cooking time is shortened by preliminary impregnation. A number of individual papers will be presented on such subjects as methods of drying paper on paper machines, the testing of crude rosin, measuring moisture in chips for cooking, facts and figures on power required for paper machines, etc.

Army Needs Commissioned Personnel

Competitive examinations will be held April 25 to fill 2,585 vacancies in the commissioned personnel of the army. There is a particular desire at this time to obtain as many technical men as possible. There are more than 4,000 vacancies in the army, but only a portion of them will be filled at this time. Among the vacancies to be filled at this examination are thirty-two in the Chemical Warfare Service.

Distribution of Industrial Stocks

A recent issue of the *Boston News Bureau* gives in tabular form a three-year comparison of the total number of stockholders in leading industrial firms. The data given in regard to the following chemical and metallurgical organizations show how these "partners" of big business have increased in number in recent years.

	—Number of Stockholders—		
	1921	1920	1919
Am. Agricultural Chemical com.	6,806	5,898	3,515
Am. Agricultural Chemical pfd.	8,225	7,930	7,382
Am. Car & Foundry com.	6,527	5,023	4,155
Am. Car & Foundry pfd.	8,414	8,206	8,004
Am. Hide & Leather com.	*2,524	*1,701	*1,596
Am. Hide & Leather pfd.			
Am. Locomotive com.	2,456	1,877	2,173
Am. Locomotive pfd.	7,411	7,083	7,019
Am. Smelt. & Rfg. com.	5,211	4,639	4,006
Am. Smelt. & Rfg. pfd.	10,249	9,535	9,030
Am. Sugar Refining com.	11,573	10,257	10,683
American Sugar Refining pfd.	13,246	12,853	12,649
Anaconda Copper	31,010	29,714	28,385
Bethlehem Steel com.	1,160	1,127	1,259
Bethlehem Steel com B.	6,082	4,306	4,459
Bethlehem Steel 8% pfd.	10,161	9,203	7,600
Bethlehem Steel 7% pfd.	544	505	486
Calumet & Arizona Mining	7,900	7,950	7,750
Central Leather com.	3,813	3,216	2,963
Central Leather pfd.	6,495	6,071	
Chile Copper	5,800	5,240	4,300
Chino Copper	8,500		6,403
Copper Range	6,945	6,640	6,508
Crucible Steel com.	1,086	946	1,363
Crucible Steel pfd.	4,178	3,934	3,858
Cuba Cane Sugar com.	2,204	2,584	1,860
Cuba Cane Sugar pfd.	5,755	4,880	4,494
East Butte Copper	2,332	2,200	2,233
General Asphalt com.	1,043	559	440
General Asphalt pfd.	836	1,453	1,709
General Electric	21,000	17,500	16,500
Goodrich Co. (B. F.) com.	6,735	3,759	4,589
Goodrich Co., pfd.	6,496	4,669	2,454
International Nickel com.	13,205	14,353	14,708
International Nickel pfd.	1,349	1,300	1,350
Invincible Oil	1,756	1,223	
Kelly-Springfield Tire com.	1,558	676	890
Kelly-Springfield Tire pfd.	1,198	893	339
Lackawanna Steel	3,302	2,372	2,670
Mexican Petroleum com.	1,077	805	290
Mexican Petroleum pfd.	473	465	482
Middle States Oil	8,500		
National Enamel & Stamp com.	*2,252	*2,529	*2,949
National Enamel & Stamp pfd.			
National Leather	136,500	32,500	
Pan-American Pet com.	2,495	1,546	707
Pan-American Pet com B.	2,831	460	
Penn Seaboard Steel	1,450	1,200	1,100
Republic Iron & Stl com.	3,300	2,100	2,500
Republic Iron & Stl pfd.	5,000	4,900	4,600
Sinclair Consolidated Oil	24,396	13,468	9,928
Swift & Co.	140,000	35,000	24,600
Texas Co.	13,465	11,838	5,367
U. S. Food Products	1,759	1,355	1,505
United States Rubber Co. com.	11,878	5,015	4,009
United States Rubber Co. pfd.	17,353	15,851	15,030
United States Steel Corp. com.	95,776	74,318	72,774
United States Steel Corp. pfd.	80,534	77,910	80,120
Utah Copper	7,400	6,100	5,700
Wes i gh use E'ec ric e m.	21,564	16,785	14,257
Westinghouse Electric pfd.	1,631	1,590	1,552
Worthington Pump com.	1,718	1,518	1,637
Worthington Pump pfd A.	1,671	1,646	1,511
Worthington Pump pfd. B.	1,262	1,115	954

* Total of all stockholders. † Exclusive of over 10,000 employees buying stock on installment plan. ‡ Approximately.

In many organizations a substantial percentage of the stock is now owned by employees. Thus, the United States Steel Corporation reports a total of 160,300 stockholders as of Jan. 31, 1921, 66,506 being employees who own stock outright. This does not include a large number of employees who are buying stock on the subscription plan.

Civil Service Examinations

Until further notice applications will be received by the United States Civil Service Commission on Form 1312 for the positions of: Associate physicist qualified in physical metallurgy, at a salary ranging from \$2,000 to \$2,800 a year; assistant physicist qualified in physical metallurgy, at a salary ranging from \$1,400 to \$1,800 a year. Vacancies in the Bureau of Standards, for duty at Washington, D. C., or elsewhere, will be filled from this examination.

Gala Night Planned at Chemists Club

The Chemists Club of New York City is getting ready for a gala night which will fall on March 17—St. Patrick's day. The purpose of this is by no means to establish the greatest of all snake charmers as the patron saint of chemists. There is no legend in connection with the great Scotchman, who went to Ireland and did *not* settle down in Belfast or Londonderry, to indicate that he had any interest whatever in the philosophy of matter. It is the tenth anniversary of the date in 1911 when the club moved into its present splendid quarters, and the trustees have planned a celebration.

The meeting is restricted to members of the club, and begins with a dinner without speeches at which the following gentlemen, made honorary members at the last general meeting, or, in the event of their inability to be present, duly accredited representatives from the embassies of their governments, will be the guests:

Giacomo Cimician, of Italy; Henri Louis Le Chatelier, of France; John Uri Lloyd, of Cincinnati, Ohio; William Henry Nichols, of New York, N. Y.; Edgar Fahs Smith, of Philadelphia, Pa.; Ernest Solvay, of Belgium; Sir Edward Thorpe, of England; Edward Weston, of Newark, N. J.

After the dinner honorary membership will be formally conferred upon the gentlemen, following which there will be an address by Irving Langmuir and Jacques Loeb on subjects not yet specifically announced, but relating to developments in chemistry, from the standpoints of pure science and biology. This will take place in Rumford Hall, and after the meeting there will be a reception to the new members and their representatives in the club parlors.

The occasion promises to be memorable and to contribute a note in the history of chemistry in America.

Chicago Section, A.C.S., Meeting

The Chicago Section of the American Chemical Society met at the City Club Feb. 18 for dinner, followed by a business meeting. Several amendments to the constitution were passed by unanimous vote of the members present. The principal one of these provided for changing the name of the *Chicago Chemical Bulletin* to the *Chemical Bulletin*. While the latter has headed the organ of the Western sections for some time, this action officially confirmed the name.

The address of the evening was delivered by Dr. L. V. Redman, who spoke on phenol condensation products, treating the subject from a practical standpoint. He reviewed the history of the development of synthetic resins from the work of Bayer in 1873. Smith of England took out the first patents in 1899, followed by Luft in Austria. Story, Claypool and Baekeland carried the work down to present developments. He spoke highly of Dr. Baekeland's work in building up a large commercial organic chemical institution which turns out excellent products. The history and details of synthetic resin production are confined almost wholly to patent literature.

He outlined the processes of manufacture now in vogue and exhibited many samples where the resins are useful in the arts. The modern automobile, airplane and other electrical machinery with comparatively high tension require insulations made from these resins compounded with wood flour, asbestos, cambric, etc.

The unusually large attendance of the second largest section at this meeting was in the nature of an ovation to the speaker. Redmanol cigar holders were served as favors at the dinner.

Production of Ore in Soviet Russia

From official Russian sources it appears that the mines of Kriwoi-Rog, which before the war contributed about three-quarters of the whole Russian iron production, have in the last year produced nothing.

The production of the copper mines has dwindled down to insignificance. The production of lead is 10 to 25 per cent that of the pre-war output.

The total of iron-ore production in 1920 was one-tenth of the quantities expected. In the Ural districts only 9,000 workmen, instead of 27,000 before the war, are employed.

Central Leather Co. Report

The annual report of the Central Leather Co. presents a typical case of the extraordinary depreciations in inventories which had such disastrous effects upon the leather industry during 1920. The report shows a loss, after charges and taxes, of \$22,428,214. This compares with a surplus of \$14,288,481 in 1919, which was equivalent after deducting preferred dividends to \$30.11 a share on common. Conditions during 1920 are summarized in the report as follows:

Distinct advance in price of raw material and finished leather, which was resumed in December, 1919, continued and increased during first two months of 1920. Our sales and advance orders in January and February of last year for active domestic consumption exceeded our supply and our production for some months in advance and raw material was therefore provided.

The abnormally severe winter, almost complete breakdown of transportation system of the country, delays in delivery and cancellation of orders with cessation of retail buying, all worked to produce by early summer a condition of almost complete stagnation in our industry, in common with or possibly beyond that in others. This situation made impossible a liquidation so obviously advisable.

Confronted by this condition—which, in short, resulted in a precipitate fall in price of raw material and practically no market for finished products—the management decided on the drastic policy of almost complete closing of its tanneries. From May until November we reduced purchases of hides to a minimum and liquidated inventories where possible. Not until November, when prices had reached or passed pre-war levels, did we again purchase hides in quantity. During this period the prices of finished products declined on a very restricted market. Inventories of finished products—necessarily large in a company of our size—have been marked down successively to meet the market declines. Result has been an inventory loss on leather sold and unsold, which has absorbed a very great part of the surplus. On Dec. 31, 1920, this company had practically no commitments for purchase of raw materials.

Directory of Petroleum Refineries Issued

A complete directory of petroleum refineries in the United States has just been issued by the United States Bureau of Mines. The report, compiled by H. F. Mason, petroleum economist, states that there are 415 completed refineries in the country, as compared with 373 in 1920. In addition, 44 refineries are in process of construction. The present daily capacity of all refineries is 1,888,800 bbl. of oil, as against a daily capacity of 1,530,565 bbl. in 1920. Texas, with 70 refineries, has the largest number of plants now in operation. Oklahoma has 68, Pennsylvania 51 and California 39 operating refineries. The daily capacity of the Texas refineries now operating is 330,800 bbl.; that of the California refineries is 312,700 bbl.; of the Oklahoma refineries, 248,050 bbl.; while New Jersey, with only 7 refineries operating, has a daily capacity of 215,500 bbl. The report contains data regarding the capacity and type of each plant listed as well as information as to whether at present in operation.

Copies of the report may be had by applying to the Director of the Bureau of Mines, Washington, D. C.

Copper Specifications Submitted for Approval

The American Society for Testing Materials has submitted the following copper specifications to the American Engineering Standards Committee for approval:

Specifications for soft or annealed copper wire (B3-15).

Specifications for Lake copper wire bars, cakes, slabs, billets, ingots and ingot bars (B4-13).

Specifications for electrolytic copper wire bars, cakes, slabs, billets, ingots and ingot bars (B5-13).

Methods for battery assay of copper (B34-20).

The committee (at 29 West 39th St., New York City) would be very glad to learn of the extent to which these specifications are made use of, and to receive any other information regarding the specifications in meeting the needs of the industry.

Petroleum Production of the World for 1920

The estimated world's production of petroleum in 1920 is 688,474,251 bbl., against 554,505,048 bbl. in 1919, according to figures assembled by the American Petroleum Institute. This represents a gain of 133,969,203 bbl., or 24.2 per cent.

Of the total production in 1920 the United States supplied 443,402,000 bbl., or 64.4 per cent. Mexico supplied 159,800,000 bbl. (based on exports of that amount plus production marketed at home), or 23.2 per cent of the world's output.

By far the greater gains were made by the United States and Mexico. United States production increased from 377,719,000 bbl. in 1919 to 443,402,000 bbl. in 1920, a gain of 65,683,000 bbl., or 17.4 per cent. Mexico increased from 87,072,954 bbl. to 159,800,000 bbl., a gain of 72,727,046 bbl., or 83.5 per cent.

The estimated production by countries follows:

	1920	1919
United States.....	443,402,000	377,719,000
Mexico.....	159,800,000	87,072,954
Russia.....	30,000,000	34,284,000
Dutch East Indies.....	16,000,000	15,780,000
India.....	8,500,000	8,453,800
Rumania.....	7,406,318	6,517,748
Persia.....	6,604,734	6,289,812
Galicia.....	6,000,000	6,255,000
Peru.....	2,790,000	2,561,000
Japan and Formosa.....	2,213,083	2,120,500
Trinidad.....	1,628,637	2,780,000
Argentina.....	1,366,926	1,504,300
Egypt.....	1,089,213	1,662,184
France.....	700,000	.....
Venezuela.....	500,000	321,396
Canada.....	220,000	220,100
Germany.....	215,340	925,000
Italy.....	38,000	38,254
Total.....	688,474,251	554,505,048

1921 Convention and Exhibition, American Society for Steel Treating

The third annual convention and exhibition of the American Society for Steel Treating will be held during the week of Sept. 19-24 at Indianapolis.

The Manufacturers' Building, on the State Fair Grounds, will be used for exhibits. It is 360 ft. in length, by 220 ft. in width; the central section of this building, measuring 240 x 100 ft., is known as the "Sunken Garden," and is 20 in. below the level of the surrounding floor space. The booths along the north wall are to be used for the live exhibits and are supplied with gas and compressed air, while arrangements have also been made for the exhibitors who require heavy electrical current to be on the promenade on the same side of the building.

Meetings are to be held in the Women's Building, located about 400 ft. from the exhibition hall, where there will be available three or more large meeting rooms.

The Indianapolis chapter of the Society is actively engaged in making comprehensive plans to insure the success of the project.

Peruvian Centennial Expositions

This year the Peruvian Government will celebrate the centennial of Peruvian independence, and approximately \$3,000,000 has been voted for this purpose. In connection with the centennial it has been arranged to hold an exhibit of manufactures of other countries and to this end the Peruvian Government has granted concessions to the Peruvian Centennial Exhibits Co., 42 Broadway, New York, and to A. Smeraldi, of Lima, Peru. Information relative to allocation of space and rental charges can be obtained from them.

The buildings in which the two expositions are to be held will very probably be centrally located in the city of Lima and the expositions will undoubtedly be of great interest to consumers and merchants throughout Peru.

British Embargo on Fertilizers

The British Board of Trade has prohibited the exportation of ammonium sulphate, superphosphate, lime, basic slag, and compound fertilizers containing any of these products. This embargo is made under the fertilizer act, 1920, and has been in effect since February 7, 1921.

Book Reviews

FUEL OIL IN INDUSTRY. By Stephen O. Andros. 244 pp. Chicago: The Shaw Publishing Co. Price, \$3.75.

This is an exposition of the qualities of fuel oil and methods of testing, storing and burning it, together with a description of its application to domestic and industrial furnaces. The book gives a concise and informative account of present-day American practice, and hence fills a gap which has existed in the literature of fuels; it is a satisfactory treatise and merits a good reception.

There are some evidences of haste in the preparation of the manuscript of the book for publication and certain of the chemical considerations are in need of revision, but the author undoubtedly will correct these minor defects in the second printing. It also may be pointed out here that, from the standpoint of the engineer, it would be desirable to give more attention to the subject of the function of oil burners in the operation of furnaces. Some one has said that "a properly designed oil furnace is in reality a combination of a gas producer and a furnace," and that "progress has been slow in the efficient use of oil fuel because more is not known about gas producers." The reviewer recently has had occasion to study the practices in heat-treatment and it is clear that there is a prevailing lack of appreciation of the differences between "burning oil," "making heat" and "properly applying heat to obtain a uniformly heated product." It seems to the reviewer that progress in the economical use of oil fuel has been retarded principally by improper furnace design and operation. Generally speaking, the various method of burning oil are similar, based upon the same principles, and learned easily.

W. A. HAMOR.

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THE JOURNAL OF THE INSTITUTE OF METALS, Vol. XXIV. Edited by G. Shaw Scott, Secretary of the Institute of Metals, 36 Victoria St., London, S. W. 1. Price 31s. 6d. net.

This second volume for 1920 contains about 550 pages of text, printed and edited in the usual excellent style. It contains the papers read before the meeting held in the middle of September, together with 100 pages devoted to abstracts of current literature on non-ferrous metallurgy. In timely publication it may well set an example to American societies.

Perhaps the contribution which has attracted most attention and drawn forth the most discussion is that by Miss Elam and Prof. Carpenter on Recrystallization, a paper which was abstracted in this journal on page 224 of the issue for Feb. 2. Another important paper discussing gases contained in brass (by Messrs. Banford and Ballard) was abstracted in this journal for Jan. 19, 1921, page 132. Other papers of interest to metallurgists controlling manufacturing operations set forth various phases of brass manufacture, the constitution of bearing metals and defects in admiralty bronze. For those more interested in research work and in theoretical metallurgy, Miss Bingham of the National Physical Laboratory has contributed a notable article on the allotropy of zinc, while D. Hanson and Miss Gayler have written an extended paper on "The Constitution of the Alloys of Aluminum and Magnesium." The latter contribution is a part of an extended research undertaken by the National Physical Laboratory during the war into the nature of aluminum alloys. Doubtless further results of this painstaking investigation will be published in due time.

This volume also contains the text of the 1920 May lecture delivered by Dr. Carl A. F. Benedicks, on "The Recent Progress in Thermo-electricity." Nearly all of the work as done by Prof. Benedicks and his associates has been published in detail in various physical journals, but in the present instance he collects the main arguments in words not too technical, only alluding briefly to the numerous necessary precautions. Altogether this makes a very interest-

ing account of his brilliant experimental demonstration that thermo-electric currents occur in strictly homogeneous metals—even liquid mercury—as a function of the temperature distribution only, currents of the same magnitude as those of the Seebeck effect. The wide application of thermo-electric pyrometers for engineering work arouses interest in the possible practical uses of these investigations.

A considerable portion of the text is descriptive of work which has gone forward at the National Physical Laboratory, the British counterpart of our Bureau of Standards. Naturally one would expect an extremely high class of work from such an institution, but the quality of the other papers published in the volume does not suffer in the least by comparison. A further point of note is that no less than three of the eleven papers were written either in whole or in large part by women. Evidently the metallurgiste has arrived.

E. E. THUM.

Personal

HOWARD C. ARNOLD, well known in ceramic circles, has recently joined the staff of Arthur D. Little, Inc., Cambridge, Mass. After the war Mr. Arnold studied optical glass at the Bureau of Mines for a short time, and then became chief chemist and plant manager of B. F. Drakenfeld & Co., New York City, where he was chiefly concerned in developing ceramic materials, especially the coloring oxides.

CYRUS E. FRYE has been elected president of the Lincoln Paper Mills Corporation, Elkhart, Ind., to succeed Edward B. Zigler, deceased. Mr. Frye has been in active management of the company for the past year.

ARTHUR L. TUTTLE, who directed the building of one of the largest fertilizer plants at Atlanta for the Tennessee Copper & Chemical Corporation, has returned to New York headquarters.

SAMUEL WANDER, general manager of S. Wander & Sons, New York, has returned to the city after a month's absence at Palm Beach and Miami, Fla., and in Cuba.

Obituary

DANIEL BAUGH, president of Baugh & Sons Co., Philadelphia, manufacturer of animal oils and fertilizers, died on Feb. 28, at Palm Beach, Fla. Mr. Baugh was eighty-five years old and well known in the philanthropic, chemical and commercial circles of Philadelphia.

ROBERT HOLBROOK, chief chemist of the Victor Chemical Works at Chicago, Ill., died at Los Angeles, Cal., on Feb. 11, at the age of thirty-six. He had been in failing health for the past two years and had gone to California to recuperate. He was a graduate of the University of Michigan (1906), a member of the American Chemical Society and the Chicago Chemists' Club, and was recognized as an authority on phosphoric acid and allied products.

WILLIAM A. JONES, president of Richards & Co., manufacturer of Zapon pyroxylin products, died on Friday, Feb. 18, at his home in Tuckahoe, N. Y. Following his graduation at Hillsboro, N. C., he studied under Prof. Ira Remsen at Johns Hopkins. After receiving his doctor's degree, he became associated with Commodore Leonard Richards, who at the time was operating one of the pioneer pyroxylin works, the Boston Artificial Leather Co., which was subsequently reorganized and moved to Stamford, Conn., under the firm name of Richards & Co., and in 1918 taken into the Atlas Powder Co. organization. Dr. Jones was known as the "Dean of the Industry," through his lifelong devotion to the chemistry of pyroxylin solutions and artificial leather. His wife and sister survive him.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, March 4, 1921.

Intermittent periods of dullness and activity characterized trading in the chemical market during the past week. In spite of recent pessimism, however, it is generally agreed that February was the brightest month since the present period of depression. Margins of profit have not been comparable with those of 1920, but the volume of business has been in some cases greater than that of February of last year. The characteristic point of difference between the two periods is the lack of repeated turnover which was so general a year ago. The market this year seems to have been based on business direct from manufacturer or importer to consumer, while business last year was carried on through a multiplicity of intermediate hands, each of whom took his profit from every individual transaction.

Sentiment is steadily improving and while price trends are still downward on account of competitive selling of foreign goods, it is generally conceded that the next three months will see business on a sound normal basis again. The readjustment of quotations recently made by manufacturers has not been altered to an appreciable degree. Consumers are still operating cautiously with the idea that more attractive prices may be established later on. There are three great factors, however, hindering any noticeable readjustments and these are the high freight rates, high coal prices and high wages. Other factors are contributors to the general result, but the removal of the three named would open the way for permanent progress and disperse any doubts which still cling to the chemical industry. Second hands who refuse to take their losses on old contracts know there is a potential shortage of goods which would develop into a real shortage with any noted improvement in trade conditions.

Light *soda ash* held quite steady on the spot market and while an isolated car was occasionally sold at a price concession, most dealers held single bags at \$2.05@ \$2.10 per 100 lb. Barrels were quoted by dealers at \$2.20@ \$2.25. The absence of any live export business left the price for resale ash in double bags at \$2.10. Producers' views are unchanged at \$1.72½ per 100 lb., basis 48 per cent, f.o.b. works, in single bags for prompt and future shipments. *Prussiate of soda* has attracted some interest, mainly because the market was flexible, and prices have receded under spirited competition from holders of imported goods. Spot prices have shown irregular weakness, with foreign material offered down to 14½c. per lb., with a possibility of shading on firm business. Forward shipments were offered at 14c. per lb.

Standard 99 per cent *copper sulphate*, large crystals, could be purchased at lower prices from producers and business is reported in carlots on a basis of 5½c. per lb. The small crystals, 98½-99 per cent, were offered by first hands at 5¼c. per lb. Smaller quantities of both varieties commanded a slight premium depending upon the size of the order. The lower prices in this commodity are directly the result of the decline in the course of production which is made possible through lower copper quotations. While the South American inquiry is practically at a standstill at the present time, a demand has developed for shipment to Europe, particularly to Italy and France and other grape-growing countries. European buyers who should have bought their requirements a few months ago have stayed out of the market as long as they could with the idea of getting material at a lower figure. The approach of the season for insecticide users has stimulated this foreign inquiry. Germany is competing for this business, but it seems that American sulphate is far superior and holds the preference.

Resale lots of domestic *caustic potash*, 88-92 per cent KOH, were on the market at prices ranging from 10@11c. per lb. Large quantities of this material have been returned from abroad during the past few months and these

are responsible for the relatively low prices prevailing. Large producers of *chlorate of potash* are asking 15c. per lb. for the domestic quality for prompt shipment from works. Importations of various grades are on the market at prices ranging from 8c. per lb. upward, depending upon the seller. Most of this material came from Germany and was manufactured during the war. The quality in many cases has been so irregular that consumers have not shown any unusual interest in the product, regardless of the comparatively low prices quoted.

Small lots of *bichromate of soda*, standard brand, were heard from 8@8½c. per lb. Transactions were reported at 8@8¼c. Buyers are only taking small lots at intervals and show little disposition to operate in any large way for prompt and future shipments. Resale offerings of this material do not appear too plentiful, but there is enough competition among second hands to keep prices moderately irregular. *Bleaching powder* has been sold quite freely to paper mills and bleacheries on the basis of 2½c. per lb., f.o.b. works, in large drums. Importers are meeting this figure with offerings of foreign bleach and have been quite successful in disposing of large quantities over the year.

Resellers of spot *carbon tetrachloride* are quoting the market as low as 10c. per lb. Producers are quoting up to 12c. Stocks in second hands are not large. Technical *magnesium sulphate* is very scarce on the spot, with nominal quotations around \$1.70 per 100 lb. Arrivals are quoted around 1¼c. per lb. Prices on *ammonia alum* have been reduced by leading manufacturers, who are quoting on a basis of 4¼@4½c. per lb. for the lump variety. Business has been done in a limited volume only. Prices were recently reduced on *nitric acid*. The new prices are given as 5¼@6¼c. per lb. for the 36 deg. in carboys, 6¼@7¼c. for the 38 deg., 6¾@7¾c. for the 40 deg. and 7½@8½c. for the 42 deg. Business continued along narrow lines, although the total quantity of acid changing hands is said to be good.

COAL-TAR PRODUCTS

The reports of different quarters of the coal-tar products market during the past week have been very much mixed. Some sellers have found an improvement, while others say they can find no change in the dullness that has been steadily manifest for weeks. The increased number of textile plants which have been put into operation during the past month or so will unquestionably result in a growing demand for colors, but so far this increased demand has failed to reach intermediate manufacturers. In no section of the market have second hands figured so largely as in this and before a real improvement can come in business it will be necessary to reduce the number of profits on a single transaction to a minimum. Basic conditions in this market are decidedly in favor of the American manufacturers in being protected, at least for the time being, from any form of foreign competition which has been such a factor in the chemical market. The actual volume of business during the past month has been better than the attitude sellers seem to indicate, since they are chiefly concerned over the fact that prices have been sacrificed in a great number of cases. Prices in general continued soft, with resale lots of many commodities in more or less distress. The crude products seem to be moving in large volume but still confined to quantities covering short periods. Prices in this branch of the market are showing more steady than the intermediate market and now that better demand is in prospect the present quotations have an air of firmness.

Prices on *benzene* continued practically unchanged. The demand has been somewhat more active, but is still below normal, especially for carlot business. Quotations are given as 30@35c. per gal. for the pure grade and 28@34c. for the 90 per cent in tank cars and drums. The inactivity in the dye trade, which has prevented any considerable amount of business recently, is passing and increased activity among dye makers will bring about a revival of interest in this commodity, as stocks in consumers' hands are conspicuously low. The *naphthalene* market in second hands is reported considerably strong. The flakes can still be found in some quarters as low as 8c. per lb., but the majority of holders of spot goods are setting their selling price at 8½c.

per lb. Producers are quoting 9@10c. on flakes and 10@11c. on balls, all f.o.b. works.

Some inquiry for *aniline oil* has been noted during the week, but prices are still very unsteady and are quoted over a wide range by holders of stocks. Resale stocks are available at 22c. per lb., drums extra. Producers are quoting all the way up to 28c. per lb. The increased volume of business being done by the textile industry is expected to reflect itself in the market in the very near future. The market on *beta-naphthol* has been of a very limited nature during the week, but has shown some improvement over other weeks. Holders are quite firm on price and have turned down bids of 32@33c. per lb. for spot material. The general quotation for resale material is 34c. per lb., with producers' figure ranging from 40@45c. per lb.

Resale lots of *para-nitraniline* are offered as low as 85c. per lb. Producers are quoting \$1.05@\$1.15 per lb., according to quantity, but are willing to shade these figures on firm business. Factors report a limited routine demand for *ortho-toluidine*. The available supply is of sufficient volume to meet present requirements and sellers are steady in their views on prices, ranging from 25@30c. per lb. Trading in the market on *para toluidine* continues along quiet lines with the movement chiefly confined to small quantities into consuming channels. Prices are fairly steady at \$1.40@\$1.50 per lb., depending on quantity. Prices on *H acid* are still heard over a rather wide range. Producers are holding for as high a figure as \$1.60 per lb. for limited amounts and name \$1.50 for round lots. Outside holders are quoting all the way down to \$1.10 per lb. for a fair quality. Other quotations generally heard ranged from \$1.25@\$1.35 per lb.

VEGETABLE OILS

Importers of *China wood oil* report quiet trading, with prices in some quarters unsettled. It was reported that scattered lots could be picked up at 9½c. per lb. in barrels, while for carlots for nearby delivery 9c. could be done on a firm bid. The Coast market was nominal at 8c. per lb. Reports on the conditions on *coconut oil* covering round lots were rather conflicting. In some quarters it was said that the situation was somewhat firmer, while advices from the Middle West indicate that offerings were made at concessions. Ceylon grade in barrels closed at 9¼c. per lb., while Cochin closed at 10½c. per lb.

The market for *linseed oil* was dull and the undertone, taken as a whole, was barely steady. A few inquiries came to light, but these were more or less in the nature of sounding sellers. So far as nearby oil is concerned, it was possible to draw offerings from crushers on a basis of 67c. per gal. in carlots, while in a few cases firm bids could have bought merchandise at some concession. Spot oil in lots of 5 and 10 bbl. was available at 70@71c. per gal. The market for *palm oil* was reported quiet and unchanged at 7¼c. per lb., immediate or prompt shipment. *Niger oil* held at 6½c. per lb. The steady position of the exchange tends to hold values on this commodity. There were offerings of domestic crude *peanut oil* for immediate shipment from mill at 6c. per lb., indicating that the market was somewhat irregular. The demand in general was reported dull.

The Iron and Steel Market

PITTSBURGH, March 4, 1921.

On the whole there is perhaps a slight downward trend in finished steel according to minimum prices quoted by independents, but the outstanding feature of the market situation is the fact that prices are declining so little when all or nearly all of the independents are willing to make further cuts in prices for the sake of getting an actual tonnage of orders. The difficulty is that consumers are unwilling to buy at any price. Repeatedly mills have solicited buyers to make bids, only to be met with the response that no steel is required just now.

The Pittsburgh Steel Co. has begun to quote wire nails at \$3 base, or 25c. a keg under the Steel Corporation price. Several weeks ago the Midvale Steel & Ordnance Co., which is generally credited with having instituted the price-cutting movement, began to quote nails at \$3.10, but subsequently the price was withdrawn, at least as an open quotation. The

Pittsburgh Steel Co., however, explains that it quotes \$3 openly because at least two other producers have been quietly doing \$3 of late.

Plates are still quotable at 2.10c. on ordinary business, bars at 2c. and shapes at 2.10c., though in each case it is understood that on a sufficiently attractive order \$1 or \$2 a ton less could be done, the difficulty being that attractive orders are not being offered in the market. An interesting point is that the Steel Corporation has just sold 3,000 tons of plates to a regular customer at its price of 2.65c.

Black sheets are quoted at 4.10c. by more producers than formerly, with intimations that 4c. could be done on a sufficiently attractive order. Galvanized sheets are generally quotable at 5.25c., with likewise a little leeway.

Report has it that standard railroad spikes could be bought at 3.35c., against 3.65c., the regularly quoted price, hot-rolled strips at 3.05c. or less, against 3.30c., and cold-rolled strips at 6c., against 6.25c. Cold-finished steel bars can be purchased even in less than carload lots at 3.35c., against a nominal or official quotation of 3.60c.

STEEL CORPORATION POSITION

The United States Steel Corporation evinces no intention or reducing either its prices or its wage rates immediately. Some of the corporation's customers have expressed themselves as opposed to price reductions at this time and there is no evidence that buyers in general are waiting for lower prices or would be induced to buy more freely even if prices were greatly reduced. As to wages, which obviously could not be reduced when shipments are being made at old prices, the cost of living has not declined sufficiently to permit of a fair and permanent readjustment being made. With light operation and a distribution of employment the earnings of the men are reduced while the cost of living has not greatly declined.

PRODUCTION

Operations at some of the independent mills have increased, but on the whole there is no increase, and common estimates are that the independents generally are not operating at over 20 or 25 per cent of capacity, which may be estimated at 30,000,000 gross tons of ingots per annum. The Steel Corporation has been operating this week at between 60 and 65 per cent of capacity, which is approximately 22,500,000 tons. Production therefore may be taken at 7,000,000 tons a year by the independents and 14,000,000 tons by the Steel Corporation, or 21,000,000 tons altogether, which is just 40 per cent of actual capacity as nearly as can be estimated. This rate is undoubtedly in excess of the actual rate at which steel is now being consumed, and however business may be distributed among the mills in the future, the total production is likely to decline for several weeks before there is any tendency toward an upturn.

Production of pig iron is at the rate of 22,000,000 or 23,000,000 tons a year, or 50 per cent of estimated capacity, not theoretical capacity. The merchant furnaces as a whole are producing at not over about one-third of capacity. A considerable part of the output is being stocked, and there are prospects of several merchant furnaces blowing out within the next few weeks. The steel interests do not seem to have reduced their pig iron production in all cases as much as their steel production, and some of them have accumulated tonnages of pig iron that look large in present conditions.

Foundry pig iron has declined 50c. in the valley market, with sales at \$26.50 valley. Bessemer remains quotable nominally at \$27 valley, with no interest manifested. The last open quotation on basic iron was \$25 valley, and merchant furnaces would willingly sell at this price, hoping to reduce costs while operating sufficiently to avoid loss. At best, of course, the \$25 price would represent taking a loss on ore bought at last season's prices, it being understood that the 1921 prices will be down, perhaps by as much as \$1. Some steel works iron could probably be bought at well below \$25, but bids are not being made. It seems to be established that one odd lot of basic of 600 or 700 tons has just been sold at \$23 to close out. From all this it can be seen that the pig iron market has not reached a stable level by any means.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.			\$0.55 -	\$0.60
Acetone.....lb.	\$0.13 -	\$0.13	.13 -	.14
Acid, acetic, 28 per cent.....100 lbs.	3.00 -	3.25	3.50 -	3.75
Acetic, 56 per cent.....100 lbs.	6.00 -	6.25	6.50 -	6.75
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	9.00 -	9.50	10.00 -	10.50
Boric, crystals.....lb.	.14½ -	.15	.15½ -	.16
Boric, powder.....lb.	.15½ -	.16½	.17 -	.18
Citric.....lb.			.46 -	.48
Hydrochloric.....100 lb.	1.45 -	1.60	1.75 -	2.00
Hydrofluoric, 52 per cent.....lb.	.15 -	.16	.16½ -	.18
Lactic, 44 per cent tech.....lb.	.10 -	.11	.11½ -	.12
Lactic, 22 per cent tech.....lb.	.04½ -	.05½	.06 -	.07
Molybdic, C. P.....lb.	4.00 -	4.50	4.50 -	5.00
Muriatic, 20 deg. (see hydrochloric).....lb.				
Nitric, 40 deg.....lb.	.06½ -	.07	.07½ -	.07½
Nitric, 42 deg.....lb.	.07½ -	.08	.08½ -	.08½
Oxalic, crystals.....lb.	.15 -	.15½	.16 -	.17
Phosphoric, Ortho, 50 per cent solution.....lb.	.15 -	.15½	.16 -	.16½
Picric.....lb.	.30 -	.32	.35 -	.40
Pyrogallol, resublimed.....lb.			2.30 -	2.40
Sulphuric, 60 deg., tank cars.....ton			14.00 -	15.00
Sulphuric, 60 deg., drums.....ton				
Sulphuric, 66 deg., tank cars.....ton	18.00 -	19.00		
Sulphuric, 66 deg., drums.....ton	21.00 -	22.00	22.50 -	23.00
Sulphuric, 66 deg., carboys.....ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 -	24.00		
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 -	26.00	26.50 -	27.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 -	35.00	40.00 -	
Tannic, U. S. P.....lb.			1.15 -	1.25
Tannic (tech.).....lb.	.45 -	.47	.48 -	.50
Tartaric, crystals.....lb.			.32 -	.35
Tungstic, per lb. of WO.....lb.			1.00 -	1.20
Alcohol, Ethyl.....gal.			4.75 -	5.00
Alcohol, Methyl (see methanol).....gal.				
Alcohol, denatured, 188 proof.....gal.			.46 -	.50
Alcohol, denatured, 190 proof.....gal.			.51 -	.54
Alum, ammonia lump.....lb.	.04½ -	.04½	.04½ -	.05
Alum, potash lump.....lb.	.05½ -	.06	.06½ -	.07
Alum, chrome lump.....lb.	.13 -	.13½	.14 -	.14½
Aluminum sulphate, commercial.....lb.	.02½ -	.02½	.02½ -	.03
Aluminum sulphate, iron free.....lb.	.03 -	.03½	.03½ -	.03½
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07 -	.07½	.07½ -	.08
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 -	.32	.33 -	.35
Ammonium carbonate, powder.....lb.	.12 -	.12½	.12½ -	.13
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	.07½ -	.08	.08½ -	.08½
Ammonium chloride, granular (gray salamoniac).....lb.	.09 -	.09½	.09½ -	.10
Ammonium nitrate.....lb.	.08 -	.08½	.09 -	.10
Ammonium sulphate.....100 lb.	3.15 -	3.20	3.25 -	3.35
Amylacetate.....gal.			4.00 -	4.25
Amylacetate tech.....gal.			3.25 -	3.50
Arsenic oxide, (white arsenic).....lb.	.09 -	.09½	.10 -	.10½
Arsenic, sulphide, powdered (red arsenic).....lb.	.14 -	.14½	.15 -	.15½
Barium chloride.....ton	65.00 -	70.00	75.00 -	80.00
Barium dioxide (peroxide).....lb.	.18 -	.19	.19½ -	.22
Barium nitrate.....lb.	.10 -	.10½	.10½ -	.11
Barium sulphate (precip.) (blanc fixe).....lb.	.04½ -	.05	.05½ -	.06
Bleaching powder (see calc. hypochlorite).....lb.				
Blue vitriol (see copper sulphate).....lb.				
Borax (see sodium borate).....lb.				
Brimstone (see sulphur, roll).....lb.				
Bromine.....lb.	.40 -	.41	.42 -	.45
Calcium acetate.....100 lbs.	2.00 -	2.05		
Calcium carbide.....lb.	.04 -	.04½	.04½ -	.05
Calcium chloride, fused, lump.....ton	27.00 -	29.00	30.00 -	32.00
Calcium chloride, granulated.....lb.	.01½ -	.01½	.02 -	.02½
Calcium hypochlorite (bleach'g powder).....lb.	.02½ -	.02½	.03 -	.03½
Calcium peroxide.....lb.			1.00 -	1.10
Calcium phosphate, monobasic.....lb.			.15 -	.16
Camphor.....lb.			.70 -	.75
Carbon bisulphide.....lb.	.08 -	.08½	.09 -	.09½
Carbon tetrachloride, drums.....lb.	.10 -	.10	.11 -	.12
Carbonyl chloride (phosgene).....lb.			.75 -	1.00
Caustic potash (see potassium hydroxide).....lb.				
Caustic soda (see sodium hydroxide).....lb.				
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.09 -	.09½	.10 -	.10½
Chloroform.....lb.			.38 -	.40
Cobalt oxide.....lb.			3.00 -	3.10
Copper as (see iron sulphate).....lb.				
Copper carbonate, green precipitate.....lb.	.24 -	.25	.26 -	.27
Copper cyanide.....lb.			.50 -	.60
Copper sulphate, crystals.....lb.	.05½ -	.05½	.06 -	.06½
Cream of tartar (see potassium bitartrate).....lb.				
Epsom salt (see magnesium sulphate).....lb.				
Ethyl Acetate Com. 85%.....gal.			1.00 -	1.00
Ethyl Acetate pure (acetic ether 98% to 100%).....gal.				
Formaldehyde, 40 per cent.....lb.	.17½ -	.17½	.17½ -	.18
Fusel oil, ref.....gal.			4.00 -	4.50
Fusel oil, crude.....gal.			2.50 -	2.75
Glauber's salt (see sodium sulphate).....lb.				
Glycerine, C. P. drums extra.....lb.			.19 -	.20
Iodine, resublimed.....lb.			3.75 -	3.85
Iron oxide, red.....lb.			.10 -	.20
Iron sulphate (copperas).....100 lb.	1.00 -	1.25	1.50 -	1.75
Lead acetate, normal.....lb.			.14½ -	.16
Lead arsenate (paste).....lb.	.11 -	.12	.12½ -	.13
Lead nitrate.....lb.			.15 -	.20
Litharge.....lb.	.08½ -	.09	.09½ -	.10
Lithium carbonate.....lb.			1.25 -	
Magnesium carbonate, technical.....lb.	.10½ -	.11	.11½ -	.12
Magnesium sulphate, U. S. P.....100 lb.	2.25 -	2.75		
Magnesium sulphate, commercial.....100 lb.			1.70 -	2.00
Methanol, 95%.....gal.			1.28 -	1.30
Methanol, pure.....gal.			1.55 -	1.60
Nickel salt, double.....lb.			.12 -	.12½
Nickel salt, single.....lb.			.13 -	.13½
Phosgene (see carbonyl chloride).....lb.				
Phosphorus, red.....lb.	.45 -	.46	.47 -	.50
Phosphorus, yellow.....lb.			.35 -	.37
Potassium bichromate.....lb.	.13 -	.13½	.14 -	.14½

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar).... lb.	\$.35 — .40	\$0.30 — \$0.35
Potassium bromide, granular..... lb.	.35 — .40	.20 — .40
Potassium carbonate, U. S. P..... lb.	.08 — .08½	.09 — .10
Potassium carbonate, crude..... lb.	.08 — .10	.11 — .15
Potassium chlorate, crystals..... lb.	.10 — .11	.12 — .13
Potassium cyanide..... lb.	65.00 — 70.00	2.75 — 3.00
Potassium hydroxide (caustic p. tash).... lb.	.09½ — .09¾	.10 — .12½
Potassium iodide..... lb.	.45 — .46	.48 — .50
Potassium nitrate..... lb.	.50 — .52	.53 — .55
Potassium permanganate..... lb.	.28 — .29	.30 — .32
Potassium prussiate, red..... lb.		2.25
Potassium prussiate, yellow..... lb.		
Potassium sulphate (powdered)..... per uni.		
Rochelle salts (see sodium potas tartrate)		
Salammoniac (see ammonium chloride)		
Sal soda (see sodium carbonate)		
Salt cake..... ton		30.00 — 33.00
Silver cyanide..... oz.		1.25 — 1.35
Silver nitrate..... oz.		.37½ — .38½
Soda ash, light..... 100 lb.	2.00 — 2.10	2.20 — 2.50
Soda ash, dense..... 100 lb.	2.20 — 2.30	2.40 — 2.60
Sodium acetate..... lb.	.05½ — .05¾	.06 — .06½
Sodium bicarbonate..... 100 lb.	2.50 — 2.75	3.00 — 3.25
Sodium bichromate..... lb.	.08 — .08½	.08½ — .08¾
Sodium bisulphate (nitre cake)..... ton	7.00 — 7.50	8.00 — 11.00
Sodium bisulphite powdered, U.S.P..... lb.	.05½ — .05¾	.06 — .06½
Sodium borate (borax)..... lb.	.08½ — .08¾	.09 — .09½
Sodium carbonate (sal soda)..... 100 lb.	2.00 — 2.25	2.50 — 2.75
Sodium chl rate..... lb.	.10 — .10½	.10½ — .11
Sodium cyanide, 96-98 per cent..... lb.	.20 — .22	.23 — .30
Sodium fluoride..... lb.	.13½ — .14	.14½ — .15
Sodium hydroxide (caustic soda)..... 100 lb.	3.60 — 3.70	3.80 — 4.00
Sodium hyposulphite..... lb.		.03½ — .04
Sodium nitrate..... 100 lb.	2.85 — 3.00	3.00 — 3.25
Sodium nitrite..... lb.	.06 — .06½	.06½ — .07
Sodium peroxide, powdered..... lb.	.30 — .31	.32 — .34
Sodium phosphate, dibasic..... lb.	.04½ — .04¾	.05 — .05½
Sodium potassium tartrate (Rochelle salts) lb.		.29 — .31
Sodium prussiate, yellow..... lb.	.14½ — .14¾	.14¾ — .15
Sodium silicate, solution (40 deg.)..... lb.	1.25 — 1.35	1.40 — 1.50
Sodium silicate, solution (60 deg.)..... lb.	.03 — .03½	.03½ — .03¾
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.75 — 2.00	2.25 — 2.50
Sodium sulphide, crystal, 60-62 per cent (conc.) lb.	.05 — .05½	.05½ — .06
Sodium sulphite, crystals..... lb.	.04 — .04½	.04½ — .05
Strontium nitrate, powdered..... lb.	.16 — .16½	.16½ — .17
Sulphur chl ride, red..... lb.	.07 — .07½	.07½ — .08
Sulphur, crude..... ton	16.00 — 20.00	
Sulphur dioxide, liquid, cylinders..... lb.	.08 — .08½	.08½ — .09
Sulphur (sublimed), flour..... 100 lb.		2.25 — 3.10
Sulphur, roll (brimstone)..... 100 lb.		2.00 — 2.75
Tin bichloride, 50 per cent..... lb.	.18 — .19	
Tin oxide..... lb.		.45 — .47
Zinc carbonate, precipitate..... lb.	.16 — .18	.19 — .20
Zinc chloride, gran..... lb.	.11 — .11½	.11½ — .12
Zinc cyanide..... lb.	.45 — .49	.50 — .60
Zinc dust..... lb.	.12 — .13	.13½ — .14
Zinc oxide, XX..... lb.	.08½ — .09	.09½ — .11
Zinc sulphate..... lb.	.03½ — .03¾	.04 — .05

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 — \$1.15
Alpha-naphthol, refined..... lb.	1.45 — 1.50
Alpha-naphthylamine..... lb.	.38 — .40
Aniline oil, drums extra..... lb.	.22 — .28
Aniline salts..... lb.	.28 — .32
Anthracene, 80% in drums (100 lb.)..... lb.	.75 — 1.00
Benzaldehyde U.S.P..... lb.	1.00 — 1.50
Benzidine, base..... lb.	.95 — 1.05
Benzidine sulphate..... lb.	.80 — .90
Benzoic acid, U.S.P..... lb.	.65 — .70
Benzoate of soda, U.S.P..... lb.	.65 — .70
Benzene, pure, water-white, in drums (100 gal.) gal.	.30 — .35
Benzene, 90%, in drums (100 gal.) gal.	.28 — .32
Benzyl chloride, 95-97%, refined..... lb.	.30 — .35
Benzyl chloride, tech..... lb.	.25 — .30
Beta-naphthol benzoate..... lb.	3.50 — 4.00
Beta-naphthol, sublimed..... lb.	.70 — .75
Beta-naphthol, tech..... lb.	.34 — .40
Beta-naphthylamine, sublimed..... lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)..... lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums gal.	.95 — 1.00
Cresylic acid, 95-97%, dark, in drums..... gal.	.90 — .95
Cresylic acid, 50%, first quality, drums..... gal.	.60 — .65
Dichlorobenzene..... lb.	.06 — .09
Diethylaniline..... lb.	1.20 — 1.30
Dimethylaniline..... lb.	.55 — .65
Dinitrobenzene..... lb.	.30 — .32
Dinitrochlorobenzene..... lb.	.25 — .30
Dinitronaphthalene..... lb.	.33 — .35
Dinitrophenol..... lb.	.40 — .45
Dinitrotoluene..... lb.	.27 — .30
Dip oil, 25%, tar acids, car lots, in drums gal.	.38 — .40
Diphenylamine..... lb.	.60 — .70
H-acid..... lb.	1.30 — 1.50
Meta-phenylenediamine..... lb.	1.25 — 1.30
Monochlorobenzene..... lb.	.14 — .16
Monoethylaniline..... lb.	1.75 — 2.00
Naphthalene crushed, in bbls. (250 lb.)..... lb.	.08 — .08½
Naphthalene, flake..... lb.	.08½ — .08¾
Naphthalene, balls..... lb.	.09½ — .10
Naphthionic acid, crude..... lb.	.70 — .75
Nitrobenzene..... lb.	.12 — .15
Nitro-naphthalene..... lb.	.30 — .35
Nitro-toluene..... lb.	.18 — .25
Ortho-amidophenol..... lb.	3.20 — 3.75
Ortho-dichlor-benzene..... lb.	.15 — .20
Ortho-nitro-phenol..... lb.	.75 — .80
Ortho-nitro-toluene..... lb.	.20 — .24
Ortho-toluidine..... lb.	.25 — .30
Para-amidophenol, ba e..... lb.	1.90 — 2.00
Para-amidophenol, HCl..... lb.	2.10 — 2.20

Para-dichlorobenzene..... lb.	.15 — .25
Paranitroaniline..... lb.	.85 — 1.00
Para-nitrotoluene..... lb.	.90 — 1.05
Para-phenylenediamine..... lb.	1.90 — 2.00
Para-toluidine..... lb.	1.30 — 1.60
Phthalic anhydride..... lb.	.55 — .60
Phenol, U. S. P., drums (dest.), (240 lb.)..... lb.	.10 — .12
Pyridine..... gal.	2.00 — 3.50
Resorcinol, technical..... lb.	1.85 — 2.00
Resorcinol, pure..... lb.	2.30 — 2.50
Salicylic acid, tech., in bbls. (110 lb.)..... lb.	.22 — .23
Salicylic acid, U. S. P..... lb.	.25 — .27
Salol..... lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.28 — .32
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.16 — .18
Sulphanilic acid, crude..... lb.	.30 — .35
Tolidine..... lb.	1.35 — 1.45
Toluidine, mixed..... lb.	.40 — .45
Toluene, in tank cars..... gal.	.28 — .32
Toluene, in drums..... gal.	.30 — .35
Xylidines, drums, 100 gal..... lb.	.40 — .45
Xylene, pure, in drums..... gal.	.42 — .45
Xylene, pure, in tank cars..... gal.	.45 — .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 — .35
Xylene, commercial, in tank cars..... gal.	.30 — .35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.24 — \$0.26
Beeswax, refined, light..... lb.	.27 — .28
Beeswax, white pure..... lb.	.40 — .45
Carnauba, Flora..... lb.	.68 — .70
Carnauba, No. 2, North Country..... lb.	.30 — .32
Carnauba, No. 3, North Country..... lb.	.18 — .19
Japan..... lb.	.19½ — .20
Montan, crude..... lb.	.07 — .08
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.04½ — .04¾
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.03½ — .04
Paraffine waxes, refined, 118-120 m.p..... lb.	.04 — .05
Paraffine waxes, refined, 125 m.p..... lb.	.05 — .05½
Paraffine waxes, refined, 128-130 m.p..... lb.	.06 — .06½
Paraffine waxes, refined, 133-135 m.p..... lb.	.07 — .07½
Paraffine waxes, refined, 135-137 m.p..... lb.	.08 — .09
Stearic acid, single pressed..... lb.	.12 — .12½
Stearic acid, double pressed..... lb.	.12½ — .13
Stearic acid, triple pressed..... lb.	.13 — .13½

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr., 0.930-0.940..... gal.	\$1.70
Pine oil, pure, dest. dist..... gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75
Pine tar, ref., thin, sp.gr., 1.080-1.960..... gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970..... gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.37
Pinewood creosote, ref..... gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl..... 280 lb.	\$6.25 —
Rosin E-I..... 280 lb.	6.25 —
Rosin K-N..... 280 lb.	6.25 —
Rosin W. G.-W. W..... 280 lb.	6.50 —
Wood rosin, bbl..... 280 lb.	6.75 —
Spirits of turpentine..... gal.	.59 —
Wood turpentine steam dist..... gal.	.54 —
Wood turpentine, dest. dist..... gal.	.53 —
Pine tar pitch, bbl..... 200 lb.	 — 7.00
Tar, kiln burned, bbl. (500 lb.)..... bbl.	 — 14.50
Retort tar, bbl..... 500 lb.	15.00 — 14.75
Rosin oil, first run..... gal.	.45 —
Rosin oil, second run..... gal.	.48 —
Rosin oil, third run..... gal.	.60 —

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41
70-72 deg., steel bbls. (85 lb.)..... gal.	.39
68-70 deg., steel bbls. (85 lb.)..... gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30

Crude Rubber

Para-Upriver fine..... lb.	\$0.17 — \$0.18
Upriver coarse..... lb.	.13 — .14
Upriver cauchoo ball..... lb.	.14 — .14½
Plantation—First latex crepe..... lb.	.19 —
Ribbed smoked sheets..... lb.	.18 —
Brown crepe, thin, clean..... lb.	.18 —
Amber crepe No. 1..... lb.	.20 —

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.08½ — \$0.09
Castor oil, AA, in bbls..... lb.	.10 — .10½
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.08 — .08½
Cocoonut oil, Ceylon grade, in bbls..... lb.	.09½ — .10
Cocoonut oil, Cochin grade, in bbls..... lb.	.10 — .11
Corn oil, crude, in bbls..... lb.	.08½ — .08¾
Cottonseed oil, crude (f. o. b. mill)..... lb.	.05½ — .05¾
Cottonseed oil, summer yellow..... lb.	.07½ — .07¾
Cottonseed oil, winter yellow..... lb.	.08½ — .08¾
Linseed oil, raw, car lots (domestic)..... gal.	.67 — .68
Linseed oil, raw, tank cars (domestic)..... gal.	.60 — .61
Linseed oil, boiled, car lots (domestic)..... gal.	.69 — .70

Olive oil, commercial.....	gal.	\$2.40	—	\$2.60
Palm, Lagos.....	lb.	.07½	—	.07½
Palm, Niger.....	lb.	.06½	—	.06½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.06	—	.06½
Peanut oil, refined, in bbls.....	lb.	.12	—	.12½
Rapeseed oil, refined in bbls.....	gal.	1.05	—	1.10
Rapeseed oil, blown, in bbls.....	gal.	1.15	—	1.20
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07½	—	.07½
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.04	—	....

FISH

Light pressed menhaden.....	gal.	\$0.46	—	\$0.48
Yellow bleached menhaden.....	gal.	.48	—	.50
White bleached menhaden.....	gal.	.50	—	.52
Blown menhaden.....	gal.	.85	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	....
Blanc fixe, dry.....	lb.	.05	—	.05½
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.16
Chalk, domestic, extra light.....	lb.	.05	—	.05½
Chalk, domestic, light.....	lb.	.04½	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.05
Chalk, English, dense.....	lb.	.04½	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) grou d, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Fla.....	net ton	25.00	—	....
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	....
Fullers earth, imported, powdered.....	net ton	35.00	—	40.00
Graphite, crucible, 90% carbon, Ashland, Ala.....	lb.	....	—	.09
Graphite, crucible, 85% carbon, Ashland, Ala.....	lb.	.07	—	.09
Graphite, higher lubricating grades.....	lb.	.11	—	.40
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.65	—	....
Shellac, orange superfine.....	lb.	.70	—	....
Shellac, A. C. garnet.....	lb.	.57	—	....
Shellac, T. N.....	lb.	.55	—	....
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	14.00	—	15.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	40.00	—	50.00
Talc, California talcum powder grade.....	ton	20.00	—	45.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	—	....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	80-100	—	....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	45-50	—	....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	....	—	55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	—	....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	—	....
Magnesite brick, 9-in. straight.....	net ton	100	—	....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105	—	....
Magnesite brick, soaps and splits.....	net ton	120	—	....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65-70	—	....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56-61	—	....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	50-60	—	....

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.16	—	....
Ferrochrome per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.16	—	.17
Ferromanganese, 76-80% Mn, domestic.....	gross ton	95.00	—	100.00
Ferromanganese, 76-80% Mn, English.....	gross ton	95.00	—	100.00
Spiegelisen, 18-22% Mn.....	gross ton	38.00	—	40.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.00	—	2.50
Ferrosilicon, 10-15%.....	gross ton	50.00	—	55.00
Ferrosilicon, 50%.....	gross ton	90.00	—	95.00
Ferrosilicon, 75%.....	gross ton	150.00	—	155.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.55	—	.60
Ferrouuranium, 35-50% of U, per lb. of U content.....	lb.	7.00	—	....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00	—	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.55	—	.60
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.50	—	.55
Coke, foundry, f.o.b. ovens.....	net ton	6.00	—	6.50
Coke, furnace, f.o.b. ovens.....	net ton	5.00	—	5.50
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	16.00	—	17.00
Fluorspar, lump, f.o.b. Hea hden, New Mexico.....	net ton	17.50	—	....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	—	25.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.40	—	.45
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00	—	....
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.16	—	....
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.16½	—	....
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	—	3.25
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	....
Zircon, washed, iron free.....	lb.	.03	—	....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.50
Aluminum, 98 to 99 per cent.....	28.3@28.5
Antimony, wholesale lots, Chinese and Japanese.....	5.25
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	35
Monel metal ingots.....	38
Monel metal, sheet bars.....	40
Tin, 5-ton lots.....	29.25
Lead, New York, spot.....	3.75@4.00
Lead, E. St. Louis, spot.....	3.75@4.00
Zinc, spot, New York.....	7.00
Zinc, spot, E. St. Louis.....	4.75

OTHER METALS

Silver (commercial).....	oz.	\$0.54
Cadmium.....	lb.	1.40@1.50
Bismuth (500 lb. lots).....	lb.	1.45
Cobalt.....	lb.	4.50
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	70.00
Iridium.....	oz.	300.00
Palladium.....	oz.	65.00@70.00
Mercury.....	75 lb.	47.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	21.25
Copper bottoms.....	33.00
Copper rods.....	28.00
High brass wire and sheets.....	18.75
High brass rods.....	16.75
Low brass wire and sheets.....	27.50
Low brass rods.....	18.50
Brazed brass tubing.....	35.25
Brazed bronze tubing.....	40.50
Seamless copper tubing.....	25.00
Seamless high brass tubing.....	24.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	11.50	18.50	10.00	10.50
Copper, heavy and wire.....	11.00	16.50	9.50	9.50
Copper, light and bottoms.....	9.00	14.50	9.00	8.50
Lead, heavy.....	4.00	7.25	4.00	4.00
Lead, tea.....	3.00	5.25	3.00	3.00
Brass, heavy.....	7.00	9.50	7.00	10.00
Brass, light.....	5.50	8.00	5.00	5.50
No. 1 yellow brass turnings.....	6.00	9.50	5.50	6.00
Zinc.....	4.00	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	*Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes.....	\$3.73	\$3.80	\$3.47	\$3.58	\$3.37	\$3.58	\$3.47
Soft steel bars.....	3.93	3.70	3.52	3.34	3.27	3.48	3.52
Soft steel bar shapes.....	3.93	3.70	3.52	3.48	3.27	3.48	3.52
Soft steel bands.....	4.33	4.65	4.22	6.25	....	....	....
Plates, ½ to 1 in. thick.....	3.93	4.00	3.67	3.78	3.57	3.78	3.67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

MONTGOMERY—The Jenkins Brick Co. has plans under way for extensions and improvements in its plant. The present kiln capacity will be increased, and corresponding enlargements made in other departments. New machinery will be installed, including pulverizing and other equipment.

Arkansas

HOPE—The Arkansas-Texas Oil Co. is considering plans for the construction of a new oil refinery on a local site. A pipe line extending to the oilfields will be installed. W. T. Knight is president.

California

RICHMOND—The Natural Soap Co., with headquarters at San Marcial, N. M., is negotiating with the local Chamber of Commerce for a site for the erection of a new plant. It is said that the proposed factory will cost in excess of \$50,000.

EL SEGUNDO—The General Chemical Co., Los Angeles, is planning for the early operation of its new acid-manufacturing plant here, now in course of erection. The plant consists of four units, and each will be placed in service as soon as completed.

Connecticut

BETHEL—The D. J. Lane Leather Co. is completing plans for the rebuilding of its local plant, recently destroyed by fire. One large plant unit will be constructed on the same site as previously used for a number of smaller buildings. As soon as the new factory is completed, the company will remove its present branch works at Danbury to the Bethel location.

WATERBURY—The Scovill Mfg. Co., Bridge St., manufacturer of brass and other metal goods, will soon commence the erection of a new 1-story brass mill, 155 x 160 ft., brick and steel, estimated to cost about \$100,000 with equipment. Hugh L. Thompson, 57 North Main St., is engineer.

Delaware

WILMINGTON—The Wilmington Leather Co. is adjusting matters regarding insurance on the recent fire at its plant at Second and Greenhill Sts., and has preliminary plans under way for the rebuilding of the works, replacing a fire damage estimated at \$1,000,000 with machinery. The reports that the plant would not be rebuilt have been denied. James J. O'Neill is president.

Georgia

HAZLEHURST—The Carter Cotton Oil Co. is planning for the rebuilding of its plant, destroyed by fire Feb. 19, with loss estimated at \$100,000, including equipment.

Illinois

CHICAGO—The American Insulated Wire & Cable Co. will locate a copper wire rod mill here. It has purchased property at the northwest corner of Twenty-second and Fisk Sts., which is at present occupied by a 1-story plant. This plant will be remodeled at a cost of about \$100,000. Additional equipment to be installed will cost about \$200,000.

CHICAGO—The American Cereal Products Co. of Chicago has acquired the plant of the Acme Malting Co., at the northwest corner of Bloomingdale Rd. and Kedvale Ave. Alterations in this plant and purchase of new equipment is contemplated.

CHICAGO—The Goodman Mfg. Co. producer of mining machinery and supplies, electric locomotives, etc., has acquired new property at the northwest corner of Halstead and Forty-Eighth Sts., anticipating enlarged facilities due to future growth of business.

LYONS—The University Oil Products Co., 208 South La Salle St., Chicago, has commenced the erection of its proposed new local oil plant. The refining works will

consist of five 1- and 3-story plant units, totaling 50 x 1,000 ft. in size. Holabird & Roche, 104 South Michigan Ave., Chicago, are architects. H. J. Halls is president.

CHICAGO—The Mid-West Box Co. of Delaware has been organized with a capital of \$7,500,000 to take over the plants and business of the Mid-West Box Co. of Indiana, 111 West Washington St., Chicago; Mid-West Box Co. of Ohio; the Mid-West Box Co. of West Virginia, and the American Straw Board Co., Akron, O. The first noted companies specialize in the manufacture of corrugated fiber shipping cases, containers and other products, and the acquisition of the American Straw Board interests is to secure a definite supply of raw materials. Expansion plans are under way at a number of the plants of the combined company, and increased output will be arranged.

Kentucky

BOWLING GREEN—The American Producing & Refining Co. has plans under way for the erection of a new oil-refining plant, with initial capacity of about 1,000 bbl. per day. It is estimated to cost close to \$200,000 with machinery.

Louisiana

MONROE—The American Carbon Co., recently organized with a capital of \$1,500,000 by interests connected with the Southern Carbon Co., has plans under way for the erection of a new local plant for the manufacture of carbon from lignite under a special process. The new carbon, it is said, will be used primarily in refining sugar, replacing the bone black now employed. The plant with machinery is estimated to cost in excess of \$750,000.

Maryland

BALTIMORE—The United States Industrial Chemical Co., Curtis Bay, has filed plans for the erection of a 1-story plant addition, 60 x 180 ft., to cost about \$14,000.

BALTIMORE—Frank G. Kitchen has leased a building at Hollins St. and Calverton Rd., adjoining the factory of the Lipps Candy Co. and previously used in connection with this business, for the establishment of a new plant for the manufacture of varnishes, stains, oils and kindred specialties. Equipment for this purpose will be installed at once.

CANTON—The Standard Oil Co. has acquired a large tract of land adjoining its local plant, heretofore held by the Canton Co., and will use the property for proposed future additions. No announcement has been made as to time of erection. The company has also taken title to a number of pieces of property on First St., Baltimore, for use in connection with its new terminal at this location.

CUMBERLAND—The American Cellulose & Chemical Co. is planning for operations at its new local plant early in the summer. The different structures are now nearing completion, forming the initial units, and machinery will be installed promptly. This section of the plant is said to represent an investment of \$4,000,000. The entire project as planned, covering additional manufacturing units, will cost in excess of \$8,000,000.

Massachusetts

FRAMINGHAM—The Dennison Mfg. Co., manufacturer of paper specialties, has plans under way for a new 4-story addition, 70 x 100 ft. Monks & Johnson, 99 Chauncey St., Boston, are architects.

Minnesota

MINNEAPOLIS—The Hannepin Atomized Fuel Co., 500 Security Bldg., is having plans prepared for the construction of a new 1-story fuel-crushing plant at St. Paul. The works will cost about \$150,000 with machinery. C. L. Pillsbury, 1206 Second Ave., is engineer.

Missouri

KANSAS CITY—The Corn Products Refining Co., 17 Battery Pl., New York, has construction well under way on its new plant at North Kansas City, and will place the work in service at an early date. Mis-

cellaneous contracts for completion work have been let. The plant will consist of three complete units, and represents an investment of about \$7,000,000.

New Jersey

NEWARK—G. N. Bick has filed plans for the erection of a new plant at 71-75 Paris St., to be 42 x 62 ft., for the manufacture of chemicals. The factory will include a laboratory.

BAYONNE—The International Nickel Co. has filed plans for the erection of a number of 1-story buildings at its plant at the foot of Twenty-second St., to cost about \$18,000.

BLOOMINGDALE—Lissberger Bros., operating the Somerville Iron Works, Somerville, N. J.; the Eagle Smelting & Refining Works, Newark, and other industries in the state, have leased the former plant of the Morris County Chemical Co., East Bloomingdale, for the establishment of a chemical, dye and affiliated products experimental plant. Operations will be inaugurated at once under the direction of Dr. S. A. Molnar, chemical engineer. The plant was at one time occupied by the Butler Chemical Co., now defunct, and later, by the New Jersey Chemical Co.

NEWARK—In addition to its proposed new plant at Beaufort, S. C., recently announced, the Ocean Leather Co., Inc., 33 New York Ave., is planning for the establishment of a similar factory for the treatment of shark skins at Hyannisport, in this same vicinity. It is said that the plant will be one of the largest of the company's works, and will be equipped for all features of fish leather production. It will be operated on an all-year basis.

New York

BUFFALO—The University of Buffalo has filed plans for the erection of a new 3-story chemistry building at Main St. and Niagara Falls Blvd. It is estimated to cost about \$400,000. A large laboratory will be installed.

Ohio

CAREY—The Hume China Co. is completing plans for the construction of a new 1-story pottery, 150 x 500 ft., and will soon call for bids. It will be of brick, tile and concrete. W. W. Matchett, 408 Alliance Bank Bldg., Alliance, O., is architect. George H. Hume is president.

SANDUSKY—The Hinde & Dauch Paper Co., manufacturer of corrugated fiber boxes, containers, etc., is having plans prepared for the erection of its proposed new paper mill and factory at Fort Madison, Ia. The plant will be about 100 x 340 ft., and with machinery is estimated to cost close to \$1,000,000. The Ferguson Co., Columbus, O., is engineer and architect.

DOVER—The Dover Coke & By-Products Co. is arranging for the immediate construction of four additional ovens at its plant. Improvements will be made in a number of present oven units at the works.

Pennsylvania

PHILADELPHIA—The Gulf Refining Co., 21 State St., New York, and Pittsburgh, Pa., has abandoned plans temporarily for its proposed new oil refinery to be located at Girard Point, Philadelphia. The company acquired a tract of about 70 acres of land some time ago at this location and has done considerable preliminary work, including the construction of a reinforced-concrete wharf, 55 x 840 ft. The company is now operating a local plant at Fifty-eighth St. and the Schuylkill River.

South Carolina

COLUMBIA—The H-W Chemical Co., recently organized, is planning for the establishment of a local factory for the manufacture of chemicals and affiliated products. A local building has been secured and equipment will be installed at once. The company is headed by J. S. Hammack and J. W. Wilson.

CHESNEE—The Crawley Gin Co., recently organized, will operate a local cottonseed oil mill. T. A. Sawyer is president, and John B. Cash, secretary and treasurer.

Texas

SWEETWATER—The Sweetwater Refining Co. has acquired a local site and has plans under way for the construction of a new oil refinery.

LINDEN—The Pratt Bros. Iron Ore Development Co., Minneapolis, Minn., has commenced preliminary work on its proposed new ore-crushing plant at Bowieville, near Linden. The works will comprise departments for crushing, screening and roasting, with initial equipment to provide for a capacity of about 400 tons per day. At a

later date it is proposed to install a magnetic process plant for ore treatment, supplanting the roasting method. The company's holdings in this district are estimated to contain about 6,000,000 tons of ore.

BURKBURNETT—The C. F. Noble Oil & Gas Co. is planning for the rebuilding of the portion of its local gasoline plant, recently destroyed by fire with loss reported at about \$18,000.

Washington

CENTRALIA—The Steel Casting Co. has been incorporated by officials of the Ten-nent Steel Casting Co., Tacoma, Wash., with a capital of \$75,000, to operate a local plant. Plans are being perfected for the new works, to be equipped for the production of high-grade steel castings.

New Companies

THE KEMIKO Co., Newark, N. J., has been incorporated with a capital of \$50,000 to manufacture chemicals. The incorporators are Adelbert L. Vandenburg, Harold W. Yapp, and Henry Faust, 112 South Seventh Street.

LOMBARD & Co., INC., Boston, Mass., has been incorporated with a capital of \$350,000 to manufacture grinding wheels, abrasive materials and kindred products. The incorporators are John H. McGill, Walter L. and William H. McGill, 21 Oxford Street, Winchester, Mass.

THE SPECIAL PRODUCTS Co., Hopewell, Va., has been incorporated with a capital of \$250,000 to manufacture paints, varnishes and affiliated products. The incorporators are J. C. Fleming and Clay Littleton.

THE WICOMICO FARMERS' ASSOCIATION, Salisbury, Md., has been incorporated with a capital of \$50,000 to establish and operate a fertilizer manufacturing plant under co-operative plans. The incorporators are William C. Mitchell, E. Dale Atkins, and William M. Cooper, Salisbury.

YARDLEY & Co., LTD., New York, has been incorporated with a capital of \$100,000 to manufacture soap and affiliated products. The incorporators are C. Smith, R. E. Gardner and L. M. Townsend, 48 Wall Street.

THE ROFF COTTON OIL Co., Ada, Okla., has been incorporated with a capital of \$50,000 to manufacture cotton oil products. The incorporators are P. A. Norris and C. L. Griffith, Ada; and W. R. Brents, Sherman, Tex.

THE MIDDLETON & PETERSON Co., Savannah, Ga., has been incorporated with a capital of \$30,000 to manufacture cotton oil products and kindred specialties. The incorporators are M. L. Middleton, and W. M. Peterson.

THE AMERICAN CARBON Co., Monroe, La., has been incorporated with a capital of \$1,500,000 to manufacture carbon products. The incorporators are M. C. Redmond, and Earl P. Hartshorne, Monroe.

THE UNION STONEWARE Co., 400 West Kinzie St., Chicago, Ill., has been incorporated with a capital of \$50,000 to manufacture glass, pottery, porcelain and other ceramic products. The incorporators are W. P. White, E. S. Hoyt and W. H. Putnam.

THE LIMESTONE PRODUCTS Co., Black Rock, Ark., has been incorporated with a capital of \$400,000 to manufacture hydrated lime and other lime products. The incorporators are William H. Woodruff, Jonesboro, Ark.; C. E. Scott and D. S. Alessi, Springfield, Mo.

THE SPANISH MOSAIC TILE Co., Washington, D. C., has been incorporated under Delaware laws with a capital of \$25,000 to manufacture floor and wall tile, mosaics, etc. The incorporators are M. A. Cahill, Redick W. Ridgely and William A. McGuire, Washington.

THE AMERICAN FIBER CONDUIT CORP., Fulton, N. Y., has been incorporated with a capital of \$350,000 to manufacture fiber conduits and other fiber products. The incorporators are G. M. Fanning, G. Crossman and R. F. Freeman, Fulton.

DOE & INGALLS, INC., Boston, Mass., has been incorporated with a capital of \$100,000 to manufacture chemicals and chemical byproducts. The incorporators are Robert C. Ingalls, Charles E. Haywood and Willis H. Doe, 236 Milk St.

THE VEREX CHEMICAL Co., Lakewood, N. J., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture chemical products. The incorporators are Lester H. Sparks, Arthur R. Smock and William J. Norton, Lakewood.

THE M. & M. MFG. Co., Tipton, Ind., has been incorporated with a capital of \$10,000 to manufacture chemicals and chemical byproducts. The incorporators are E. L. and T. M. Mitchell, and J. W. Meader, Tipton.

THE DUNBAR OIL Co., 43 East Ohio St., Chicago, Ill., has been incorporated with a capital of \$100,000 to manufacture refined oil products. The incorporators are J. O. Karstrom, E. W. Spicer and R. B. Kee.

THE KARVA LABORATORIES, INC., New York, has been incorporated with a capital of \$15,000 to manufacture chemicals and affiliated products. The incorporators are J. Schron, L. L. Leventritt and R. S. Mazzola, 128 Broadway.

THE PENNSYLVANIA METAL REDUCTION Co., Pittsburgh, Pa., has been incorporated with a capital of \$10,000 to operate a metal-refining plant. E. F. Straw, Pittsburgh, is treasurer.

THE ALLIED RUBBER COMPANIES, INC., Calvert Bldg., Baltimore, Md., has been incorporated with a capital of 500,000 shares of stock, no par value, to manufacture rubber products, gutta percha specialties, etc. The incorporators are William Leary, James A. Curtis and Leslie E. Mihm.

THE PARKER RUBBER MFG. Co., Boston, Mass., has been incorporated with a capital of \$125,000 to manufacture rubber goods. The incorporators are David H. Finberg, Philip Finberg, and Harry D. Finberg, 621 Albany St.

KEINER & Co., Newark, N. J., have been incorporated with a capital of \$125,000 to manufacture chemical products. The incorporators are Erich G. Keiner, Wilmington, Mass.; Irving Willner and Jacob Lubetkin, Newark.

THE DUQUESNE SHEET GLASS Co., Pittsburgh, Pa., has been incorporated under Delaware laws with capital of \$100,000 to manufacture sheet glass specialties. The incorporators are Thomas H. Chadwick, Pittsburgh; George W. Fees, Arnold, Pa.; and John A. Wilson, Wilkinsburg, Pa.

THE IMPERIAL JAPANING & ENAMELING WORKS, INC., 408 West Grand Ave., Chicago, Ill., has been incorporated with a capital of \$100,000 to manufacture enamelled products, japanned goods, etc. The incorporators are John A. Skailand, Joseph V. Janda and William Link.

THE RICHFIELD GRANT OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$1,500,000 to manufacture petroleum products. The incorporators are W. J. Honam, Los Angeles; J. E. Michel, Corcoran, Cal.; A. W. Miller, Riverside, Cal.

THE TAYLOR RUBBER Co., Detroit, Mich., has been incorporated with a capital of \$1,000,000 to manufacture rubber products. The incorporators are Hugh Thorburn, 510 Newport Ave., Detroit; and Parker G. Ballon, Rathbone, Ont.

THE MCLAIN OIL CORP., New York, has been incorporated with a capital of \$175,000 to manufacture refined oil products. The incorporators are J. D. Martensen, C. W. Osborne and J. F. Renfro, 212 West 68th St.

THE EXCHANGE CHEMICAL Co., Bangor, Me., has been incorporated with a capital of \$50,000 to manufacture chemicals and byproducts. The incorporators are Julius Byer, Moses L. Friedman and Max S. Kominsky, Bangor.

THE AMERICAN APPARATUS GLASS Co., Vineland, N. J., has been organized to manufacture scientific laboratory glassware. The company is headed by S. A. Giederoye, president; W. Shewell Hood, vice-president and general manager; and Otto Lind, treasurer and superintendent.

THE KENTUCKY SHALE PRODUCTS Co., Bardstown, Ky., has been organized to manufacture brick and other burned clay products. The company is headed by J. B. Beam, L. B. Samuel and J. A. Fulton, Bardstown.

THE NEW PROCESS METAL CORP., Newark, N. J., has been incorporated with a capital of \$250,000 to manufacture refined metals and metal alloys. The incorporators are Walter F. Young, Newark; Sydney T. Edge, West Paterson; and Frank J. Morris, West Orange, N. J.

THE CHRISTENSEN & OLSEN FOUNDRY Co., 1713 Carroll Ave., Chicago, Ill., has been incorporated with a capital of \$5,000 to manufacture aluminum, brass and bronze, castings, etc. The incorporators are Arthur O. Olsen and S. L. Christensen.

THE SUPERIOR PRODUCTS Co., Cortland, N. Y., has been incorporated with a capital of \$15,000 to manufacture paint and kindred products. The incorporators are A. A. Loomis, C. M. Smith and C. R. Hall, Cortland.

Capital Increases, Etc.

THE TEXAS Co., 17 Battery Pl., New York, operating oil refineries at various points in Texas, has arranged for an increase in capital from \$130,000,000 to \$143,000,000.

THE MICHIGAN PAPER Co., Plainwell, Mich., has increased its capital from \$1,000,000 to \$3,000,000 for expansion.

THE NOXON CHEMICAL PRODUCTS Co., 22 Hackett St., Newark, N. J., has filed notice of increase in capital from \$150,000 to \$325,000 for general operations, expansion, etc.

THE CHEMICALS INDUSTRIALS CORP., New York, has filed notice of increase in capital from \$29,000,000 to \$33,000,000 for proposed extensions.

THE SIMPSON CLARK GLASS Co., 164 West Randolph St., Chicago, Ill., has filed notice of increase in capital from \$75,000 to \$100,000.

THE GEORGE STRATFORD OAKUM Co., Cornelison Ave., Jersey City, N. J., manufacturer of marine oakum, etc., has filed notice of increase in capital from \$60,000 to \$500,000 for proposed expansion.

THE CHEMICAL RESEARCH Co. OF AMERICA, Boston, Mass., has filed notice of change of name to Korite Products, Inc., to manufacture chemical specialties.

THE GILMAN PAINT & VARNISH Co., Chattanooga, Tenn., manufacturer of paints, oils, varnishes, etc., has increased its capital to \$75,000. W. D. Gilman is president.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17.

AMERICAN PAPER & PULP ASSOCIATION will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

HARVARD ALUMNI CHEMISTS' ASSOCIATION will meet Tuesday noon April 26 at Rochester, N. Y., for luncheon.

NATIONAL PETROLEUM CONGRESS will meet at the Hotel Baltimore, Kansas City, Mo., March 22 to 25.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

REFRATORIES MANUFACTURING ASSOCIATION will hold a meeting at the Hotel Pennsylvania, New York City, March 17 to 19.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27 to 29.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: March 11, American Chemical Society; March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

CHEMICAL & METALLURGICAL ENGINEERING

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Legislation That Passed

And Legislation That Failed

THE chemical industries cannot find a great deal of comfort in the legislative status at the close of the last session of Congress, for many of the measures in which these industries are interested failed of passage. Moreover, it should be understood that the new Congress which will convene shortly will start afresh in all these matters, just as though there had not been any legislative effort made by the previous Congress. Each bill, no matter how far it had advanced in the last session, must be introduced, referred to committee, reported to each house, acted upon, sent to conference to adjust differences between the two houses, and the conference report acted upon in each house, and transmitted to the President for signature. It is easily seen why it is such a shame to have legislation fail at the end of a Congress when all this effort and expense must again be incurred for the passage of bills which were previously so near enactment.

Conspicuous among the incomplete legislation at the end of the Congress were the Army and Navy appropriation bills. In these two supply measures are included the money for chemical warfare, for the helium investigations and for other military and naval activities. The separate bill providing for the Fixed Nitrogen Corporation also failed of passage, although it was approved by the Senate in much emasculated form following amendments proposed by Senators WADSWORTH and LENROOT. This bill, which would have provided for the continued operation of the Muscle Shoals nitrate plant, died because the House Committee on Military Affairs under the chairmanship of Representative KAHN held the bill without action from Jan. 14 to the end of the session of Congress. However, it is doubtful whether the bill would have passed in any useful form even if it had been reported by this committee, since the appropriation for the Muscle Shoals project for power development through the Wilson dam was defeated. The defeat of this power measure was doubtless the result of the co-operation of two groups, one of which sought economy in expenditures, the other of which opposed the bill on the ground of policy, objecting to the Government entry into further power development, especially under circumstances where the power project was so closely associated with the nitrate plant.

In connection with power matters, special notice should be given to the failure of Congress to provide adequately for the Federal Power Commission. This and the failure to provide for reorganization of the Patent Office will mean that these two important engineering services of the Government will either mark time or actually slip backward during the coming fiscal

year unless some new legislation is successfully handled in the coming session of Congress. Without a Patent Office adequately manned, business is sure to suffer. Without a Power Commission provided with suitable personnel all industry will be condemned to delay in its effort to secure adequate water power. No measure of economy can possibly justify these items of saving in appropriation. It is simply an unfortunate result of our political system that permits two Senators (SMOOT and JONES) to defeat the Power Commission measure and one Senator (NORRIS) to hold up the Patent Office bill.

It is not surprising to record that the duty-free importation of glassware and chemicals and the dyestuff import legislation remained without favorable action in the Senate. Both these measures and the emergency tariff legislation, which was vetoed by the President, will doubtless be reconsidered in connection with the general tariff revision which will be a leading measure in the new Congress. It is to be hoped that these technical matters will thus receive most sympathetic consideration in the Fordney tariff law, which will undoubtedly be enacted at an early date unless it is decided as a matter of policy to reenact the Payne-Aldrich tariff as an immediate but temporary measure. It is rumored that this may be done in order that the Republican policies of protection for industry provided by the Payne-Aldrich law may at once supersede the Democratic free-trade idea which was, of course, basic in the Underwood law of 1913, which still stands on the statute books.

With such important matters as the two remaining appropriation bills, the whole problem of taxation, tariff and revenue legislation, and the responsibility for some sort of peace treaty upon the hands of the new Congress, much minor legislation will doubtless suffer. However, it is likely that the Congressional commission appointed to investigate the needs and possibilities of Government reorganization and creation of the new Department of Public Works will be busy during the coming year. This commission under the chairmanship of Senator SMOOT is already engaged upon certain work which will doubtless lead to bills to supersede those introduced in the last Congress which received no attention after the appointment of this commission was agreed to. Incidentally this reorganization of the Government departments, in which Secretary of Commerce HOOVER will doubtless have a large influence, has an important bearing upon budget legislation. In view of this fact the technical branches of the Government service, which are those most vitally concerned, may receive the attention which they deserve, being carried forward to prominent place in the legislative program because of the desire to have the budget measures adequately considered at an early date.

What We Want Is Orders

VERY fortunately one fashion is going out—that of counting up the “needs” in steel of the railroads, or the United States as a whole, or the world. Everyone can recall how much talk there has been along this line and everyone can see that we have got nowhere with it. What we want is orders.

Needs are of no importance unless they can be expressed, and then they do not count unless they can be met. There must be the ability to buy and the ability to produce. We certainly have the ability to produce, although we did not have it during the first nine months of last year. Then there was heavy demand, yet the steel mills did not average over an 80 per cent operation.

In a measure the transaction of business is a cycle of operations. One buys from another, he from a third and so on around to the first again. One line cannot be very active unless other lines are active. The farmer raises corn, the breakfast food factory buys it, the story writer consumes the corn flakes and the farmer subscribes for the magazine. A partial exception to the ordinary circle of transactions occurs when there is construction work, for it is set not against present consumption but prospective consumption. If the respective prices of corn, corn flakes, stories and magazines have proper relationship, no matter what the basis, business can be transacted, but construction work must cost in relation to values in future. Hence when prices in general are declining, construction work lags, while when prospects are for higher prices investors hasten to take hold.

As steel is used largely for construction purposes, its selling price needs to be in relation to future values in general. In addition to this there is the situation that there are large “needs” for steel, yet the needs are not expressed in orders, because those who need steel cannot afford to buy. The gap can be bridged by movement from each side, by increasing ability to buy and by the quantity of steel available for a given sum of money being increased. The per ton price of steel can never mount so high as to prevent steel from being used for watch springs, but it can be too high to warrant the building of a given bridge. The steel-making capacity is so large that it requires demand from all possible sources. Steel must make as wide a market for itself as can be found.

We have had enough of this talk about there being great needs in steel, of the world being short of steel. Let the talk be dismissed by a sweeping admission that it is all true. The vital fact today is that the great need is for steel orders. The constructive work to be done is in getting down the cost of producing steel. There has been some talk lately in various quarters about the necessity of steel prices being reduced. The matter of selling price is of very little moment just now. The steel price list is ephemeral. There is no demand in the market just now, and if there is an improper gap between production cost and market asking prices the gap will no doubt be reduced in ample time. The vital thing is the cost of production, which is too high. The labor cost is too high. Wage rates are too high in relation to the cost of living and the cost of living is too high. Wholesale prices are down and the retail storekeeper is either making too much money or is not performing his function of distribution properly. Freight rates are altogether too high. The amount of money that must be

paid so that a ton of finished steel may be delivered to the consumer is altogether out of a natural proportion, chiefly because the railroad payrolls, on which freight rates are based, have been entirely too high and out of all proportion to the service performed by the railroads. Analyses that may be made of “what becomes of the railroad dollar” vary widely because conditions change so rapidly. The railroad operating ratio, operating expenses to operating revenues, was 70.57 per cent in 1917 and 93.53 per cent in 1920, while now it is a still different thing. One illustrative comparison can be made, however, that the railroad payroll has lately been running at about \$3,700,000,000 a year while the extra half per cent the Interstate Commerce Commission accorded the railroads under the permission given by the transportation act would, if the railroads were able to collect it by having enough traffic, amount to about \$95,000,000. There is a ratio of about 39 to 1, certainly very suggestive. The steel industry has already addressed itself to these two big items, of its wages and its freight bills, as well as to many other smaller items, for the purpose of reducing costs and making a market for steel.

Labels to Inform And to Deceive

“MADE in Germany,” “Made in Nippon” and “Made in U. S. A.” are all labels of distinct industrial significance. It is well, therefore, that the Federal Trade Commission is giving particular attention just now to the deceptive practice which is creeping into American commerce whereby certain foreign interests and American importers seem to be co-operating in an effort toward deception of the American public and the defeat of legitimate American industry.

The Federal Trade Commission has just announced (March 5) a citation of a New York manufacturing company to show cause why it should not cease mislabeling the device which it sells. On the outside of this device a brand “White House” appears, and the company even labels the exterior portion of the device “Made in U. S. A.” to convey the impression that the entire device is of domestic production. As a matter of fact the main portion of this device is made in Germany, and careful examination of the interior of the instrument shows this fact. Obviously the trade practice is a vicious one and it is to be hoped that the commission will be successful in eliminating this type of bad practice.

It is very unfortunate that each unit of chemical production, such as dyestuffs, intermediates, pharmaceuticals, etc., cannot be clearly labeled as to its original source. It might even be worth while for the American chemical industry to appeal to Congress for legislation requiring that materials important to domestic industry should be labeled as to their source. Such a plan would be entirely feasible, for on repackaging it would not be at all difficult to label properly and conspicuously the container with the source of original production. The only question would be to decide when a material refined or purified in this country has ceased to be essentially of foreign production and become properly “naturalized” as an American product. Yet there is no question that instruments and other articles of manufacture which can easily be labeled should be properly so stamped.

Actual Smoke Damage

Must Cause Visible Markings

IT MUST be a source of deep satisfaction to Dr. O'GARA and his assistants to find that the conclusions they reached so early in their researches on the smoke problem have received the unqualified assent of independent investigators. The main results of their studies, started about seven years ago, are now fairly widely known and accepted by plant pathologists. Officials of their own concern, the American Smelting & Refining Co., have also been convinced of the soundness of the deductions, as witness the expenditure of several hundred thousand dollars for new flue and stack systems at various plants. While a marked reduction in the number of complaints from neighboring farmers immediately followed the completion of such improvements, the final test of all remained—whether a smelter operating under correct conditions, as determined by the researches, would be permitted to continue so to operate by a judge when deciding a so-called "smoke suit"; that is to say, whether a court could be thoroughly convinced of the efficacy of modern methods of eliminating damage by sulphur smoke.

That this final test has been successfully passed is apparent from a perusal of the report rendered by Prof. ROBERT E. SWAIN, acting as commissioner, to Federal Judge JOHNSON. Judge JOHNSON expressed the opinion over a year ago that the A. S. & R. Co. officials had "practically solved the smoke problem." They were then given the opportunity of suggesting operating stipulations embodied in an interlocutory decree, which must have been done by them with a knowledge that they could operate with a good factor of safety. Dr. SWAIN'S most painstaking and independent researches now give that company a clean bill of health.

How far apart the parties to a litigation may be is apparent from the fact that only a few years ago most operating companies stoutly contended that only solid matter in smelter smoke was dangerous, and since gases could easily be cleared from fume they were doing no damage. Farmers, on the other hand, were not able to recognize the true enemy, but were sure that in some cases a low yield of second grade crops resulted even when visual plant damage was entirely absent. Recognition that sulphur dioxide is the great trouble maker is no less an achievement than that plant damage to be real must be visible. What a task is the latter can be appreciated by any one who has tried to replace prejudice or fear by reason.

Dr. SWAIN bases his findings on the fact that repeated fumigation of plants with concentrations of sulphur dioxide too slight to give rise to foliar markings will not cause injury by reducing their vitality or the crop yield, even though visible typical discolorations are not produced. In other words, he assumes that the theory of "invisible injury," the "unsichtbare Beschädigungen," advanced especially by some of the earlier German investigators is untenable. That theory has never been supported by any conclusive evidence.

A turning point in the investigation of the effects of smelter smoke on plant life occurred early in the work of the Selby Smelter Commission when MARSTON and WELLS devised a method for the determination of sulphur dioxide which will yield results of a high degree of accuracy even at very low concentration. With this method at hand the way was at once open to a much more accurate control of fumigation experiments.

It was soon demonstrated that sulphur dioxide is absorbed very rapidly by soil, and by vegetation with which it is in contact. Sulphur dioxide in the air of a closed fumigation cabinet containing plants was also found to decrease rapidly. This observation revealed only one more weakness to add to those already recognized in the older methods of fumigation, and it was not long until apparatus was developed for the fumigation of plants by moving currents of air, rather than by still atmospheres, a type of apparatus used in all important recent work.

Therefore we now have every reason for believing that sulphur dioxide is freely tolerated at concentrations which are below those which will produce foliar markings and hence visible injury. In all probability SO_2 is even directly utilized by plants and there are no effects, immediate or remote, on their general metabolism which lead to a lowered vitality, to any interference with the processes of growth or reproduction, or to any reduction in crop yield. When the limiting concentrations under the prevailing conditions of humidity, light, temperature and duration of exposure are exceeded, resulting in injury, this is primarily a local injury, and quickly leads to discolorations which are quite typical and pronounced. When this point is reached, and not until then, can it be claimed that injury has been done.

A Review on Book Reviewers

THE Valentine Number of *Life* makes a few comments that should not be overlooked by all who write or read book reviews. "T. L. M." states that he is quite positive that book reviewers as a class are wholly misunderstood. Their nice sense of honor prevents them from associating with authors whose books they review, their relationships being with people of a lower order, such as publishers and editors. Their only knowledge of authors is of necessity derived from the past, and when one reads that ARISTOPHANES was extremely vulgar, that GOETHE was undomestic in his habits, that SHAKESPEARE deserted his wife, that SAMUEL JOHNSON gorged himself and that SHELLEY was excessively irreligious, it is quite natural that book reviewers should view all authors with distrust. The simple fact that any author writes a book is indeed quite likely to prejudice the book reviewer against him.

The complaint is that they do not actually read the book they review but use it as a peg to hang a few pet thoughts on, and not to tell what it is or what it ought to be. The fact is, of course, that reading the books is not necessary. It is not the province of book reviewers to tell what is in a book. If they did this there would be no use in offering the book to the public as food for the mind. It is only necessary to give their opinion after analyzing samples taken here and there after the fashion of a chemist working on coal. They should also have themselves under such control as to restrain themselves from writing anything clever about the book, merely for the sake of being clever, without regard to the damage done to the author and publisher.

All the big bow-wow book reviewers who are obliged by necessity to read one or even two books a day in order to keep up with the literary profession should certainly be provided with helpers, who might be apprenticed to their masters for a term of years before being classed as reviewers.

Readers' Views and Comments

Compensation of Chemists and Salesmen

To the Editor of Chemical & Metallurgical Engineering

SIR:—At a time when our various chemical societies are paying so much attention to the development and promotion of chemical industry, it may be well to investigate the compensation which these industrials are paying their chemical and technical employees. One thing is certain, the chemical societies themselves have up until this time done nothing of this character for their membership.

When the employers of professional chemists begin to weep and wail because of their unparalleled misfortune and the threatened destruction of their income, it is natural that one should examine some of the underlying causes of their distress. For example, we find that some of them employ college-trained chemists, and that they are paying these chemists from \$2,000 per year all the way up to \$3,000 per year. Now a capable stenographer in prosperous sales offices is frequently paid \$2,000 per year, and the "college training" which she has endured may have lasted anywhere from three to five months in some "business college" at a cost of about \$50 for tuition.

These chemists at two or three thousand per annum meet periodically in chemical societies, where they pass sundry resolutions asking for a high protective tariff for the dye industry, and are asked to vote in favor of the passage of certain industrial bills. At a recent meeting of one of these chemical societies the chairman before asking for a vote on a dye tariff bill asked the members if any one was able to state the text of the proposed bill and later asked if any one who had voted for the bill knew anything about the dye industry. The response to this question was a blank silence. And so we find that these \$3,000 per annum chemists are working in and out of office hours for the benefit of their employers. They believe that this is necessary in order to retain their positions. Here is altruism of the purest and highest sort.

Now let us see what the average employer of chemists is giving his *salesmen* in the way of compensation. He offers to a young man with a grammar school education \$2,000 a year to start as a salesman; if he possesses average ability he can earn \$5,000 per year; if he possesses special ability he is later paid \$7,500 and commissions; but if he is a star salesman he expects and receives \$10,000 to \$15,000 per year. The *star* salesman can be recognized in some firms by his acts. For example, he will send in orders to the chief chemist as to what he wants done so that the salesman's salary and commissions will be maintained. The general manager tells the chief chemist and the laboratory department of which he is the head: "You will have to get busy and help us over this trouble, for if you can't, there is no use of having a laboratory." And so the \$3,000 or \$5,000 chemist is warned to "get busy" so that a series of \$10,000 and \$15,000 salesmen may thrive.

Now let us see what the average employer of chemists is doing for his chemical adviser. He gives him a one- or two-year contract with the proviso that it may be

canceled by the employer, in case there should be any "error of judgment" on the part of the employer. He gives his chemical adviser a two-weeks' vacation, and asks him to "assign all inventions and discoveries to the company."

If on the other hand you will note how the employer finds his chemists you will see such advertisements as this: "Wanted, a young college graduate, to take charge of a new laboratory. We want a young man, one who will grow up with the business. Salary to start, \$1,500 per annum." Presently we find this same employer complaining bitterly about his "chemist," whereas in reality he has no chemist at all in his employ. All that he has is a young college graduate, and that was what he advertised for. He proudly boasts that "I pay my chemist what he is worth, and he is hardly worth the \$1,500." The employer apparently does not realize that he is actually giving this young man a post-graduate course, and the \$1,500 is merely a stipend, annuity, scholarship or bread-money while he is learning the business.

The employer will also state very seriously that many chemists are fakers, bluffers and sons of black magic. Within the last six months a representative of a prominent firm of manufacturing chemists came to me and asked if I could supply him with details for the manufacture of blue-stone or copper sulphate. He said verbatim: "I would pay as much as \$50 for this information." When told that this was somewhat out of proportion to the money which he hoped to make from the process, he stated verbatim: "Well, I think I will send my man over to the Chemists' Club to the next dinner meeting. He will be able to pick up some information there, and it will cost me only the price of a dinner." This man is the executive of a flourishing chemical company. He thrives on chemists, and he pays them anywhere from \$1,500 to \$2,500 per annum, because in his opinion "they are not worth more."

I firmly believe that the time has arrived when chemists in each state of the Union must organize state chemical societies for the purpose of:

1. Protecting college-trained chemists from unscrupulous employers.
2. Providing honest employers with chemical advisers whose record and achievements are known.
3. Providing a bureau of "professional rating" for college-trained chemists and for such other men who have scientific knowledge of a specified industry.
4. Publishing correct advice to professional chemists regarding their legal rights in matters of employment.
5. Recommending to college professors suitable courses of instruction for chemists who are to help our American chemical industries. If, however, the college professors refuse to consider recommendations, the matter should be taken up with the college executive, because he is the man who appeals to the industrial corporations for financial assistance.
6. Restricting the use of college apparatus and equipment by professors who now really carry on a practice as "consulting chemist" and who compete directly with consulting chemists who do not receive salaries as professors. From all accounts it seems that some colleges solicit funds from the public in order to maintain a private consulting practice for a college professor. In such cases it is obvious that the college is in fact maintaining a private business conducted by one of its professors. If the professor is a valuable asset to the college, he should undoubtedly receive a

salary commensurate with the salaries paid to other persons having similar experience and ability.

7. Conducting meetings at which older practitioners will discuss the "practice of chemistry as a profession." To these meetings the chemical students of colleges should be invited, so that gradually a system of ethics may be built up without the need of a printed code.

8. Supporting a journal or other publication whereby chemists throughout the state will be kept informed of the activities of chemists and chemical industries in the state.

9. Offering to banks, investors and chambers of commerce proper guidance in the choice of chemical advisors.

10. Keeping a lookout on the water supply, gas supply and garbage disposal conditions within the cities. Demanding justice and fair treatment of the citizens by the public utility companies.

11. Advising public officials when cases arise within the state relating to pollution of the air by chemical fumes or smoke, pollution of the streams by factory waste waters or sewage, special fire hazards due to dangerous location of new factories, the sale of bad milk, butter or other food products.

12. Informing the U. S. Tariff Commission and those intrusted with the framing of tariff acts if a given industry in the state is worthy of tariff protection.

13. Securing and maintaining within the state at one or more places a modern library of books on chemistry and the sciences related to chemistry. This provides for co-operation with all existing agencies of the kind by acts as well as by resolutions.

14. Maintaining friendly relations with all other State chemical societies and providing for an interchange of information.

15. Constituting special committees of competent chemists whose business it shall be to discuss and report on the preceding "purposes."

Newark, N. J.

WALTER FERGUSON.

Purity for the Pure

To the Editor of Chemical & Metallurgical Engineering

SIR:—Several of our most distinguished scientists in the teaching profession are going up and down the land expounding on a theme which might be titled "Pure Scientists Want to Remain Pure." They talk against business and commercial tendencies as applied to research and teaching with a tone almost bitter in its denunciation of business and business methods until one might be led to believe that "business" in connection with anything is a term of reproach. Now we would not quarrel with them in the matter of abstract research as long as it deals with live subjects and we would certainly favor freedom of choice in methods of procedure but must deplore the strong aversion manifested toward the ways of commerce.

Business is a science founded on economic laws quite as exact as those of chemistry, and far from being a questionable occupation is certainly as honorably practiced as other sciences, and by men of equal honor. Business men play their game for the love of the work to as great an extent as do our pedagogical friends. The main difference is that dollars are the counters in one instance and technical accomplishments in the other. Another variation lies in the fact that when the business man loses his counters he must perforce stop the play, while the college professor, supported as he is by taxation of lenient business men, can continue in the face of numerous negative results.

It is well to support research and teaching on a high plane, but certain concentration so necessary to business success will not go amiss in the schools and laboratories. The line of thought should not wander so far from the sphere of practical application as to pass like atoms in the air through the orbital strata and become lost in the universe of dreams. Until the work in

schools and colleges is conducted on a business basis—till they become self-supporting—the business men who now support them through taxes and endowments will demand a certain "hewing to the line."

Were the universities left to the management of un-businesslike faculties the result would be a decay of purpose throughout all departments. They would attain the condition of the inveterate bookworm who reads without plan for his own pleasure until he becomes nothing but mere dreamer and puts his life away in the library corridors, a sad example of premature senility.

This is not intended as a sermon against abstract science, but rather a plea from the lowbrow business outpost. Perhaps many of your readers, too modest or too busy to express their views, may concur in these opinions.

F. GISTON.

Analytical Control of Electrolytic Zinc Production

To the Editor of Chemical & Metallurgical Engineering

SIR:—For the benefit of those chemists who may have tried the methods given under the above title in *CHEMICAL & METALLURGICAL ENGINEERING*, vol. 22, p. 651 (April 7, 1920), I should like to present a few revisions which will simplify matters in some cases.

Analysis of Leach Solution (Unpurified).—With certain kinds of solutions it is impossible to filter the precipitate obtained with H_2S unless the solution is diluted to several volumes before making the precipitation. Copper and antimony may be determined as usual in this precipitate, or copper may be precipitated with "hypo" without much dilution.

Cadmium in such a solution is easily determined as follows: Take 200 c.c. of solution. If considerable ferrous iron is present, oxidize it in presence of acid with $KMnO_4$ from a burette, avoiding excess $KMnO_4$. Add 25 g. NH_4Cl , then sufficient NH_4OH to redissolve $Zn(OH)_2$, boil, filter by suction, and wash with warm dilute NH_4OH . To the filtrate add slowly, with stirring, enough Na_2S (3 per cent solution of crystals) to precipitate copper and cadmium, plus a little excess. Roughly, $Cu \times 3.8 + Cd \times 2.2 = Na_2S.9H_2O$. Heat to boiling, let settle about one hour, and filter by suction on Büchner funnel, using three close papers, and washing with warm dilute NH_4OH . The precipitate is treated with 25 per cent H_2SO_4 , etc., exactly as in the determination of cadmium in "Pure Electrolyte."

Analysis of Zinc Dust Precipitate.—The following short methods are applicable when the material is low in SiO_2 and the cadmium and zinc are entirely soluble in H_2SO_4 :

Copper.—To 0.5000 g. sample in small covered beaker add 2 c.c. HNO_3 and agitate until violent action has stopped. Wash cover and sides of beaker with a fine jet of water, add a small grain of $KClO_3$, and evaporate to about 0.5 c.c. Add about 20 c.c. of water, neutralize with KOH , acidify with acetic acid, add about 0.25 g. of sodium ammonium phosphate in 20 c.c. of water, and finish by the iodide method.

Cadmium and Zinc.—To 0.5000 g. sample add 40 c.c. of water, 6 c.c. H_2SO_4 , and a few drops of HCl . Heat to boiling, add a drop of dilute platinum chloride, and boil about two minutes. Cool the liquid to about 40 deg. C., remove the copper as in the original method, dilute to 125 c.c., and precipitate CdS from the cold solution. The rest of the procedure is identical with the original method.

H. F. BRADLEY.

Park City, Utah.

Notes on French Industries

FROM OUR SPECIAL CORRESPONDENT

PARIS, France, Feb. 15, 1921.

THE subject of nitrogen fixation is now occupying a prominent place in French financial and industrial circles. The Compagnie Nationale de l'Azote (National Nitrogen Co.), recently founded and capitalized at 12,500,000 f., hopes to obtain a license for the Haber process, which, as reported in CHEMICAL & METALLURGICAL ENGINEERING of Nov. 17, 1920, p. 956, was bought by the French Government for 50,000,000 f. from the Badische Anilin- und Soda-Fabrik; but this license privilege will require the sanction of the French Parliament. In the meantime the shareholders of the company have voted an increase of capital to 20,000,000 f., and in addition, it is rumored, to issue bonds for 100,000,000 f. This last policy will be strongly opposed, especially by the periodical *L'Engrais*, devoted to the fertilizer industry. It is also stated that the company is intimately connected with the Société Kuhlmann, which is already using the Haber process. To complicate things even more, it is expected that in the near future patent infringement litigation will start between the companies using the Haber process and the Société L'Air Liquide (Liquid Air) which uses the Georges Claude process, based on the allegation that this last process is merely a modification of the Haber process.

FINANCIAL DIFFICULTIES IN THE CHEMICAL INDUSTRY

The Société Alsacienne de Produits Chimiques, which has recently increased its capital to 30,000,000 f., as reported in my previous letter (CHEM. & MET., Feb. 23, 1921, p. 328), is now facing great financial difficulties due to the precarious situation of the Banque Industrielle de Chine (China Industrial Bank), which is the backer of the company.

The Compagnie Nationale de Matières Colorantes (National Dyes Co.), with its new plants at Oissel and Villers, is now in a position where it can work only part time and had to close and finally abandon its model research laboratory at Suresne. It is foreseen that the company will soon be forced to increase its capital.

The Usines Chimiques du Rhone has made the announcement that it will increase its capital from 3,200,000 f. to 21,600,000 f. by issuing 184,000 100-f. new shares. The company is now producing synthetic perfumes, pharmaceutical and other organic synthetic products. It has completely abandoned the manufacture of war-time products. (During the war this company produced 150 tons of phenol per day.)

Sales of chemically manufactured products have almost completely stopped and this is a source of great concern, especially to the Union des Producteurs et Consommateurs pour le Développement de l'Industrie des Matières Colorantes (Union of Producers and Consumers for the Development of the Dye Industry in France). This union, which was created to serve as a go-between for producers and consumers, bought in Germany soon after the armistice was signed practically all the dyes it could find on the market, but it cannot sell them, so that now it has vast quantities of dyes in stock waiting for buyers.

The French Government is trying by every means at its disposal to encourage the national chemical industry and to counteract the flooding of the French market with German chemical products. The best the govern-

ment could do was to treble the import tariff for the greater part of the intermediates derived from coal tar. The list of these products which are now subjected to the new tariff was published in the Jan. 14, 1921, number of the *Journal Officiel*. The impression which prevails among the French chemical producers and especially among the dye manufacturers is that the aim of this new tariff schedule is to give to the national industry an opportunity to develop and to demonstrate whether it can resist foreign competition and subsist.

SITUATION OF THE FRENCH METALLURGICAL INDUSTRY

The Comptoir Métallurgique de Longwy, which for the last forty-five years has controlled the market of French phosphoric pig iron, was dissolved on Feb. 1, 1921. This comptoir, which comprised twenty French metallurgical companies, was forced to cease its operations due to its inability for some time past to exercise on the market a regulating and stabilizing influence as in former years and which was its *raison d'être*. This is due especially to the strong influence exercised by the new Lorraine companies, which possess great producing capacities and have yet vast quantities in stock, thus enabling them to flood the French market with their products. To this is also to be added the continuous inflow of Belgian and Great Duchy of Luxembourg products, which can be placed on the French market at prices far more advantageous than those asked for the French products.

Negotiations are now going on for the creation of a combination of French, Belgian and Luxembourg producers; it is expected that if such a combination is formed it will result in the elimination of an abnormal competition system and will put a stop to the policy of price cutting beyond reasonable limits.

FRENCH OIL SHALE

The increasing demand for oil and the continuous increase in its cost contribute to a serious consideration of giving an impetus to the French shale oil industry. Although France has extensive deposits of oil shale, especially around Bussières and Autun, very little attention has been given to this important material and at present there is only one oil shale-distilling plant of importance in all France. This plant is situated at Seyssel (Department of Ain) and produces annually about 100,000 hl. of oil (about 2,500,000 gal.), necessitating the treatment of about 200,000 tons of shale. The Scotch type of retorts has gradually displaced the older iron vertical retorts. The density of the oil is between 0.870 and 0.900; it contains about 5 per cent light oils of 0.730 to 0.750 density and about 30 per cent of oil of 0.810 to 0.850 density, the remainder being heavy oil used generally for manufacturing oil gas; the coke residue amounts to about 2.7 per cent. The greater part of the 0.850-density oil is used for lighting and a small part of the 0.875-density oil serves as a solvent for the extraction of alkaloids from quinine. The gas is used partly under the retort and the remainder, after washing and purifying, is used for lighting. In addition the Seyssel plant is producing about 10 lb. of ammonium sulphate per ton of shale treated.

The oil-shale industry, which up to 1914 subsisted only with difficulty, has since then grown steadily, and it is expected that in the near future the production will be trebled. Plans are now under consideration for the development of the French oil-shale deposits.

Swain's Report on Smoke in Salt Lake Valley

Summary of Field Conditions Surrounding Murray and Midvale Smelters and the Resulting Effect on Plant and Human Life — Notes on Operating Conditions Giving Immunity From Damage and Difficulties in Stipulating Maintenance Without Hampering Progress

IT MAY be recollected that during February, 1920, Federal Judge Johnson decided a smoke suit against the American Smelting & Refining Co. and the United States Smelting, Refining & Mining Co., allowing their smelters at Murray and Midvale respectively to continue operations under certain conditions and under observation of a staff headed by Prof. R. E. Swain of Leland Stanford University.¹ Prof. Swain, acting as commissioner, was to report his findings to the Judge after one year, this report to form a basis of a permanent stipulation as to methods of smelter operation whereby no nuisance or damage in the surrounding country would result.

After a year's research by eight assistants the commissioner has presented an exhaustive report, containing about 500 typewritten pages and many plates and photographs. A summary of his conclusions of general interest follows:

CONDITIONS AT MURRAY

The evidence appears to be conclusive that the plant of the American Smelting & Refining Co. at Murray was not at any time during the period of this investigation an agent of injury to crops or to vegetation of any kind, or the cause of personal discomfort or ill-health to the residents of that district.

Dr. Pool was in residence here without interruption from May 3 to Sept. 8. It is his expressed opinion that there was no damage whatever by sulphur dioxide even to the extent of questionable foliar markings on the most sensitive plants in the Murray district during the period of his residence here. My own observations are in entire agreement with those of Dr. Pool.

CONCENTRATION DANGEROUS TO PLANT LIFE

A study of the record of the atmospheric analyses made on the Murray smoke stream reveals no series of consecutive determinations, nor any average concentration for an hour or more, at any point in that district which, under critical weather conditions, would give rise to undoubted injury to sensitive vegetation. During the growing season—from May 2 to Oct. 19—4,386 determinations of sulphur dioxide were made on the air of this district at locations which were as nearly as possible in the line of movement of the roaster stack gases. When proper allowance is made for the probable analytical error in the method employed as determined by the control tests which were made at intervals during the investigation, none of these determinations shows an hourly average of more than one part per million. Even under weather conditions most favorable to sulphur dioxide action on the more sensitive crops, injury may not be expected to arise from any maximum hourly average obtained in this field. Owing to the changeable

character of the wind in this section, it rarely happened that a series of determinations could be continued at one station for more than one hour with any reasonable expectation of getting positive results.

It is now generally conceded that a concentration of at least one part per million over a period of three hours is necessary to produce undoubted injury to the more sensitive crops. It will require a concentration of at least 1.3 parts per million if the period of fumigation were reduced to one hour. From either viewpoint, there is not in this record, even in the highest hourly averages found and an assumed coincidence of critical weather conditions, any proof that the more sensitive crops of the Murray district were subject to injurious action by sulphur dioxide at any time during the season of 1920.

CONCENTRATION CAUSING NUISANCE TO HUMANS

The question of whether the waste products discharged from the exit stacks of the Murray plant are injurious to the health or a substantial menace to the comfort and happiness of the residents of the district must be approached from another direction. Fortunately, reliable scientific data are at hand, as a result particularly of the work of the Selby Smelter Commission, bearing on the subject of the local and immediate physiological reactions which are induced by the breathing of air containing sulphur dioxide. The average human adult, who is already acquainted with the odor of this gas, will first be able to detect it at a concentration of 3 to 3.5 parts per million.

The average person not well acquainted with the smell could detect the gas at a concentration of from 4 to 5 parts per million. Above 5 parts the presence of the gas is increasingly apparent until at 10 parts per million the action is usually sufficient to cause most subjects to feel slight discomfort or to cough. Further results of that study, based on observations made on sixty subjects, are that occasional short whiffs of less than 5 parts per million certainly could not be considered a nuisance to anyone; long-continued breathing of air containing slightly more than 5 parts per million would probably cause discomfort to most people, although occasional momentary whiffs of 5 to 10 parts per million would not be disagreeable; and a few breaths of 10 parts per million would probably be called a nuisance by most people, even if this were present only at considerable intervals.

A survey of the entire record of atmospheric tests in the Murray district, amounting to 5,923 single determinations, shows that only nineteen of these represent a concentration of 3 parts or more per million, and only one a concentration of 6 parts per million. The highest concentration ever found in this district was 7.6 parts per million. These higher readings were in all cases preceded and followed by much lower readings. In

¹See "Smoke Litigation in Salt Lake Valley," CHEM. & MET. ENG., vol. 22, p. 1145, June 23, 1920.

other words, they represent momentary "puffs" of smoke, running much higher in sulphur dioxide, which are occasionally noted especially on days of gusty winds. No other conclusion is possible than that the concentrations of sulphur dioxide which occurred in the Murray district during the period of this investigation could not possibly be regarded as a nuisance or an actual cause of notable physical irritation or discomfort to the residents.

GROUND GAS

The contamination of the air in the immediate neighborhood of the plant through leakage of sulphur dioxide from furnaces and flue systems is relatively slight. These so-called "ground gases" or "low-down gases" have often been the cause of justifiable serious complaint by persons residing very near to smelters in other sections of the country. Certain of the older types of roasting furnace were especially hard to control in this respect, back drafts would often occur, and high concentrations of sulphur dioxide would escape directly into the air at the ground level. Although often of high concentration, these low-down gases, with furnaces of modern design, as a rule represent small volumes and rarely travel far from the point of discharge at an objectionable concentration, owing to the rapid absorption of the sulphur dioxide by the soil. At both of the plants concerned in this investigation precautions have been taken to prevent the discharge of furnace gases except through the exit stacks.

Both plants employ the Dwight-Lloyd and the Wedge type of roasting furnaces. The amount of leakage from these furnaces is small, owing to their construction and to the good draft maintained, and the products of combustion are swept away under induced draft into the main flue system. The blast-furnace building at each plant is well ventilated, and points where objectionable waste products may escape are hooded and the emanations are swept out into the ventilating flue.² At the Murray plant the ventilating flue leads to a large brick settling flue where the velocity of the gases is very low, and finally enters the roaster flue near the base of the 455-ft. stack. At the Midvale plant the ventilating gases are conducted to a small bag house, filtered to remove suspended solids, and thence discharged into the air. There is a small loss of sulphur dioxide from the bag house at each plant, especially during shake-down and other periods. This is greatest at Midvale, in the roaster section of the bag house, where the concentration of the sulphur dioxide is (0.70 to 0.85 per cent) much higher than it is in the section which handles the blast-furnace gases (0.01 to 0.05 per cent sulphur dioxide).

LEAD AND ARSENIC LOSSES

The results of the filtration tests at the Murray plant point to an average daily loss from roasting operations through the 455-ft. stack of approximately 90 lb. of lead and 120 lb. of arsenic. These figures are probably fairly representative of the efficiency of the Cottrell process of electrical precipitation, with only two units in operation at one time. There is no evidence that the above losses of lead and arsenic are objectionable. The amounts of arsenic found in the vegetation of near-lying areas are small, and even these are undoubtedly

due in part to the prevalent arsenic in the soils of the valley.

PRECISE EXPERIMENTS ON SOOT FALL

It was our intention to find out much more accurately than would be possible from the analyses of plant samples what the actual atmospheric precipitation of arsenic and lead is in this valley by collecting snow samples by skimming the surface at various locations to a depth of $\frac{1}{2}$ in. over an area of 25 sq.ft. after a heavy snowfall. Then at as long an interval as possible thereafter without the interference of thawing or another snowfall it was planned to make a second collection of samples. The difference in the arsenic and lead in the control and the ensuing test samples would give a fair basis for estimating the amounts of these substances which are thrown into the air by industrial establishments and residential coal burning. With the country blanketed by snow, soil dust would be excluded quite perfectly. By studying the result in relation to wind prevalence and velocity it was hoped that data of real value would thereby be secured.

Unfortunately, there has been no time this winter when a fall of snow has not been followed within twenty-four hours either by another snowfall or by a rapid thaw. It was planned early in the investigation to expose vaselined plates at various stations as a means of approach to this question, but this was abandoned in view of the fact that wind-swept dust from the soil could not be excluded by this proposed method.

But even in the absence of more exact data than those based on the analyses of exposed vegetation, there can be no reasonable cause for concern over the discharge into the open atmosphere, at a considerable height, of the above amounts of arsenic and lead in such a state of extremely fine division as these escaping dusts represent. I am confirmed in this conclusion by an experience with another smelter from which the stack loss of arsenic amounted to approximately thirty tons per day, and with several cement plants from which, before remedial measures were installed, dust in amounts ranging as high as sixty to seventy tons per day was lost.

CONDITIONS AT MIDVALE

The results of the investigation lead to the unavoidable judgment that the Midvale plant has been at times during the past season, and under present conditions and methods of operation may continue to be, an agent of injury to the vegetation of the neighboring district. The conclusions reached by Dr. Pool are clear on this point. The "burns" reported by him in the Christensen, Lemich, Turner and Norwich cases were called to my attention by Dr. Pool and gone over carefully by us together. Thus in these cases my confidence in his judgment is supplemented by my own observations.

The work done by the chemists on the Midvale "smoke stream" also is indicative of a dangerous condition. Out of the 4,311 single determinations of sulphur dioxide made during the growing season, there was an average concentration of 0.49 part per million. There were twenty-eight determinations of 6 parts or more per million, the highest single determination made being 19.4 parts. There were four determinations over

²See "Tapping-floor Ventilators," CHEM. & MET. ENG., vol. 21, p. 118, Aug. 1, 1919.

10 parts per million; 153 over 3 parts per million; and 438 over 1 part per million. The highest hourly average recorded was 2.78 parts per million, there being thirty-four hourly averages giving over 1 part per million by analysis.

It cannot be denied that the more sensitive crops cannot, under weather conditions favorable to sulphur dioxide action, endure such concentrations as have been found in this field. On the other hand, the results hardly justify the finding that the sulphur dioxide in the gas stream from the Midvale plant is the cause of actual discomfort to the residents of the district. There were momentary concentrations sufficient to cause coughing and local irritation, but only four determinations in all the time spent in the gas stream making tests were above 10 parts.

All results on filtration tests at the Midvale plant point to the efficient operation of the bag house units through which all flue gases are passed. The average daily loss in lead and arsenic is certainly too small to be a source of any possible injury to the animal life of the district.

REMEDIAL STEPS

It is my belief that steps should be taken by the United States Smelting, Refining & Mining Co. as soon as possible to improve the situation in regard to atmospheric concentrations of sulphur dioxide during the season of plant growth. The best means for accomplishing this end, in my opinion, lies in increasing the temperature of the roaster gases before their discharge into the air. No measure approaches this one in relieving an unfavorable field condition. I believe that a solution of the matter at the Midvale plant may be found without going to the expense of the suggested erection of a 450-ft. stack in addition to heating the gases.

SAFE OPERATING CONDITIONS

It is my firm opinion that if the Murray plant is continued under skillful management, if attention is paid to keeping the bag house and the Cottrell plant at their highest practical efficiency, and if the general operating conditions which prevailed during 1920 are maintained, the plant will be able to operate hereafter without being an agent of injury to its neighbors. But the fact should not be overlooked that the very favorable record of the past year is in all probability due to a number of important contributing factors, most of which fortunately involve no more than the continued intelligent and consistent use of operative measures which are already at hand and a part of the routine normal operation of the plant.

The operative measures which should receive attention are:

1. The bag-filtration of the blast-furnace gases.
2. The electrical precipitation of roaster dusts and other suspended solids by means of the Cottrell installation, two of the three units of which have been in regular operation.
3. The discharge of the roaster gases, which carry the highest concentrations of sulphur dioxide, at a temperature high above that of the outside air. During the dormant season for plants the temperature of these roaster gases was increased, and incidentally their volume as well, by the delivery of the boiler gases from a neighboring power house directly into the main exit stack. During the season of plant growth the

gases were heated by means of coal furnaces near the base of the stack.

4. The discharge of the gases from roasting operations from a high stack at a point approximately 455 ft. above the ground level.

5. A maximum daily elimination of sulphur from roasting operations amounting to about 100 tons.

Industrial plants such as this are complicated and sensitive organisms. They will not run themselves. Their successful operation from the standpoint of a high recovery of metal at a low cost of production requires that painstaking attention be paid to all factors which have to do with the efficiency and cost of smelting operations. The situation is not now different in regard to smelter operation in relation to smoke injury. With the recent development of remedial measures having to do with plant operation a new responsibility has been thrust upon the operating staff, a responsibility which calls for no less skillful and painstaking attention on their part.

It can scarcely be denied that this plant is a potential agent of injury. Allow the filtration bags to deteriorate, reduce the voltage in the Cottrell plant, neglect the measures which have to do with maintaining a relatively high temperature in the exit gases, and a discharge of lead and arsenic in objectionable amounts or of sulphur dioxide under conditions of concentration and temperature which could give rise to serious injury to crops might easily result.

GUARANTEES AND RESTRICTIONS

At once the question arises of what reasonable guarantees should be exacted, or what operating restrictions or other stipulations imposed to insure the indefinite continuance of safe operation. At first thought it would not appear unreasonable, with a plan of plant operation of proved safety before us, to make this the basis of future operation. This should at once give adequate protection to the residents of this community, but it has several serious objections. In the first place, as has been pointed out, there are many phases of plant operation involved as contributing factors to the present condition of immunity from damage. These are not so much independent as they are interdependent.

Thus it is no longer wholly logical, as a single measure of protection, to place a restriction on the amount of sulphur eliminated or the tonnage of ore roasted when it is known that by a suitable change in one or more other factors, such as the temperature of the exit gases, double that amount might be eliminated with even greater assurance of immunity from trouble. Accordingly, if stipulations are drawn up along the line of plant operation, they must deal not with one but with a number of factors and to that extent be more or less complicated. There is another objection to this proposal which is more serious. These are days of industrial progress based largely upon a new relation between science and industry. Rule-of-thumb methods are yielding to more intelligent and progressive direction. A set of stipulations dealing with plant operation, such as mentioned above, are at once a barrier to progress. Until changed, they may be just as effective in preventing the introduction of improved methods of operation as they are in preventing a relapse into a condition which makes plant operation a menace to the community.

Phosphoric Acid Evaporation

Description of a New Method for the Evaporation of Phosphoric Acid Without the Formation of Scale in the Apparatus During Operation—Accomplished Without Raising the Temperature of Liquid to Ebullition Point

By H. E. LABOUR

THE early manufacturer of phosphoric acid used bone char or its equivalent as a source of phosphate supply. The phosphoric acid was readily extracted from this material and the process of purification was simple. In order to concentrate phosphoric acid made from bone, ordinary steam-jacketed kettles or open pans were most commonly used, and aside from the necessity of properly protecting against the corrosive action of the acid itself, very little trouble was encountered. The acid carried only a small amount of scale-forming material and the volatile impurities were not so annoying that evaporation could not be carried on safely in an ordinary plant.

The supply of bone char did not increase in proportion to the demand for phosphoric acid and phosphates, and this led to the use of phosphate rock as a substitute source of supply. The purification of phosphoric acid as made from rock brought in different and much more difficult problems than were encountered when bone was used. Impurities were introduced into the acid which required elaborate and careful means for removal, and in the process of removing these impurities it frequently happened that others were introduced so that the liquid, by the time it was ready for concentration, carried a very high percentage of scale-forming material, as well as highly corrosive volatile materials, the most troublesome of the latter being fluorine.

Up to the time of the active production of double superphosphate, the difficulties already mentioned were mostly those encountered by manufacturers of food phosphates, and as the production of the material was limited in this country to a few concerns, the problem of evaporation of phosphoric acid was not given the thought and attention which it should have received.

DIFFICULTIES ENCOUNTERED IN THE USE OF COMMON TYPES OF EVAPORATORS

As soon as the fertilizer manufacturer attempted to concentrate his phosphoric acid, he found that the evaporation constituted a real problem, and many different methods were proposed and tried for this work. The vacuum evaporator was early given consideration due to its high economy of operation, but two distinct troubles were encountered which were never satisfactorily overcome. The first of these was the kind of material to be used for the parts coming in contact with the acid or the vapors. About the only metal which successfully withstood the acid was lead, and to make the matter still more serious, lead had to be used for all of the vapor fittings also, on account of the liberation of fluorine during evaporation. Even assuming that these difficulties could have been overcome, the second problem would have made the use of a vacuum evaporator entirely out of the question. The

acid as delivered to the evaporator carried in solution a very high percentage of scale-forming materials such as calcium sulphate, and as soon as concentration began these were deposited on the heating pipes or surfaces and would sometimes build up to as much as $\frac{3}{4}$ in. thick in the course of a 12-hr. run. This heavy scale materially reduced the economy of operation and introduced the frequent cleaning factor, making the vacuum evaporator an impracticable unit for this work.

Various atmospheric methods of evaporation were also in service, such as troughs or pans having submerged steam pipes, or which were heated by hot gases, or even direct fire. These had the advantage of simplicity, but were low in economy, and the scale-forming trouble was always present.

Much work has also been done in connection with the use of towers, both packed and open. The packed tower gives a much better distribution of acid and of the hot gases, but the packing accumulates scale and sludge pockets, and the tower requires frequent cleaning. Furthermore, if hot gases are used as the means of evaporation, an entirely different trouble is encountered—namely, the formation of metaphosphate, which hangs up on the packing and tower walls as a rather sticky material. The sludge from the upper part of the tower gradually works down and accumulates with the metaphosphate formation until finally a hard, tough coating is formed. This is extremely difficult to remove, and of course the metaphosphate represents an actual loss. The open tower had the advantage of offering less surface for accumulation of sludge or scale, but the metaphosphate was still formed and frequent shut-downs resulted.

SPRAY EVAPORATING SYSTEM

In studying this problem, the writer decided that in order satisfactorily to solve the problem of construction materials, it would be necessary to make the evaporating unit of as small dimensions as possible, especially those parts coming in contact with the acid, and, to reduce the corrosion difficulties as well as to eliminate the chance of formation of metaphosphate, evaporation should be carried on without raising the temperature of the liquid to ebullition point. It was recognized that it would be perfectly safe to heat the liquid to some temperature below that producing ebullition and still get no scale formation, as it was quite obvious that the scale formation was due to the deposition of sludge on the heating surfaces, and formation of the sludge was in turn due to the concentration of the acid. If, then, the acid was merely heated and not evaporated by contact with hot surfaces, there would be nothing to cause the formation of scale. If part of the heat that had been introduced into the acid could be utilized converting it into latent heat of

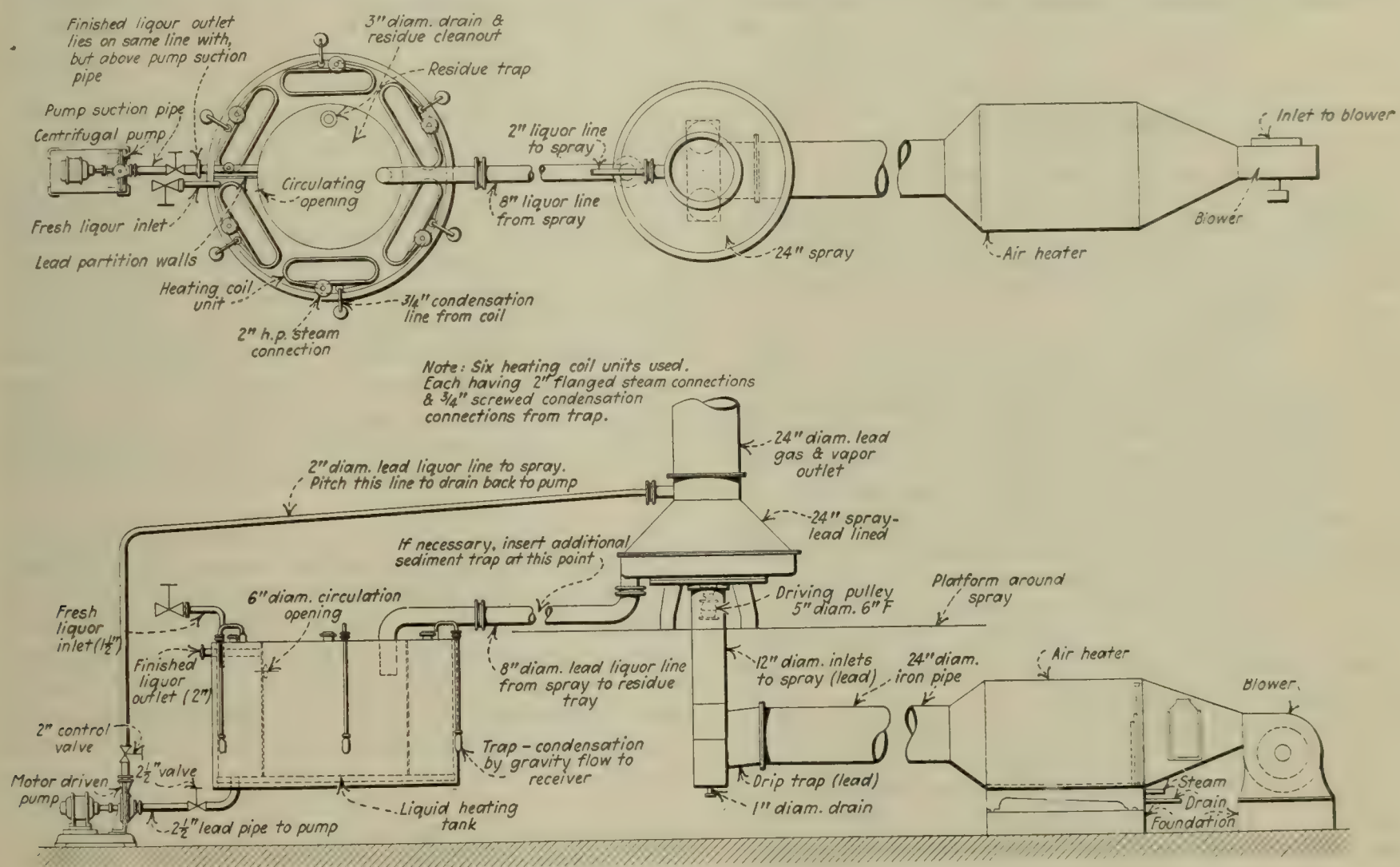
vaporization, out of contact with any heated surface, the scale-forming materials should come down as a sludge and should wash out with the acid as long as the whole body of material was kept in motion.

The use of a spray machine producing spray by throwing the liquid from the surface of a revolving disk seemed ideally adapted to this work, and experiments were carried on to determine the feasibility of the process. The experiments were successful, and the process has now been thoroughly worked out.

The accompanying drawing shows the general arrangement used in this method of evaporation. A heating tank having two concentric compartments is used. The outer or annular one of these has a partition which converts it into a circular trough, and in this outer compartment are placed steam coils. The weak acid is delivered to this circular trough on one side of and immediately adjacent to the dividing partition, and also on this same side of the partition is a large

practically the same, the only difference being in the relative humidity. The latent heat of vaporization is supplied by the acid and the temperature of the exit acid is consequently considerably below that at which it entered the spray machine. Also the scale-forming material comes down as a sludge, and having no hot surfaces on which to cling is washed out of the spray machine and is carried along with the acid. If the amount of scale-forming material is particularly heavy, a settling trap should be introduced between the machine and the center compartment of the heating tank.

The center compartment of the heating tank is also provided with an overflow pipe at the maximum liquid level and a portion of the finished acid is discharged from this constantly; the volume of this discharge being, of course, a factor of the volume of weak acid supplied and the amount of water evaporated. The remaining and greatest bulk of the acid delivered to the center compartment passes through the communi-



PHOSPHORIC ACID UNIT EVAPORATOR

submerged communicating opening between the inner and outer compartments. The weak acid, together with a certain amount of strong acid from the inner compartment, flows around this circular trough and is heated to the required temperature. On the opposite side of the dividing partition from that on which the weak acid is delivered is a large outlet at the bottom, and connected to this is a centrifugal pump. This pump draws the hot acid at the required rate and delivers it to the spray machine. Here the acid is thoroughly atomized and brought into contact with conditioned air. Evaporation of water takes place, the air in passing out carrying away the water vapor together with practically all of the fluorine content, and the concentrated acid passes out from the bottom of the machine to the center compartment of the heating tank. The temperature of the ingoing and outgoing air is

cating opening between the two tanks, and joining the weak acid, is again passed through the spray. The function of recirculating this large volume is twofold: first, to supply sufficient heat units for evaporation, and second, to insure the elimination of fluorine.

A standard size unit is used. This size is ordinarily rated in terms of the number of pounds of water it will evaporate per minute from the acid. This rating usually remains unchanged regardless of the initial or final strengths of the acid to be handled.

As an example of the operation of this equipment, assume a weak acid of 19 deg. Bé. to be concentrated to 40 deg. Bé. Also assume a desired rate of evaporation of 35 lb. of water per minute. Deliver to the spray 150 gal. per minute of acid at approximately 40 deg. Bé., and at a temperature of 220 deg. F. allowing for radiation losses, the temperature drop will be approximately 38.6

deg. F., or the exit temperature of the acid will be approximately 181.4 deg. F. Assuming that air fully saturated at 160 deg. F. will carry the proper amount of moisture when the exit volume of the gas mixture equals 3,000 cu.ft. per minute, then allowance must be made for an actual exit temperature of something in excess of 160 deg. F. on account of the partial vapor pressures existing in the system. In this case the actual exit temperature would have to be in the neighborhood of 175 deg. F. In order to insure maximum evaporation with a minimum time of contact, it is advisable to preheat the relatively dry incoming air to approximately the same temperature as that at which it will leave the spray.

Assuming that the rate of feed of weak liquor to the heating tank is approximately 10 gal. per minute, and the rate of delivery to the spray is 150 gal. per minute, then the remaining 140 gal. per minute must be recirculated and delivered to the heating compartment from the inner or settling compartment. This 150 gal. per minute would pass to the spray, where there would be, roughly, 4 gal. per minute of water removed, and 146 gal. per

minute of concentrated acid returned to the center compartment of the heating tank. Since only 140 gal. of this has to be recirculated, the remaining 6 gal. would pass off from the overflow pipe as finished product. It will be noted that any change in the rate of feed of weak liquor will automatically change the rate of exit of finished liquor, and consequently the concentration, so that the entire control of the apparatus once it is in operation is carried on by means of the valve controlling the supply of weak liquor.

If all power, both steam and mechanical, be converted to a steam basis with the best of the pan or submerged type of evaporators 1 lb. of steam will evaporate only approximately 0.5 lb. of water and as the scale formation increases even this rate of evaporation is reduced. With the spray evaporator radiation losses are materially reduced and the heat transfer is handled in a much more efficient manner; consequently, the economy obtained is approximately 0.65 lb. of water evaporated per lb. of steam condensed. This economy of evaporation holds uniform, as scaling trouble is not encountered.

More Flakes

BY HAAKON STYRI

IN THE issues of CHEMICAL & METALLURGICAL ENGINEERING for April 1 and May 1, 1919, the writer discussed several types of flakes, their occurrence and possible elimination.

Recently a particular type of flake has come to the writer's notice of which there can hardly be any doubt as to the origin. We had found a number of flakes in a 4½-in. bar of high-carbon chromium steel and wanted to investigate this trouble further. For that purpose thirty-one disks about ⅜ in. thick were cut from an annealed bar. All these disks were treated with gasoline containing fine grinding chips of steel. It was found that Nos. 1 to 17 inclusive contained cracks and that Nos. 18 to 31 inclusive did not reveal any.

Disks 11 to 15 inclusive were bent slightly and it was found that they contained more cracks than were found with gasoline treatment only.

By fracturing disks 16 and 17 it was found that the structure where the flakes opened was coarser and more crystalline than the surrounding normal material.

Disk 2 was examined microscopically where a crack had shown up with gasoline, but no crack could be found even under 1,000 magnifications after the piece had been

polished and etched with 1 per cent nitric acid in alcohol, but the crack was revealed with deeper etching.

Two disks, 18 and 20, which had not shown cracks with the gasoline treatment, revealed cracks in bending.

Eighteen disks, 3 to 10 inclusive and 20 to 29 inclusive, were now hardened and thereafter fractured. All these showed flakes and in disks 3 to 10 inclusive they were found to correspond with the cracks located with gasoline before hardening. Some additional flakes also appeared. The structure of these flakes after fracturing had the same coarse crystalline appearance as the structure of the flakes found in bending the unhardened disks, but outside the flakes the structure was fine and silky.

Several streaks were found in the flakes, probably manganese sulphide, but sulphur prints did not reveal the presence of more sulphide in the flakes than other places in the fracture. Some of the flakes found extended through the whole thickness of the disks, even where no flakes had been located with the gasoline treatment, and were from ⅛ to ⅙ in. long. All the flakes found were parallel to the direction of rolling, and were comparatively flat.

It seems evident that these flakes were produced during rolling and not by any heat-treatment of the bar.

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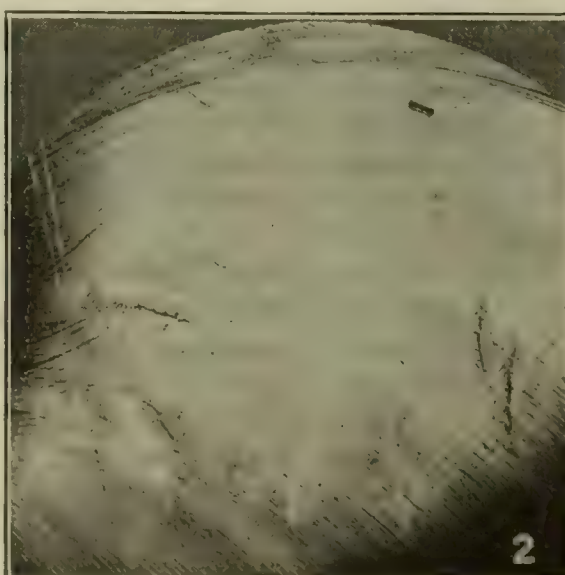
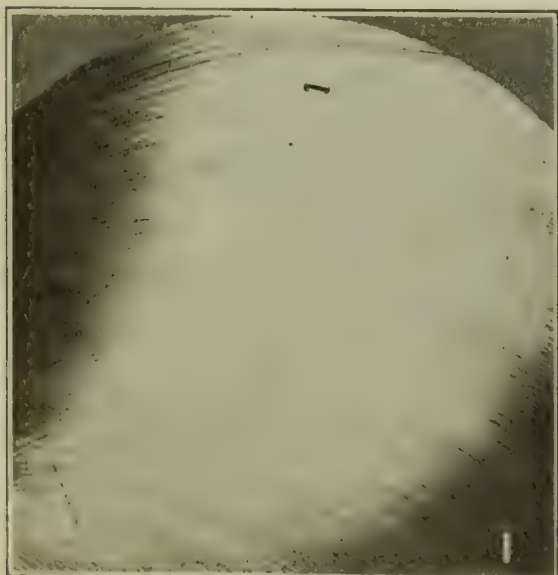


Fig. 1. Disk as cut from bar.

FIGS. 1 TO 3 (ABOUT ¼ NATURAL SIZE)
Fig. 2. Same as Fig. 1, magnetized.

Fig. 3. Same as Fig. 2, slightly bent.

Refinery Practice in Beet Sugar Manufacture

Description of Modern Practice in the Beet Sugar Refinery—Purification of the Diffused Juice by Precipitation of Lime Carbonate and Filtration—Evaporation in Vacuum Pans to Massecuite—Treatment of Sirup and Sugar

BY WALLACE MONTGOMERY

THE first step in the sugar recovery process is to heat the raw juice. This is done with exhaust steam or vapors from the evaporators. The temperature of the juice entering the heaters is about 55 deg. C., depending, of course, upon the temperature carried in the battery. The juice leaving the heaters should not be less than 80 to 85 deg. C., as it has been found that the saturation of the juice with CO_2 is best carried on at about 80 deg. C. From the heaters the hot raw juice is pumped to what are known as carbonation tanks. The tanks may be of any shape, though the ones in general use have quite a slope in the bottom allowing free discharge. In the bottom of the tank is some form of distributor for the gas, either a perforated coil or a long box, inverted, with saw-tooth edges allowing the escape of the gas on all sides.

The raw or diffusion juice from the beets varies in quantity from 125 to 160 per cent on the weight of the beets and is of approximately the following composition:

Brix, deg.....	12.50	to	15.00
Specific gravity.....	1.0506	to	1.0613
Sugar, per cent.....	11.5	to	13.50
Purity.....	82.00	to	85.00
Ash, per cent.....	0.55	to	0.65

PURIFICATION OF THE BEET JUICE

It is now essential that the juice be purified or defecated. This is accomplished by the addition of lime solution. In a factory not using the Steffens process of recovery of sugar from the waste molasses, milk of lime alone is added at carbonation, but in a factory that has a Steffens house in connection, the lime is added in the form of a lime-sugar combination or saccharate. The burning of the limestone is accomplished in large vertical kilns.

The hydrated burned lime reacts with the salts present in the juice and neutralizes any acids present. A heavy precipitate is formed upon addition of CO_2 , and the lime is again converted into CaCO_3 . As the precipitate settles out there is some mechanical purification.

In a refinery not using the Steffens system the addition of from 3 to 3.5 per cent of lime, based on the percentage of beets, is sufficient. In a Steffens house from 4 to 6 per cent is added, depending upon the speed of working and the impurities present. The control of the carbonation is of utmost importance. It is carried on until the juice has an alkalinity of from 0.085 to 0.110 g. CaO in 10 ml. This partly treated juice is again pumped through heaters, the temperature being raised to 90-95 deg. C., then pumped through some form of filter. In some factories the plate and frame type is used. Work is now being done on a continuous filter for this purpose and shortly it will be in use.

From the presses a clear liquid of light straw color is obtained. In the presses the precipitate, or lime cake, as it is called, remains. This cake contains considerable

sugar, removed by washing with hot water. The quantity of cake varies with the process, but usually amounts to from 40 to 48 lb. per ton of beets sliced.

Wash water to the extent of from 30 to 40 per cent of the weight of the beets, lime approximately 4.5 per cent and CO_2 from 3 to 4.5 per cent is used, bringing the total volume of juice up to about 200 to 220 per cent on the weight of the beets.

From the first presses the juice goes through another heater and is raised to about 95 to 96 deg. C., precipitating any salts or combination of salts that are still present from the first saturation. From these heaters the juice is again filtered and then passes to the second carbonation or saturation tanks. Here the procedure is much the same as in the first carbonation, only no lime is added. The juice is gassed until it contains only 0.025 to 0.030 g. CaO per 10 ml.

INVERSION REDUCED TO MINIMUM

The addition of a solution of soda ash here has been found beneficial in further reducing the lime salts present in the juices. Soda added up to 2 lb. per ton of beets worked will be found beneficial, though an excess will tend to increase the inert sugar content. In all cases the amount should be strictly governed by determining the lime salts present by titration with standard soap solution and holding the juice at 0.030 to 0.045 g. CaO per 100 ml.

Further heating and refiltration give a clear straw color juice, known as second carbonation juice. The addition of SO_2 is usually the next step. Here the alkalinity is reduced to approximately 0.010 to 0.012 g. CaO in 10 ml., after which the juice is filtered again, and the resulting juice, known as thin juice, amounts to approximately 220 to 240 per cent of beets and is of the following composition:

Brix, deg.....	12.0	to	14.0
Specific gravity.....	1.048	to	1.057
Sugar, per cent.....	10.00	to	12.00
Purity.....	85.0	to	88.0
Ash, per cent.....	0.85	to	1.15

The juice is now ready for evaporation, which is carried on under vacuum in multiple effect evaporators, of which there are numerous types and makes.

The juice is concentrated to from 55 to 60 deg. Brix and is sent to the melter to mix with the raw sugar or sent direct to heating tanks, heated, filtered and sent to vacuum pans, where crystallization is carried to completion.

PREPARATION OF THICK LIQUOR

When the juice goes to the melter raw sugar amounting to from 4 to 6 per cent of the weight of the beets is added, making the thick juice amount to 46-48 per cent of the beet weight.

A further sulphuring is usually made here, reducing the alkalinity, which, due to concentration, is about 0.060 to 0.075 g. CaO to 10 ml., down to 0.010 to 0.012 g. CaO in 10 ml.

In a series of experiments by the writer the following results were obtained:

Sample	D.S. by Refract.	Color to 100 D.S.	CaO to 100 D.S.	Alk. to 100 D.S.	
1	63.0	60.2	0.206	0.216	Before SO ₂
2	62.0	65.4	0.266	0.222	
1	63.0	40.0	0.119	0.013	After SO ₂
2	62.05	50.8	0.129	0.032	
Per Cent Reduction of Color			Per Cent Reduction of CaO		
1		33.4		42.2	
2		22.3		51.5	

This shows that for reduction in color the alkalinity should be 0.010 to 0.012 g. CaO per 10 ml., but for greater reduction of lime salts 0.030 to 0.040 g. CaO per 10 ml. gave best results.

FIRST LIQUOR

The evaporator thick juice, after having been mixed with raw sugar, is called first liquor and is approximately of the following composition:

Brix, deg.....	60	to	65
Specific gravity.....	1.289	to	1.319
Sugar, per cent.....	55	to	58
Purity.....	87	to	91

and amounts to 45 to 48 per cent on beets.

This liquor is sent to tanks known as blow-ups, which are nothing more than heating tanks. Here the temperature is raised to 95 to 98 deg. C. and kieselguhr is added at the rate of 0.50 to 0.75 lb. per ton of beets worked.

The kieselguhr acts as a filtering medium in the filter presses, through which the hot liquor is pumped.

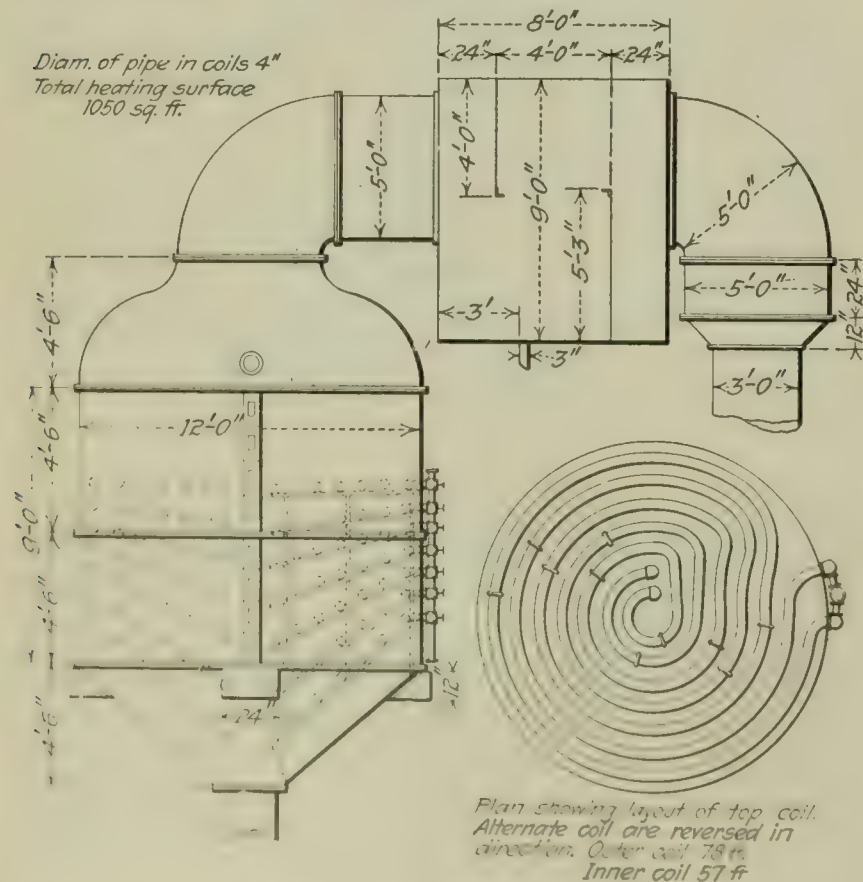


FIG. 1. VACUUM PANS

The resulting clear, light-colored liquid is now ready for graining. The graining is accomplished in vacuum pans. Fig. 1 shows one type. The proper control of the crystallization requires experienced operators or sugar boilers.

The principle of graining consists of evaporating the liquor or sirup until such a concentration is reached that the crystals of sugar form, after which more sirup is added and evaporation continued successively until the operator has finished the pan or strike.

There are many methods of graining a pan besides the above-mentioned, one of which is the adding of sugar powder or dust to the saturated or nearly super-

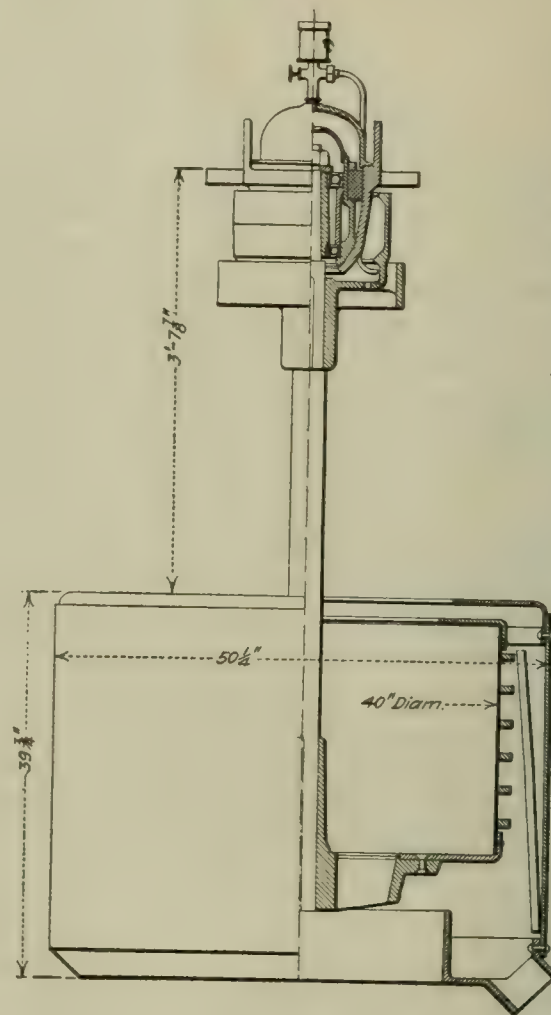


FIG. 2. CROSS-SECTION OF SUGAR CENTRIFUGAL

saturated solution. The point of supersaturation varies with the purity of the juice. A higher purity or purer juice will form crystals at a lower point of supersaturation than one of lower purity. By the sugar powder method a more uniform grain is formed, which means a higher yield and a slight saving in steam consumption, due to time gained in graining.

MASSECUITE CENTRIFUGED

The sirup having been boiled to grain, the first massecuite, as the product of these first pans is called, is sent to the centrifugals. Fig. 2 shows a common type. The liquor coming off is called green sirup. This is the liquor that has not formed any grain in the pan while boiling the first strike. The purity of the green is about 72 to 75 and the quantity is approximately 22 to 25 per cent, based on beets worked; the massecuite amounts to approximately 46 to 50 per cent of the beets.

Some green sirup stays in the centrifugals with the crystals and later has to be washed out. This is where the wash sirup is obtained. In the case of very fine crystals the wash purity will probably go higher than the original purity of the pan on account of some of the grain dissolving. In a coarse grain strike there is less danger of this happening. So from the liquor originally boiled we have

	Purity
Green sirup.....	72 to 75
Wash sirup.....	84 to 89
Sugar.....	100

We still have the green and wash sirup to contend with. The wash is sent to blow-ups as was the first liquor, where it is heated, sulphured and filtered, though only 0.25 to 0.35 lb. of kieselguhr per ton beets worked is used on this sirup. The filtered solution is sent again to the pans, where it is drawn in with the first liquor and reboiled. The green is similarly treated, but being of such low purity it is impossible to make white sugar from it directly; therefore it is boiled separately and put in crystallizers, Fig. 3 showing the open type, where it is allowed to remain for 72 to 96 hours, in which time the size of the crystals increases, due to the cooling of the supersaturated solution. It is then centrifuged and we have a similar condition as with the first pans, although the purities are much lower, the green from the second pans or raw pans being 60 purity or less, while the wash water, only sufficient being added to remove the green, runs about 62 to 65 purity.

STEFFENS HOUSE

It would not be possible to use these liquors for the recovery of sugar in the pans, due to the amount of impurities present. If they were boiled blank—that is, concentrated almost to the point where crystals should form and then placed in tanks or crystallizers and

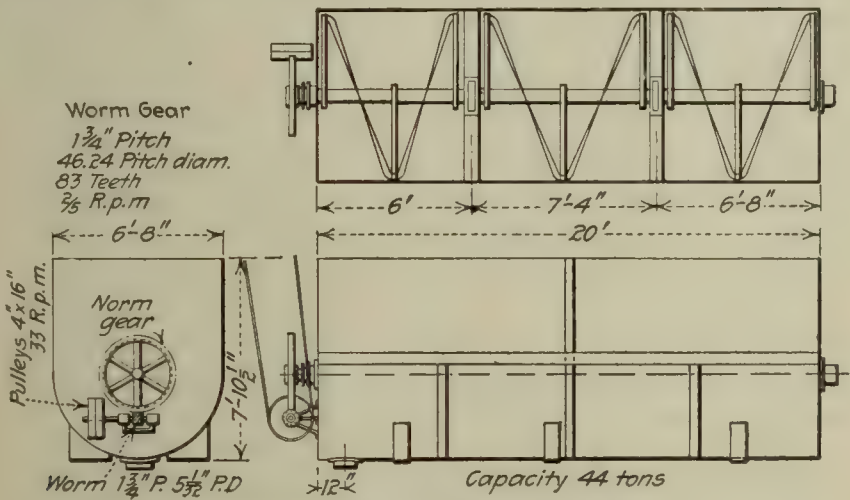


FIG. 3. CRYSTALLIZER

allowed to cool—grain would form, but the yield would be very low and the sugar of low purity. Therefore these final sirups, low green and low wash, are sent to the Steffens house for the recovery of sugar from the molasses by another method. This process will be taken up in another article later on.

DRYING THE GRANULATED SUGAR

The white sugar from the centrifugals, containing about 2.5 to 3.5 per cent moisture, is sent to driers or granulators, usually in two steps, one above the other. The sugar enters one end and as the drum revolves is worked toward the farther end, while hot air is pulled through the drum by means of an exhaust fan. Figs. 4 and 5 show in a general way this type of apparatus. From the granulators the sugar, containing about 0.10 to 0.15 per cent moisture, is bagged and ready for market. The raw sugar is melted and mixed with thick juices, as we have seen before.

QUANTITY AND QUALITY TABLE

From the accompanying table some idea may be gained of the quantity and analysis of the products in the order of their appearance in the process. These figures are only approximate and vary considerably in some factories.

The term purity is best explained by an example. If we speak of a molasses of 60 purity we mean that 60

QUANTITY AND ANALYSIS OF PRODUCTS

Name	Per Cent on Beets	Brix, Deg.	Sugar, per Cent	Purity
Beets	100		16-18	79-86
Diffusion juice	130-150	12.5-14.5	10-12	82-86
Saccharate milk	60-65	30-35		84-89
Total lime used	4-6			
Juice of first carb.	210-225			
Lime cake	20-25		0.20-0.35	
Thin juice	225-250	12.5-14.0	10-12	85-89
Thick juice	40-44	55-65	50-54	85-89
First liquor to pans	45-48	58-65	52-55	86-91
First wash at high	18-22	60-65	50-55	82-88
First massecuite	48-50	92-95	78-82	86-90
White sugar	15.5-17.5		99.7-99.85	100
First green or high green	20-25	60-65	48-52	73-76
Raw pans or second mass	15-18	95-97.5	64-70	73-76
Molasses (low green)	4.5-6.5	82-87	48-52	57-62
Molasses (low wash)	1.5-2.5			
Raw sugar	5-6	95-97	92-94	95-98

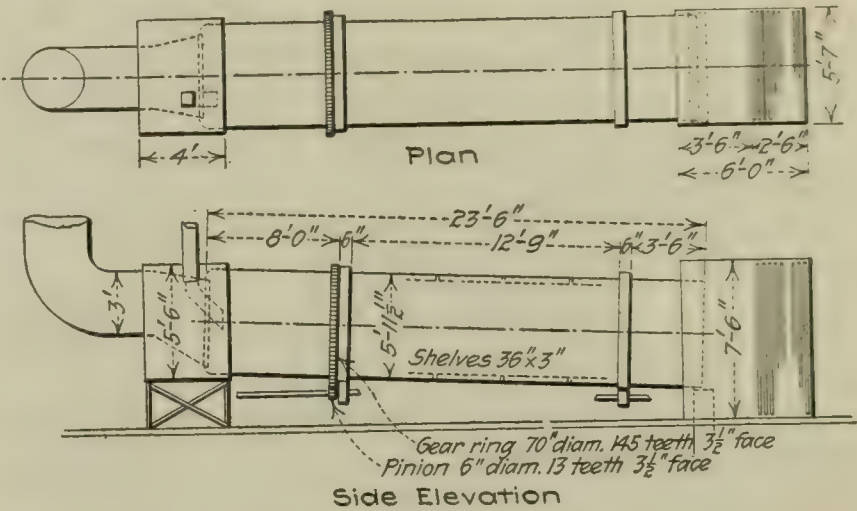


FIG. 4. SUGAR DRIER

per cent of the total solids in 100 lb. is sugar. By Brix we mean the per cent solids in the solution. Therefore sugar divided by Brix or solids equals purity.

CALCULATION OF THE GRANULATED EQUIVALENT

To determine the amount of sugar recovered from the beets we must take stock of all products in the factory, measuring carefully all tanks and containers and sample each substance. Then by the following formulas we may calculate the amount of sugar to be expected from

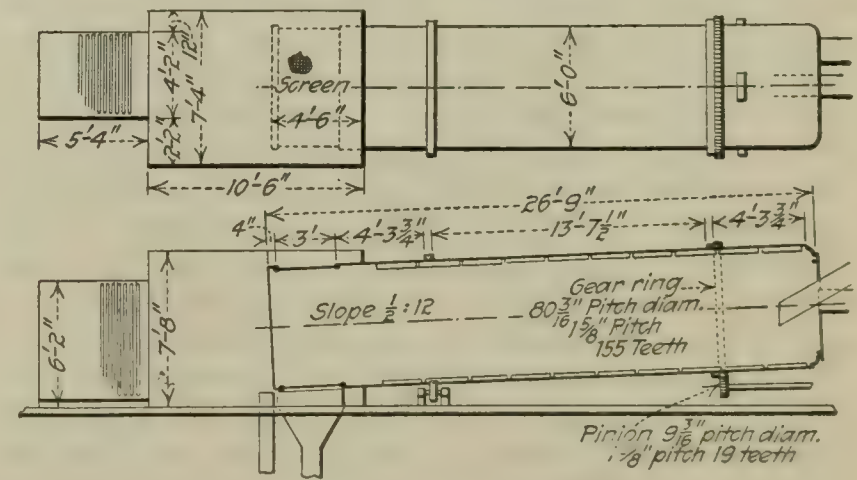


FIG. 5. GRANULATOR

the stock in house. This is called the granulated equivalent, or

- (1)
$$\text{Granulated equivalent} = \frac{\text{Pounds dry substance or solids} \times \text{Average purity stock} - \text{Purity final molasses}}{100 - \text{Purity final molasses}}$$
- (2)
$$\text{Sugar in molasses in stock} = \frac{\text{Total pounds sugar in stock} - \text{Sugar crystallizable or gran. equiv.}}{100}$$
- (3)
$$\text{Sugar recoverable in molasses in stock} = \frac{70 \times \text{Pounds sugar in molasses in stock}}{100}$$

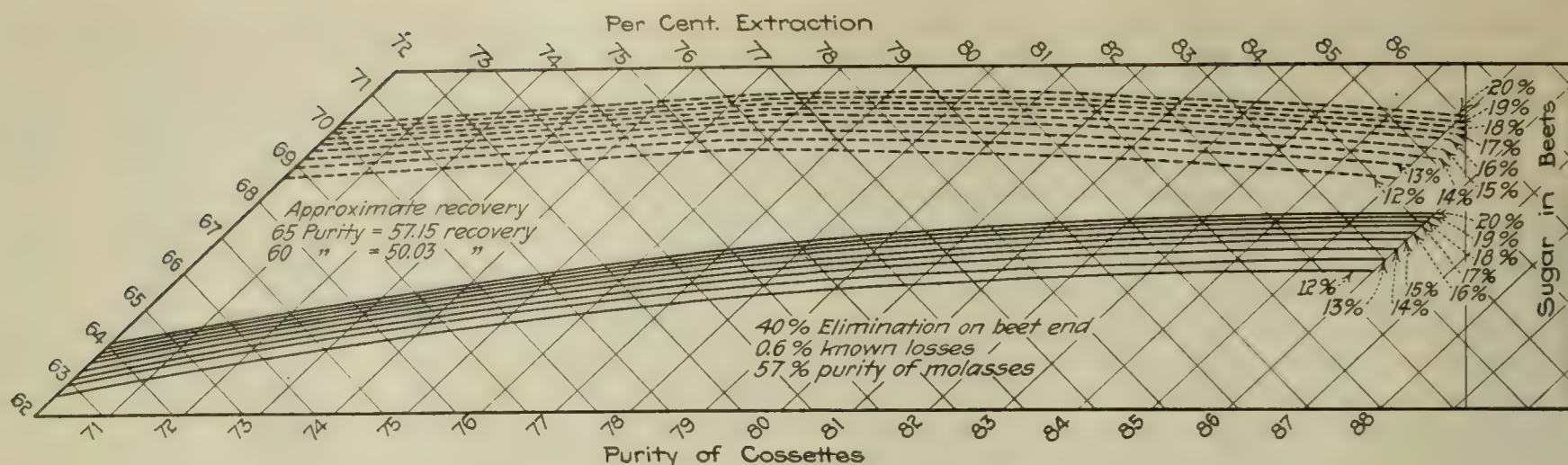


FIG. 6. EXTRACTION CHART

(4) *Sugar not recoverable in molasses in stock* = *Pounds sugar in molasses in stock* — *Pounds recoverable*
 Items (1) and (3) = Total sugar in stock as granulated sugar.

Another formula for expected yield that gives results comparable to above is as follows:

Per cent yield =

$$\frac{\text{Purity sugar (Purity of stock — Purity final molasses)}}{\text{Purity stock (Purity sugar — Purity final molasses)}}$$

Multiplying total sugar by percentage obtained gives sugar to be expected.

To calculate the yield from a pan or strike the following formula is used:

$$\text{Yield in per cent sugar} = \frac{M - G}{100 - G} \times 100 \div \frac{M}{100}$$

where *M* = purity massecuite

G = purity green sirup

This formula is of comparative value only as we assume sugar to be 100 purity and do not take into consideration the wash sirup. Likewise if we know the sugar content of the beet and purity we may calculate the yield by curves plotted on this basis and the assumption that total elimination beet end is 40 per cent, total known losses are 0.6 per cent, and purity of final molasses is 52 to 57 as shown by Fig. 6. This chart is applicable in a factory working only the sugar from the beets and shipping waste molasses. It does not apply to a factory having a Steffens house in connection.

The results obtained by the use of this chart will be found to check out very closely with actual work in the factory.

Fig. 6 is produced with one-fifth the scale used in a works drawing, with tenths deleted.

Union Sugar Co.
 Betteravia, Cal.

Draft of British Home Office Regulations for Chemical Works

Regulations applying to a wide variety of chemical processes and plants have been drafted by the British Home Office and published so that possible objections might be raised.¹ These new regulations will supersede the Special Rules for Chemical Works first established in 1894, regulations made Dec. 30, 1908, for the manufacture of nitro and amido derivatives of benzene and those made Aug. 9, 1913, for the manufacture of sodium or potassium chromate and bichromate. The manufacture of white compounds of lead and red lead, orange lead or flaked litharge is covered by separate codes. Bleaching, dyeing, mercerizing, brewing, tanning, alcohol distillation and processes carried on only by way of experiment are also exempted.

It has been recognized that in certain classes of chemical works special dangers exist which are not found in other branches of the industry and for this reason the regulations are divided into two parts, the first of which is applicable to all chemical works as defined in the schedule and the second to those only in which special dangers need to be dealt with.

Part I, applying to all chemical works, covers such items as: Providing railings on low open kettles, etc.; using an efficient exhaust draught when drawing the charge from a salt cake furnace or from a pyrites kiln, slaking lime or where arsine may be generated; enclosing mills and screens for use with lime; equipping stills and autoclaves with safety valves. The remaining sixteen clauses are devoted to an elaborate set of

hygienic measures covering mess and washing accommodation, ambulance and rescue equipment.

Part II applies to plants or parts thereof in which: Caustic pots are used; chlorate or bleaching powder is made; gas tar or coal tar is distilled or is used in any process of chemical manufacture; synthetic coloring matters or their intermediates are made; a nitro or amido process or a chrome process is carried on; shale oil is refined or used in a chemical process; nitric acid is used in making nitro compounds. In these cases the regulations relating to washing facilities are naturally more stringent and involve the supply of baths, nail brushes, soap, clean towels, etc. Protective clothing is also specified.

Certain of the hygienic features of the regulations have been criticized by the Association of British Chemical Manufacturers as being too extravagant and impracticable for introduction at a time when the financial position of the industry cannot bear the additional expense.² This is particularly true of some of the smaller and more recently established plants. While these precautions are generally recognized as absolutely essential in the manufacture of such irritants as dinitrochlorobenzene and TNT, it is feared that according to the schedule of processes included under Part II, it will be necessary to satisfy these provisions in many cases where they are not absolutely necessary. It is generally felt in the industry that had the collaboration of such a body as the above association been secured in the compilation of the regulations they would have been found more generally acceptable to all sections of the industry.

¹Copies of this draft may be obtained from the Factory Department, Home Office, London, S. W. 1.

²See *J. Soc. Chem. Ind.*, vol. 40, p. 39R, Feb. 15, 1921.

Dust Explosions

Some Methods of Prevention of Dust Explosions—Engineering Problems Demanding Attention— Reduction of Atmospheric Oxygen Content Below Combustion-Supporting Mixture— Grounding Static Electricity

By DAVID J. PRICE

Engineer in Charge Grain Dust Explosion Investigations

IT IS now generally understood that disastrous dust explosions can occur in any industrial plant where combustible dusts are created during the operating processes. Experimental work has shown that a proper proportion of dust and air creates an explosive mixture which can readily be ignited by an external source of heat or flame. Although for some time the common causes such as open flames and matches have been accepted, the investigations of recent dust explosions and resulting fires have developed causes associated particularly with the mechanical and electrical equipment. Some of these causes relate to metallic sparks in grinding machinery and dust-collecting systems, especially in connection with the exhaust fans now in common use. Electrical causes such as broken incandescent lamp bulbs in dusty atmospheres and dust settling on the lamps have been new determinations. In addition it has been found that disastrous explosions have been caused by sparks of frictional or static electricity, and by dust ignition, resulting from the rubbing of pulleys and belts during choke-ups in elevator legs. The extent of these explosions, together with the losses caused by them, indicates the importance of the problem.

METHODS OF PREVENTION

The installation of efficient dust-collecting equipment is one of the most effective methods of controlling explosions of this nature. The accumulation of dust through-

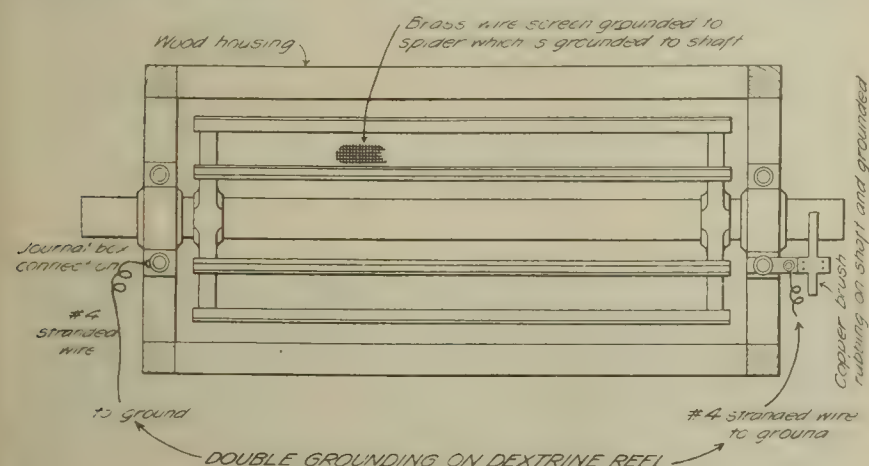


FIG. 1. DOUBLE GROUNDING METHOD FOR CONDUCTING STATIC ELECTRICITY FROM DEXTRINE REELS

out the plant permits the propagation of flame from the time of the original ignition until the secondary or larger explosion occurs.

The elimination of open flames in dusty parts of the plant is of course very essential and should be rigidly practiced. The electrical equipment should be well protected and incandescent lamp bulbs located in dusty sections of the plant should be properly guarded. As a result of special experimental work with the lamp-manufacturing companies it is felt that vapor-proof globes would afford additional protection.

Attention should be given to the proper grounding of equipment where static electricity would be produced. This is essential in connection with pulleys, belts, grinding equipment, revolving reels and other similar types of machinery.

The entrance of foreign material into grinding machinery should be prevented by effective magnetic separators, or other devices now designed for this purpose. Special attention should be given to the prevention of choke-ups in elevator legs by systematic inspection during the operating periods.

ATMOSPHERES OF LOW OXYGEN CONTENT

Some experimental work has already been carried on in an effort to maintain an atmosphere which would not support combustion by reducing the oxygen content in the atmosphere in places where dust-laden air is unavoidable.¹ If, for instance, it was possible to maintain in a grinding machine an atmosphere which would not support combustion the dust would not ignite. The experiments conducted were for the purpose of determining to what amount the oxygen content of the air must be reduced in order to prevent propagation of flame in explosions of various kinds of dust.

The results of the tests indicate that an explosion of starch dust cannot occur in an atmosphere containing less than 12 per cent of oxygen. This limit can possibly be extended to 14 or 14½ per cent of oxygen if grain elevator dusts are considered. The maintaining of an atmosphere of inert gas in all systems grinding or handling carbonaceous materials which form dangerous dusts would, therefore, be an effective means of preventing many dust explosions. Even though an amount of dust ordinarily dangerous may be present and a spark or other source of heat may be formed, the dust would not be ignited nor an explosion be propagated, because the oxygen content of the atmosphere would be too low to support combustion.

Harger, in an article on "Coal Dust Explosion and Prevention"² states: "The only way absolutely to prevent dust explosions is to reduce the oxygen percentage below the lower limit, which varies with the different coal dusts. A reduction of 2 per cent will do for all mines, but to get a guarantee of absolute immunity 17½ per cent oxygen is the figure. A 17½ per cent oxygen atmosphere is ideal for a coal mine, if it is not too expensive to obtain, although this should not be the case."

The most easily secured inert gas around the plant is flue gas. Flue gas contains a large amount of nitrogen, 79 per cent, and the remaining 21 per cent consists of various amounts of carbon dioxide, oxygen and carbon monoxide. The results of the tests show that

¹J. Ind. Eng. Chem., vol. 9, p. 347, April, 1917.

²J. Soc. Chem. Ind., vol. 31 (1912), p. 413.

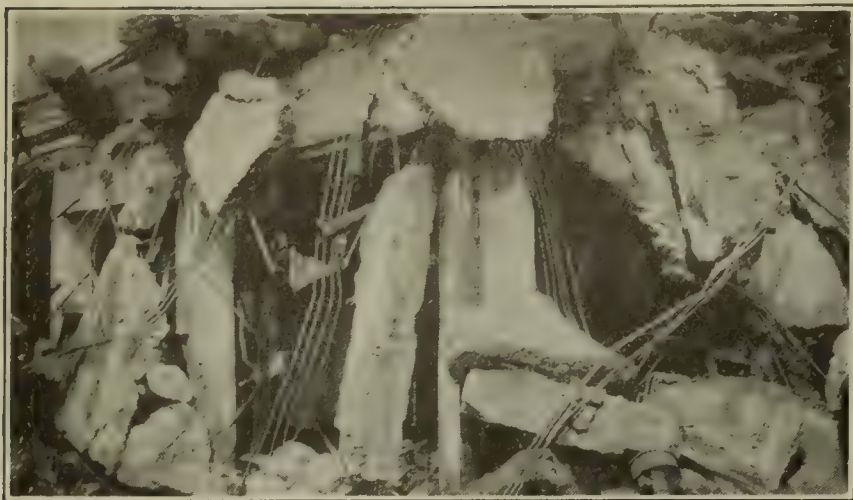


FIG. 2. CONCRETE CONSTRUCTION WRECKED BY STARCH EXPLOSION

a lower oxygen content in the inert gas mixture is probably necessary to prevent an explosion of grain dust than would be required to prevent an explosion of coal dust. The results obtained with coal dust would indicate that a lower oxygen content in the mine atmosphere than that recommended by Harger would be necessary to prevent a coal dust explosion. However, a limit of $17\frac{1}{2}$ per cent oxygen was very close to that determined in this work. As a result of the tests it has been determined that an inert gas mixture containing not over 12 per cent of oxygen will prevent a dust explosion from starting or propagating.

INERT DUST

Effective results have been obtained by the U. S. Bureau of Mines in the use of inert dusts, such as shale, limestone, etc., in preventing flame propagation. The mixture of inert dusts and air prevents the flame from propagating and has a "blanketing effect" much the same as the gauze or screen in the Davy safety lamp. Although only a limited amount of work has been done, it is felt that there is a possibility of inert dust being used in the prevention of dust explosions in mills and elevators under certain limited conditions.

It may be possible to design a method of introducing the inert dust into elevator or conveyor lines to prevent the spreading of flame from the original explosion. In numerous instances the explosion has traveled from the point of origin through the conveyor or elevator legs to bins of large capacity in which considerable dust was present. If a method of introducing inert dust could be perfected it would possibly prevent the propagation of flame and limit the explosion to small proportions.

DUST REMOVAL

In connection with dust-collecting systems as now installed in our industrial plants recent investigations have indicated that a number of explosions were directly associated with the manner in which the exhaust fan was installed in the system. In one instance a disastrous explosion of aluminum dust was caused by a piece of wire entering the exhaust fan, causing six deaths and injury to a similar number of persons. In many instances exhaust fans are installed for the removal of fine dust from buffing or polishing wheels, grinding rolls and similar equipment. In these installations as a rule the fine dust is drawn from the source of production through pipe trunkings into the exhaust fan and then blown into the collecting device. In a number of recent disastrous explosions the origin has been associated with the exhaust fan.

In installations of this nature a flammable mixture is usually formed when the dust passes through the exhaust fan. Explosions may be caused by the ignition of the dust by sparks from foreign material striking the fan blades or from the fan blades becoming loose. This situation has suggested the possibility of changing the location of the fan from its present position—namely, between the source of dust production and collection—to a position beyond the collector. In other words, can the dust be drawn into rather than blown into the collector?

The Industrial Commission of Wisconsin has designed and installed in a factory in that state a system of primary and secondary air currents for dust removal.² The commission reports that tests demonstrating the practicability of the system have already been made.

RESEARCH ENGINEERING PROBLEMS

In order to conduct a special educational campaign of dust explosion prevention both during the period of the war and until the expiration of the wheat guarantee act it was necessary for the Bureau of Chemistry to discontinue a number of the important lines of research work. Several problems are now presenting themselves for consideration indicating the necessity of further development before effective methods of prevention can be determined.

Although the laboratory and small-scale experiments have shown that the propagation of flame in dust explosions can be prevented by the use of "inert gases" it is necessary to determine definitely if it is commercially practicable to use installations of this nature. This will require further experimental engineering work relating to the securing of inert gases from the boiler flues and the developing of proper equipment for its introduction into grinding machines and milling equipment. This is a very important phase of the work, since a large number of explosions are continually occurring in plants where flammable dusts are produced during grinding operations.

In the construction of industrial plants consideration must be given to dust explosion prevention. The construction should be of such a type that dust cannot collect or settle in certain parts of the plant and thereby increase the explosion hazard.

Development of effective methods for the control or

²CHEM. & MET. ENG., vol. 23, No. 19, p. 915, Nov. 10, 1920.



FIG. 3. BINS WITH "STEEL TROUGH-PLATE CONSTRUCTION" WRECKED BY DUST EXPLOSION

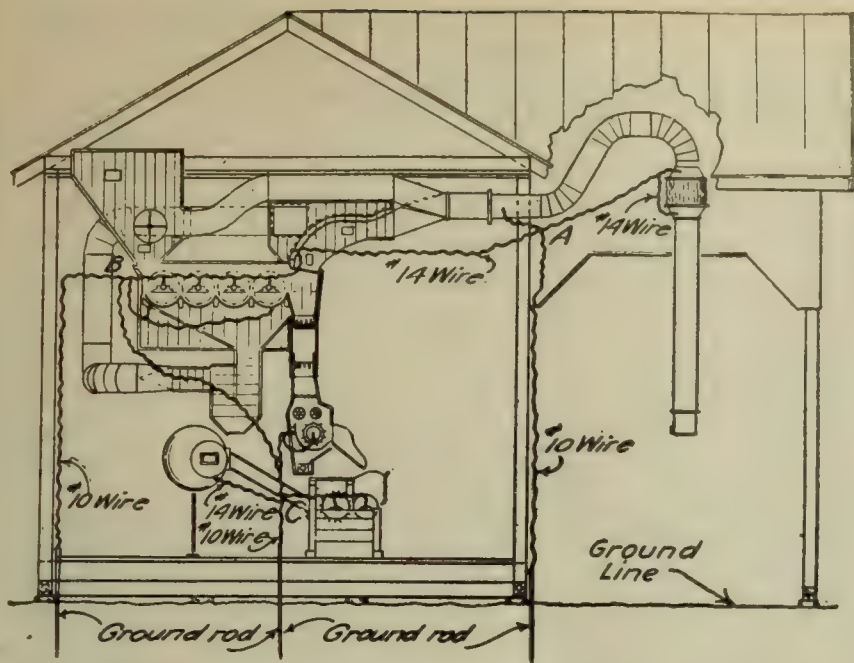


FIG. 4. METHOD OF GROUNDING COTTON GIN

the elimination of static electricity generated by the mechanical equipment in industrial plants is another important question which should be given attention. Satisfactory results have been obtained in the prevention of thresher explosions and fires in the Pacific Northwest and also in the prevention of cotton gin fires in the South assigned to this cause.

The development of aspirating systems for dust removal in grain elevators and similar industries, with specified limitations, and the preparation of a code covering the use of same should receive special consideration. In many industries this is already an essential requisite, especially if the product is commercially valuable.

Experimental work to develop effective methods for control of chokeups in elevator legs is essential. More disastrous dust explosions in grain elevators have been assigned to this particular cause than any other.

The designing of equipment for the prevention of flame propagation following the ignition of dust in grinding machines is commanding attention. The efficiency of revolving dampers, pressure vents and similar devices designed for relieving pressure should be determined.

Electrical sources of dust ignition are presenting themselves and must be given attention. While the electric lamp gives the most satisfactory artificial light, certain practices in use with the equipment have resulted in disastrous dust explosions.

The development and application of methods for measuring the quantities of dust suspended in air in grain-handling plants is one of the important phases demanding attention. Such determination is of importance not only to explosion prevention but to the health of the employees as well.

CHEMICAL RESEARCH PROBLEMS

In addition to the experimental engineering work a number of chemical problems demand attention and consideration. The following more important ones are mentioned:

Determination of the flammability of various dusts, of the various methods and conditions under which dusts can be ignited, of the relation of moisture, ash, volatile content and other factors to the explosibility of dust.

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Preparation of Small Pieces for Microscopic Examination

By HENRY S. RAWDON*

DURING the preparation—i.e., the grinding and polishing—of the specimens for microscopic examination the edges are rounded and beveled off somewhat unless care is taken to protect them. In many cases such precaution is absolutely necessary—for example, case-hardened steels, coated metals, the fractured ends of test-bars, etc. Often specimens available are too small for use unless held in some kind of a matrix. For all such cases it is very convenient to coat the specimen with a heavy deposit of electrolytic copper, to mount it in a matrix of some kind and then to cut and polish a section through the resulting duplex specimen.

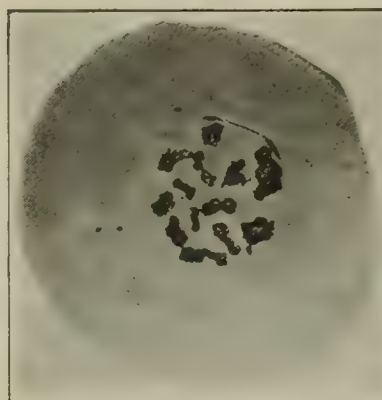
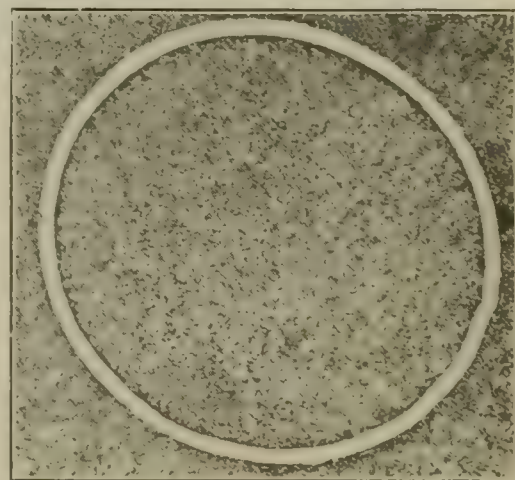


FIG. 1. VERY FINE COPPER WIRE MOUNTED FOR EXAMINATION. X 1

The common acid sulphate bath consisting of 250 g. crystallized copper sulphate and 50 g. (approximately 30 c.c.) concentrated sulphuric acid and water sufficient to make 1 liter of solution may be used for the solution in which the specimens are copper-plated. For iron, steel, zinc-coated articles and the like it is necessary to plate the specimen with a thin coating first in a nearly neutral bath before using the acid-sulphate bath, otherwise a spongy deposit will result if the specimen is inserted directly into the acid-sulphate bath. This preliminary coating may be very conveniently deposited by means of a cuprous cyanide bath.

Such a solution may be made as follows: The precipitate formed by mixing aqueous solutions of 300 g. each of copper sulphate and sodium carbonate (crystallized) is added to 5 liters of water. This is then reduced to the cuprous condition by adding 1 liter of water containing 200 g. sodium bisulphite. A more convenient way, however, is to bubble sulphur dioxide gas from a cylinder of the liquefied gas through the liquid and the suspended precipitate, until the color indicates that the reduction is complete. One liter of water in which 250 g. crystallized sodium carbonate has been dissolved is added; this is followed by a liter of water containing 250 g. potassium cyanide in solution and the whole, which upon shaking should give a clear solution, is diluted to a volume of 10 liters. In many cases, particularly with copper alloys, it is very desirable to deposit a preliminary layer of nickel before the heavy

FIG. 2. ONE OF THE WIRES OF FIG. 1. X 100
Etched with ammoniacal solution of copper ammonium chloride.

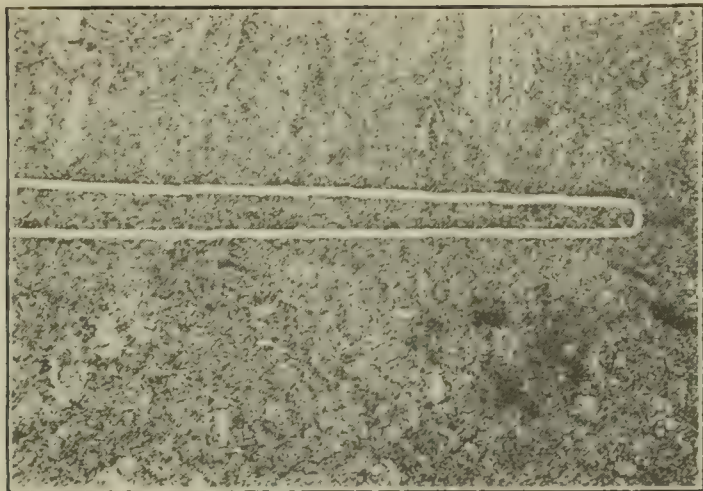


FIG. 3. SMALL STRIP OF COPPER. $\times 100$
Etched with ammoniacal solution of copper
ammonium chloride.

copper layer is added, so that there will be no uncertainty as to the line of demarcation between specimen and coating. This has been found very necessary in such problems as the microscopic study of corrosion of brasses and bronzes. A very convenient solution may be made up as follows: Nickel ammonium sulphate, 90 g.; ammonium chloride, 22.5 g.; boric acid, 15 g. and sufficient water to produce a volume of 1 liter.

After the specimens are heavily plated they are mounted as follows: A short section of brass or other tubing is filed smooth on one end and placed, with this smoothed end down, upon a block of graphite. The specimen is placed inside the tube with the face to be examined down, and then backed up with a matrix. Molten 50:50 lead:tin solder is used a great deal where gentle heating of the specimen is not objectionable. In the case of hardened steels, etc., an alloy of very low melting point—for example Rose's alloy (lead approximately 28 per cent, tin 22 and bismuth 50, melting point

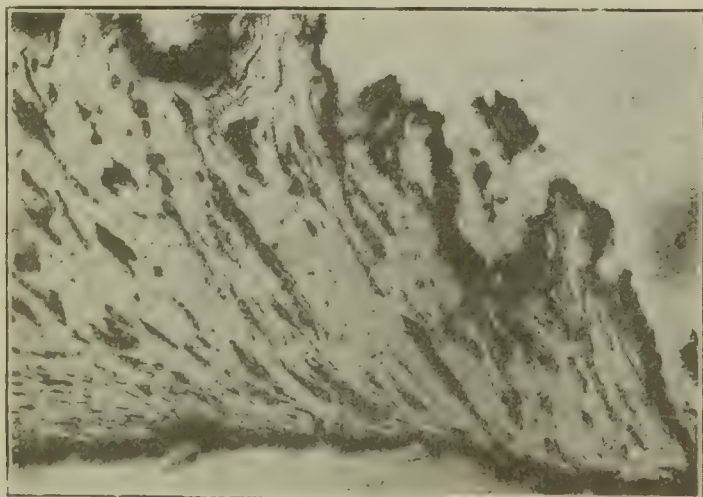


FIG. 4. SMALL LATHE TURNING OF MILD
STEEL. $\times 100$
Etched with picric acid in alcohol.

approximately 95 deg. C.) or Wood's alloy (lead 25 per cent, tin 13, bismuth 50 and cadmium 12, melting point 65 deg. C.)—may be used. A much cheaper substitute that is very suitable for almost all classes of work is made by mixing litharge (PbO) and glycerine in the form of a thick paste. This is poured around the specimen and will set and form a very hard surface which does not interfere with the polishing of the metal. It is sometimes necessary, however, to detach the specimen from such a matrix after polishing, before etching; this is particularly true if alkaline reagents, such as sodium picrate, are used. Often it is very convenient to cut a cavity in the graphite block so that the speci-

men, which is inserted into this hole, will project beyond the face of the solidified matrix which holds it. The projecting portion is then cut off with a fine hack saw and the metal is ground and polished without removing as much of the whole as would have been necessary if the specimen had been mounted flat within the ring.

The figures show some applications of the plating and mounting of metallographic specimens. Fig. 1 shows the polished face of a specimen prepared for microscopic examination. The material to be examined, copper wire 0.015 in. in diameter, was electrolytically plated with nickel and with copper, imbedded in a matrix of molten tin:lead alloy (solder) and a section of the duplex specimen, after cooling, was prepared.

A cross-section of one of the small wires of Fig. 1 is shown in Fig. 2. The white ring is the layer of nickel; outside of this a heavy layer of electrolytic copper was deposited.

A wire similar to that of Fig. 1 was rolled to a strip 0.003 in. in thickness before mounting in the manner described, then photographed in Fig. 3 at 100 diameters.

Fig. 4 shows a small lathe-turning of mild steel electroplated with copper and then mounted.

Diminished Production of Norwegian Paper Industry

The total number of cellulose mills in Norway is twenty-six. There are sixty-three wood-pulp grinding mills and forty-eight paper and cardboard factories. The total number of workmen employed in these mills is about 15,000. The annual production as of 1918 for these factories was as follows: 438,438 tons of cellulose and wood pulp, worth 132,600,000 crowns (\$35,536,800); 116,889 tons of paper and cardboard, worth 86,200,000 crowns (\$23,101,600), reports Consul-General Osborne, of Christiania. Most of the factories in these industries are located in the eastern part of Norway.

The situation at present for the Norwegian paper industry is not as bright. A large number of the mills have been obliged to resort to considerable reductions in output, and some of them have been forced to close, as has been the case with Torp Papirfabrik, with its 400 workmen. There are in the Norwegian paper factories from seventy-five to eighty paper machines, of which at present about one-half are idle. At some of the factories work is carried on only three days a week, and at others for five days a week. At the Borregaard factories, which have a capacity of 23,000 tons of paper a year—i. e., about one-fourth of the production of the entire country—a reduction of 50 per cent has been made. As yet no reduction in production has been made at the Borregaard cellulose mills, which have a capacity of 55,000 tons of cellulose annually.

One of the leading exporters stated recently that the supply of paper on hand in Norway was greater than the demand. There are practically no sales. In Copenhagen, where prices are lower, there are large stocks with no buyers. He further states that the prospects for the future are uncertain and that conditions will not improve until stocks in foreign countries have been consumed.

With regard to the wood-pulp situation, he states that as yet there has been no reduction in production in Norway, with the exception of cases where the production of wood pulp is being carried on in connection with the manufacture of paper. The stocks of cellulose and wood pulp on hand are not as large as those of paper.

Investigations of the Chemical Literature—II

Suggestions for Library Research in Public Documents and the General Periodical Literature in English, German and French—Periodicals Covering Special Fields—Check Lists and Union Lists of Periodicals*

By FRANK E. BARROWS

Public Documents

COPIES of some Government publications are sent free upon request to the particular bureau or department from which they are issued. When they are not thus available copies can be obtained from the Superintendent of Documents at the Government Printing Office, Washington. Price lists of Government publications relating to different subjects are issued by the Superintendent of Documents and are sent free upon request. The following is copied from one of these price lists:

The Government of the United States is the greatest of all publishers of scientific works. It employs thousands of scientists, who are engaged the year round in making researches and investigations in all branches of agriculture, in geology, in mining, in electricity, in chemistry, in astronomy, in engineering, in aviation, in preventive medicine, in forestry, in irrigation, and almost all other branches of scientific inquiry. The arts of war as well as those of peace are also actively cultivated. The greatest art of all, that of free government, is strenuously carried on by President, Cabinet, Senators and Representatives.

The results of all these activities of the most comprehensive and effective organization ever known are constantly reduced to print and poured out in an incessant flood from the largest printing works in the world.

These publications of the Government Printing Office in Washington constitute the Public Documents of the United States.

The greater number of them are sold by the Superintendent of Documents, located in the Government Printing Office. The Government did not establish this sales office for purposes of profit, but as a public convenience. The prices charged cover only paper and printing, no charge being made for the services of the statesmen and scientists who are the authors of the astonishingly varied books, pamphlets, periodicals and maps, and no commissions being allowed to anybody. The documents even have the freedom of the mails and are sent without postage.

The only condition is that payment be made in advance of shipment. The Superintendent of Documents is not authorized to supply free copies, except of his price lists, and it is useless to ask him to do so.

Separate lists of publications of some of the Government departments or bureaus are also published—for example, the Geological Survey publications, those of the Bureau of Mines, those of the Library of Congress, etc., and lists of these are obtainable upon request.

Since 1914 the *Journal of Industrial and Engineering Chemistry* has had abstracts of Government publications.

Periodicals

The periodical literature is so extensive that a comprehensive search through it is often difficult, yet it forms one of the most valuable fields of search because of the numerous original papers which it contains and the wide field which it covers.

Frequently it is possible through the general reference works (previously referred to) to obtain reference

to many of the relevant papers of the periodical literature. In organic chemistry the searcher may thus begin with Beilstein and Richter; in inorganic chemistry with Gmelin-Kraut or Abegg; and from these or other reference works he will be directed to the periodicals where the original papers are to be found. The extent to which the periodical literature can be covered in this way will vary greatly with different subjects.

Where suitable general reference works are not available, or when they have been exhausted, the searcher must turn to the periodicals themselves. The abstract journals are of special value for search purposes, because of the wide field which they include. *Chemical Abstracts* is thus an abstract index or digest of about 783 other periodicals covering the whole field of chemistry and chemical industry.

Cumulative or general indexes covering a number of years are also of particular value. A preliminary examination of a few of these general indexes will often enable the searcher to tell whether the literature of the subject he is investigating is abundant or meager, and in what direction the search can most profitably be continued.

In looking up original articles it will frequently be found that one article contains reference to many others of earlier date relating to the same general subject. These references may represent the results of a comprehensive search which the writer of the article made in preparation for his own investigations. Not infrequently one article will thus give a fairly complete review of the prior available sources of information along the very line in which the searcher is interested. Some of the prior articles thus referred to may in turn refer to others, and so on.

Again, bibliographies will sometimes be found either in the periodicals themselves or in some other publication of which the citation is given, and these bibliographies may give the results of an extended search made by the bibliographer in its preparation.

By making use of short cuts, such as bibliographies or articles giving the results of searches made by others, cumulative indexes of periodicals, abstract journals and general reference works, the searcher will frequently be able to obtain much of the readily available information upon any particular subject within a comparatively short time.

ABSTRACT JOURNALS IN ENGLISH

In making a comprehensive search, however, it is necessary to proceed in a systematic manner through the periodical literature itself. The abstract journals will naturally receive first consideration. The ten-year subject-matter index of *Chemical Abstracts* (1907-16) will furnish one of the best starting points for searching the recent literature. The annual indexes and the current numbers of *Chemical Abstracts* will

*For Part I see CHEM. & MET. ENG., vol. 24, No. 10, p. 423, March 9, 1921.

bring the matter practically up to date. It should be kept in mind, however, that *Chemical Abstracts* was less complete during the early years of publication, and that, complete as it now is, it cannot be relied upon as exhaustive or as including reference to everything of interest appearing in other chemical publications.

Next to *Chemical Abstracts*, the most valuable abstract journals in English are the *Journal* of the Society of Chemical Industry (published since 1882), and the *Abstracts* of the London Chemical Society.

The *Journal* of the Society of Chemical Industry has cumulative indexes for the periods 1882 to 1895, and 1896 to 1905, and annual indexes thereafter. It contains many original works, as well as a large number of abstracts, and it reflects and records the development of chemical industry in Great Britain, and, to a lesser extent, in other countries.

The *Abstract Journal* of the London Chemical Society is less comprehensive in the field it includes than *Chemical Abstracts*, but its abstracts are often more complete. It has been published as a separate publication since 1878. Prior to that date the abstracts appeared as a part of the *Journal* of the society. There are cumulative indexes covering the period from 1841 to 1872, and for each of the ten-year periods thereafter up to 1912.

Chemical News is another English periodical with a useful general index for the first 100 volumes, from 1860 to 1909.

Prior to *Chemical Abstracts* (1907), the abstract section of the *Journal* of the American Chemical Society was known as the *Review of American Chemical Research*. It first appeared in the *Technology Quarterly* for the year 1895, and continued as a part of that publication through 1901.

Beginning with vol. 3 (year 1897), the *Review of American Chemical Research* also appeared as a publication of the American Chemical Society, and continued to do so up to and including vol. 12, of the year 1906. From 1895 to 1901 it was contributed by members of the instructing staff of the Massachusetts Institute of Technology (Arthur A. Noyes, editor). In the first issue of 1895 (*Technology Quarterly*, vol. 8, p. 90) it was stated that:

The purpose of this publication, which is hereafter to appear serially in this journal, is to present in a concise form a review as complete as possible of all original work having a chemical bearing published in the United States after the beginning of the year 1895.

While this publication is not comparable in its scope or value with *Chemical Abstracts*, yet it is of particular interest to American chemists as the predecessor of *Chemical Abstracts* and as a review of American research.

The *Journal* of the American Chemical Society is provided with a general index for the period from 1879 to 1898.

The *American Chemical Journal* also has cumulative indexes for the first ten volumes (1879 to 1888), for vols. 11 to 20 (1889 to 1898) and for vols. 21 to 50 (from 1899 to 1913). In 1914 it was incorporated with the *Journal* of the American Chemical Society.

OTHER PERIODICALS IN ENGLISH

Other important chemical periodicals in English are the following:

Journal of Industrial and Engineering Chemistry, published by the American Chemical Society since 1909.

CHEMICAL & METALLURGICAL ENGINEERING; (*Electrochemical Industry*, vols. 1 and 2, 1902-1904; *Electrochemical and Metallurgical Industry*, vols. 3 to 7, 1905-1909; *Metallurgical & Chemical Engineering*, vols. 8 to 18, 1910-1918; CHEMICAL & METALLURGICAL ENGINEERING, beginning with volume 19, 1918.)

Transactions of the American Electrochemical Society, published since 1902, and with a general index for the first twenty volumes (1902-1911).

Engineering and Mining Journal, published since 1866.

Journal of the Franklin Institute, published since 1826, and with indexes for vols. 1 to 120 (1826-1885), 121 to 140 (1886-1895) and 131 to 160 (1896-1905).

This list is not intended to be complete, and many others could be added, particularly those relating to special fields, such as metallurgy, oils, pharmaceutical chemistry, etc.

"MINERAL INDUSTRY" AND "MINERAL RESOURCES"

In the metallurgical and mineral field, "Mineral Industry" and "Mineral Resources" are deserving of special mention.

"Mineral Industry" has been published since 1892, when its first volume appeared as:

A statistical supplement of the *Engineering and Mining Journal*, the mineral industry, its statistics, technology and trade, in the United States and other countries from the earliest times to the end of 1892.

It contains many articles on metallurgy, and a considerable number of bibliographies.

"Mineral Resources" is published annually by the Geological Survey, and has been published since 1882. In addition to its statistical information and many special articles on mineral production and technology, it also contains a considerable number of bibliographies.

GERMAN CHEMICAL PERIODICALS

If the searcher is limited to the field of English literature, he may nevertheless make an extended search through the various cumulative indexes, abstract journals and other chemical periodicals, such as those above referred to and others relating to special fields. In any comprehensive investigation, however, the searcher will find it a serious handicap if he does not have a working knowledge of French and German, particularly German, since so much of the chemical periodical and technical literature is published in these languages, and especially in German, and since so many of the general reference works and works on special subjects are published in German.

Among the German periodicals *Chemisches Centralblatt* is the abstract journal corresponding to *Chemical Abstracts*. It goes back to 1856, and has general indexes covering at least part of the volumes since that time.

Another valuable German abstract journal is the *Jahresbericht über die Fortschritte der Chemie*. It has been published since 1847 and has cumulative indexes covering about ten-year periods up to 1904.

For industrial chemistry, Wagner's *Jahresbericht der Chemischen Technologie* is a valuable record of chemical technology in German and has cumulative indexes covering about ten-year periods from 1859 to 1904.

The *Berichte der Deutschen Chemischen Gesellschaft*, published since 1868, included abstracts up to 1896. It has general indexes up to 1907.

Other important German chemical periodicals are the

following, although the list is not intended to be complete:

Zeitschrift für Angewandte Chemie, with cumulative index covering the period from 1887 to 1907.

Zeitschrift für Anorganische Chemie, with a general index for the first fifty volumes from 1892 to 1906.

Zeitschrift für Physikalische Chemie, with cumulative indexes covering the first fifty volumes from 1887 to 1905.

Journal für Praktische Chemie, published since 1828, and with cumulative indexes.

Dingler's *Polytechnisches Journal*, published since 1820.

Liebig's *Annalen*, published since 1832 and with general indexes up to 1911.

Poggendorff's or Wiedmann's *Annalen*, published since 1824, with Gilbert's *Annalen* taking it back to 1799.

Die Chemische Industrie, published since 1877.

Monatshefte für Chemie, published since 1880.

FRENCH CHEMICAL LITERATURE

The French literature is less extensive than the German, but there are likewise abstract periodicals and periodicals with general indexes.

The *Bulletin de la Société Chimique de France* (prior to 1907 *Bulletin de la Société Chimique de Paris*) has been published since 1858 and contains abstracts. It also has general indexes up to 1906.

The *Annales de chimie et de physique* goes back to 1789 and for a long time contained abstracts. It has general indexes up to 1903.

The *Comptes rendus* has been published since 1835 and has general indexes up to 1900.

The *Revue générale de chimie pure et appliquée*, published since 1899, with its supplement, the *Répertoire général de chimie pure et appliquée*, published since 1901, is an abstract and review periodical.

The *Revue de chimie industrielle* has been published since 1890.

In the French literature (and the same is true of the literature of other countries) much of the chemical literature is contained in the general science publications—e.g., the *Moniteur Scientifique*, published since 1857.

PERIODICALS COVERING SPECIAL FIELDS

In addition to the periodicals above mentioned, there are many more, including other periodicals of the same countries, as well as periodicals of other countries. In particular there are many periodicals relating to special fields, which those interested in those fields will naturally include in their investigation. We thus find periodicals devoted to rubber, oils, gas, colloids, metallurgy, electrochemistry, physical chemistry, medicinal chemistry, etc. A more detailed discussion of these various fields and periodicals is outside the scope of the present paper. The searcher will readily locate and identify the available periodicals of interest in connection with his investigation from the general reference works, from the abstract journals, or from the card index catalogs.

Not infrequently the searcher will be referred to periodicals which are not accessible in the library in which his search is being made, and it may be important to obtain further information about a particular article in such a periodical, or to find out whether the periodical itself is available in some other library.

If the date of publication and the author are known, a search of the contemporaneous periodical literature may disclose that the same article was reproduced, or that abstracts of it were published, in other periodicals. The same original article may thus be abstracted in *Chemical Abstracts*, in the *Abstracts* of the London Chemical Society, in the *Journal* of the Society of Chemical Industry, in *Chemisches Centralblatt*, and in other abstract or review periodicals, and it may also be reproduced in periodicals of other countries.

To ascertain whether any particular periodical is available in other libraries, reference must be had to the available check lists of these libraries.

CHECK LISTS OF PERIODICALS

For periodicals prior to 1895 the most valuable library check list of periodicals is that of Bolton in his "Catalogue of Scientific and Technical Periodicals, 1665-1895." This list includes 133 American libraries and about 3,160 scientific and technical periodicals, and indicates in which libraries each periodical may be found.

Various other check lists and union lists of periodicals have been issued for certain libraries, or the libraries of certain cities, including the following:

Union List of Periodicals, Transactions, etc., currently received in the Principal Libraries of the District of Columbia, pub. 1901, by the Library of Congress.

Catalogue of Technical Periodicals, Libraries in the City of New York and Vicinity, pub. 1915, by the United Engineering Society.

A List of Serials in the Public Libraries of Chicago and Evanston, pub. 1901, by the Chicago Library Club, and the John Crerar Library Supplement, pub. 1906.

A List of Current Periodicals in the Reading Room, the John Crerar Library, Chicago, pub. 1902.

A List of Serials in the Principal Libraries of Philadelphia and Its Vicinity, pub. 1908, and Supplement, pub. 1910. (Bulletins of the Free Library of Philadelphia, Nos. 8 and 9.)

A List of Periodicals, Newspapers, Transactions and Other Serial Publications Currently Received at the Principal Libraries of Boston and Vicinity, pub. 1897.

A List of Periodical Publications Currently Received by the Public Library of the City of Boston, pub. 1903.

Report of the Committee on "A List of the Scientific and Technical Serials in the Libraries of the State of Indiana." (Reprint from Ind. Acad. of Sci. Report for 1913.)

A Joint Catalogue of the Periodicals, Publications and Transactions of Societies and Other Books Published at Intervals, in the Various Libraries of the City of Toronto, pub. 1913, Univ. Press, Toronto.

Periodicals and Other Serials Currently Received by the Carnegie Library of Pittsburgh, 7th Ed., pub. 1915.

Current Periodicals on File in the Reading Room, Library of the Franklin Institute, Philadelphia, pub. 1916. (Bull. 4.)

Union List of Serials in the Libraries of Rochester, pub. 1917, Rochester Pub. Library.

Catalogue of the Periodicals and Other Serial Publications in the Library of the U. S. Dept. of Agriculture, Washington, pub. 1901 (Lib. Bull. 37); and Supplement 1, 1901-1905, pub. 1907.

Alphabetical List of Abbreviations of Titles of Medical Periodicals Employed in the Index-Catalogue of the Library of the Surgeon-General's Office, U. S. Army, from vol. 1 to vol. 16, inclusive, pub. 1895.

List of Serials in the Univ. of Illinois Library, and Other Libraries of Urbana and Champaign, pub. 1911. (Univ. of Ills. Bull., vol. 9, No. 2.)

List of Serials in the Univ. of Colorado Library, pub. 1913, Boulder, Col. (Univ. of Col. Bull., vol. 13, No. 1.)

Periodicals and Serials in the Library of the Catholic Univ. of America, Washington, pub. 1910.

List of Serials in the Univ. of California Library, pub. 1913. (Univ. of Cal. Lib. Bull. 18.)

List of Serials in the Leland Stanford, Jr., Univ. Library, pub. 1916.

(Part III will be published in a subsequent issue.)

Legal Notes

BY WELLINGTON GUSTIN

Employee May Recover Damages for Accident That Aggravates a Disease

An employee of the Coffeyville (Kan.) Vitrified Brick & Tile Co. had his foot lacerated while attempting to start a gas engine. Later he was found to be suffering from multiple sclerosis, which, according to the medical testimony, is a hardening of many areas of the brain and spinal cord which have become infected by some organism or poison that causes a deadening of the cells, from which they never recover, for the reason that they have no blood vessels to nourish them. When the nerve center hardens or becomes destroyed it fails to function—that is, to carry along the impulses from the brain.

About two years after the injury a trial was had and the court gave the employee compensation of \$4,513.11. An appeal was made on the ground that the evidence did not establish the fact that the disease was caused by an injury arising out of and in the course of his employment.

There was a conflict in the testimony of physicians for both parties over the question whether multiple sclerosis could develop from a traumatic injury immediately after such injury. The authorities agree that there are various causes that produce the disease, and some include acute infection, or it may come from measles, scarlet fever, smallpox, whooping cough and other infectious diseases. Many include traumatic injuries, but the authorities indicate that in 50 per cent of the cases it was impossible to determine the cause. The physician of the injured employee gave his opinion that the condition of employee was due to an injury or shock which aggravated and may have been the absolute cause of the disease. The Supreme Court of Kansas affirmed the jury's verdict that the injury did precipitate or contribute to the development of the disease and was fully responsible therefor.

"The courts very generally hold that, if an existing disease is aggravated by accident or injury, compensation must be paid for the resulting injury. Note L. R. A. 1917 D., pages 105-129, 130.

"Even where a workman dies from a pre-existing disease, if the disease is aggravated or accelerated under circumstances which can be said to be accidental, his death results from injury by accident. 279 Ill. Rep., 356."

In a Connecticut case it was held that:

"Whatever predisposing physical condition may exist, if the employment is the immediate occasion of the injury, it arises out of the employment because it develops within it." 90 Conn., 539.

It has been held sufficient to justify an award under the workmen's compensation act in Maine, where "by weakening resistance or otherwise, an accident so influences the progress of an existing disease as to cause death or disability."

In a Massachusetts case, a workman "with an already impaired heart suffered further injury through the muscular exertion" required by her work, and it was held that she could recover compensation

not only for that part of the injury resulting directly from the work, but for that following directly from the previous defective condition of her heart.

The Kansas court said: "It is true that under our compensation law a workman may not recover compensation for an incapacity resulting merely from a disease, although the disease developed in and was caused by the nature and condition of his employment. It is only where he has sustained some accidental injury, arising out of and in the course of his employment, which aggravates a disease and thereby causes incapacity, that he may recover compensation."

Liability of Buyer by Acceptance of Part of Shipment

The liability of a buyer by an acceptance of part of the goods shipped him was a question presented the Court of Appeals of Kentucky in the case of B. R. C. Battle Co. vs. Peaslee-Gaulbert Co. The latter, a wholesale company, of Louisville, Ky., ordered a bill of glass bottles of the former, a manufacturer of Louisiana. While seven different kinds of bottles were ordered, but four kinds were shipped, and not in the quantities ordered except in one instance. Two kinds of the bottles were defective and the buyer declined to pay for them. The seller ordered a return of the whole shipment within a few days after receiving the complaint of the buyer.

Subsequently the seller filed suit to cover for the entire shipment, amounting to \$1,609.76. The buyer admitted liability in the sum of \$723.20 for the good bottles, and resisted payment for the defective bottles by counterclaim for damages of an alleged warranty. Upon trial of the case the seller recovered a judgment against the buyer for \$259.52.

The trial court held that the contract was severable, and permitted the buyer to recover, upon its counterclaim, damages for breach of an implied warranty as to the two rejected kinds of bottles, of which action alone complaint is made upon the appeal. The seller contended that the contract was entire, and not severable, and that by the acceptance of a part of the shipment the buyer became liable for the whole shipment.

On appeal the Court of Appeals said the several different kinds of bottles involved were separately priced and separately invoiced, and constituted different items not inherently interdependent, but easily severable, of a single order in which the aggregate sum does not seem to have been considered or mentioned. Such contracts, says the court, may be either severable or entire, depending upon their terms and the intention of the parties involved, to be ascertained from the language employed, the character of merchandise, attendant circumstances, and the act of the parties. (2 A. L. R., 643.) Further it appears, as the court found, that the seller did not itself regard the contract as entire, because without agreement so to do, it accepted and complied with only several parts thereof. And there was nothing in the contract nor in the acts of the parties to indicate that either considered it other than a severable contract, except the telegram and letters of the seller to the buyer after it had been informed by the buyer that the latter treated and considered the contract as severable, by accepting in part and rejecting in part the goods shipped. In like manner the court pointed out that the seller had treated it as severable, by accepting in part and rejecting in part the order tendered it by the buyer.

Influence of Silicon Upon the Properties of Ferrosilicon

Pure Commercial Alloys Containing More Than 50 per Cent Silicon Contain the Primary Compound FeSi and a Decomposition Product FeSi_2 —Very Accurate Estimates of Silicon Content Can Be Made Quickly by Specific Gravity Determinations

By A. T. LOWZOW

TRANSLATED* BY O. A. HOUGEN

Research Chemist, Carborundum Co., Niagara Falls, N. Y.

FERROSILICON has repeatedly been studied by different investigators. These investigations have been based chiefly upon ferrosilicon produced in small charges, the alloys being then treated with different solvents and the residues analyzed. Hahn assigned¹ the compounds Fe_2Si , FeSi and FeSi_2 . De Chalmot² described the compound Fe_3Si_2 . His determinations, however, checked up so poorly that they were not accepted as full proof of the existence of this compound, and none of the later investigators have encountered it. Gins³ believed that the compound Fe_3Si was produced in the blast furnace from 10 per cent ferrosilicon. Tick maintained that this compound did not exist in the pure state, but only in combination with manganese such as the compound $(\text{FeMn})_3\text{Si}$. Naske⁴ believed that he had found the compound FeSi_3 in 50 per cent ferrosilicon after treatment of this alloy with hydrofluoric acid. This compound was not encountered by any later investigators and there is little proof of its existence.

In 1905, W. Guertler and G. Tammann⁵ published the results of their researches on ferrosilicon, based chiefly

in Fig. 1, they encountered the two compounds Fe_2Si and FeSi , but not the compounds Fe_3Si , Fe_3Si_2 , FeSi_2 and FeSi_3 . However, we are not justified in excluding the existence of these last-named compounds on this account. Guertler and Tammann worked with very small charges at an average rate of heating and cooling of 100 deg. per minute. It is easily understood that the manner of crystallization obtained in this way is different from the manner obtained in large commercial charges; for instance, Dr. Pick (1906) found crystals of FeSi_2 in large blocks of ferrosilicon which had cooled slowly. On the whole, the following list represents the supposed ferrosilicon compounds, all but the first being relatively definitely proved:

	Per Cent Si		Per Cent Si
Fe_3Si	14.289	FeSi	33.33
Fe_2Si	20.00	FeSi_2	50.00
Fe_3Si_2	25.00	FeSi_3	60.00

MATERIALS FOR THE PRESENT INVESTIGATION

For investigation a series of samples of ferrosilicon containing from 49.1 per cent Si to 77.46 per cent Si were obtained from Borregaard, and a sample containing 93.41 per cent Si from Kopperaaen, Meraker.

The following samples were selected and analyzed:

No.	Per Cent Si		Per Cent Si
1.....	93.41	12.....	66.25
2.....	77.50	13.....	65.70
3.....	76.28	14.....	64.10
4.....	76.00	15.....	61.95
5.....	75.90	16.....	61.40
6.....	74.82	17.....	59.10
7.....	72.90	18.....	56.01
8.....	72.55	19.....	52.30
9.....	72.00	20.....	50.90
10.....	71.25	21.....	49.10
11.....	70.32		

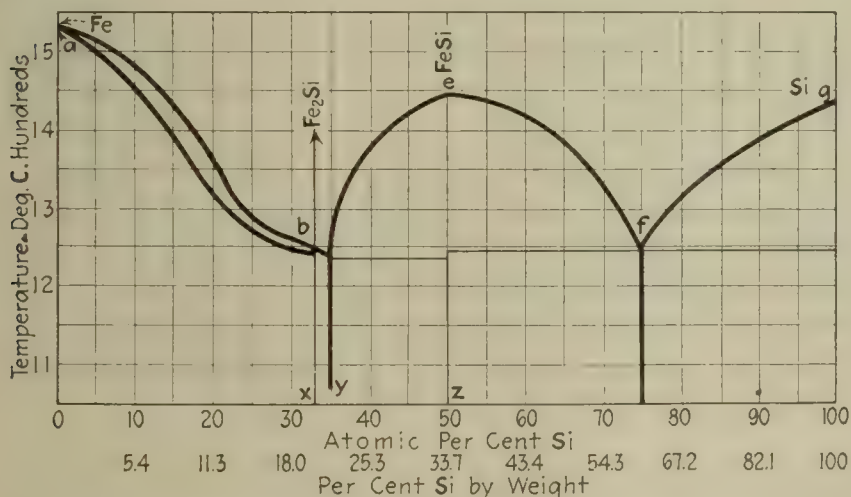


FIG. 1. EQUILIBRIUM DIAGRAM FOR IRON-SILICON ACCORDING TO GUERTLER AND TAMMANN (1905)

upon thermal investigations. They melted Fe (99.77 per cent) and Si (98 per cent Si, 1 per cent Fe) in a porcelain test-tube placed in an electric furnace and observed the cooling and heating curves. Thermoelements were protected by ordinary porcelain tubes in the investigation of alloys containing less than 75 per cent Si. With higher silicon content the porcelain tubes were protected by sheet platinum and magnesia. Melting was performed in an atmosphere of nitrogen. In their investigations, results of which are diagrammed

It was necessary to polish the specimens with the greatest care, because there was a tendency for large pieces to break loose from the surface, especially with alloys between 55 and 70 per cent Si. Alloy No. 18 with 56.01 per cent Si was so brittle that it could easily be broken apart with the fingers. The most brittle specimens were bonded with Canada balsam in a bunsen flame whereby they received sufficient mechanical strength for polishing.

Eutectic and separated crystalline aggregates could easily be distinguished under the microscope without etching. An attempt was made to etch the sections with weak hydrofluoric acid and weak NaOH solutions in order to see the structure of the crystalline aggregates. However, this etching gave unfavorable results, the portion of the sections which were broken out became larger and the image in the microscope less distinct. Crystals of FeSi_2 etched satisfactorily.

*Tidskrift for Kemi, vol. 16, No. 1 (1919). From the Technical High School Laboratories of Technical Inorganic Chemistry, Prof. Thv. Lindeman.

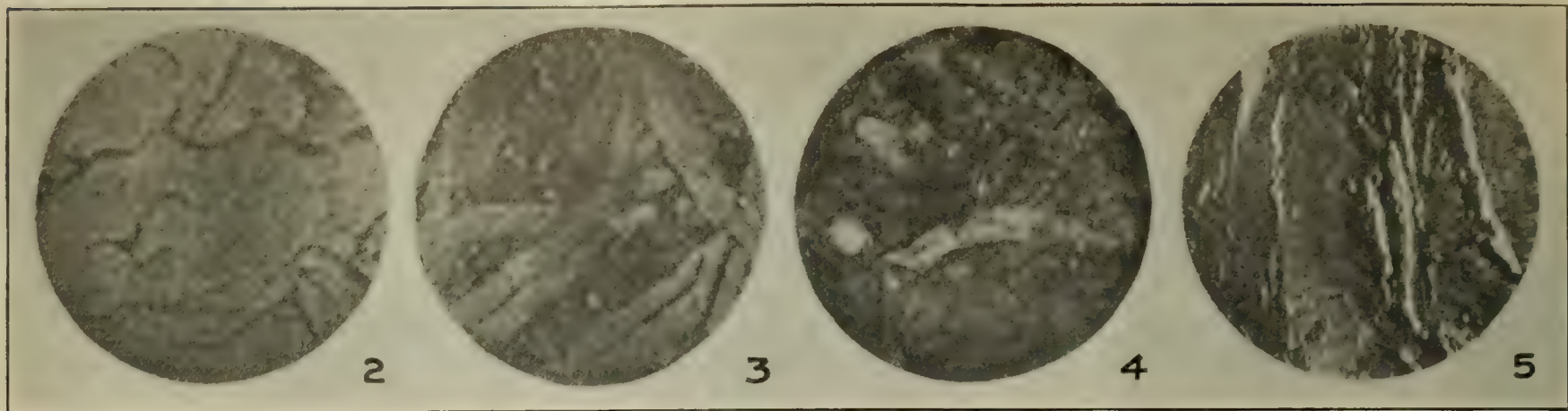
¹Lieb. Ann. vol. 129, p. 57 (1864).

²J. Am. Soc., vol. 21, p. 58 (1899).

³Elektrochemie (1901), vol. 3, p. 38.

⁴Chem. Zeit. (1903), vol. 27, p. 48.

⁵Z. Anorg. Chem., 1905, vol. 47, p. 163.



FIGS. 2 TO 5. MICROSTRUCTURE OF FERROSILICON SAMPLES
 Fig. 2. 93.4 per cent Si. $\times 50$. Fig. 3. 77.5 per cent Si. $\times 50$. Fig. 4. 56 per cent Si. $\times 65$. Fig. 5. 49.1 per cent Si. $\times 20$.

In silicon-rich melts, according to the diagram (Fig. 1), one would expect to find silicon crystals in a surrounding eutectic having a composition of about 60 per cent Si and 40 per cent Fe. This proved to be the case, except that the eutectic apparently has a composition of about 55 per cent Si and 45 per cent Fe. Crystals of silicon were observed as rather long crystalline aggregates in the midst of the surrounding eutectic; they are gray and have a bright hard surface with only a few small pieces chipped away from the surface. The surrounding eutectic presents a dotted structure with a light gold color. Large portions of the eutectic which were removed during polishing appear as black spots under the microscope.

Silicon in alloy No. 1 (93.41 per cent Si) appears in large smooth surfaces, separated by veins of eutectic (Fig. 2). The relative proportion of Si and eutectic could not be determined with accuracy by the planimetric method on account of the relatively large sizes of the crystals.

In Fig. 3 I have found it possible to obtain more truly representative portions of silicon and eutectic in one microsection. An alloy containing 56.01 per cent Si shown in Fig. 4 is the lowest in the series where crystals of pure silicon are found. This is not a representative picture of the distribution of Si, but it is that part of the section which shows the maximum amount of crystallized silicon; other portions were entirely without crystallized silicon. Intermediate analyses (alloys 2 to 17) show a progressively diminishing silicon content and an increasing eutectic content. As above noted, the eutectic works out to be about 55 per cent Si, 45 per cent Fe.

Besides the sections which are illustrated above, alloys 13, 14, 15 and 16, with 65.70, 64.10, 61.95 and 61.40 per cent Si respectively, were also investigated with the microscope. These samples, together with No. 17, approach the percentage corresponding closely to the compound FeSi, proposed by Naske. I could, however, find no indication of such a compound. All specimens showed

a uniform decrease in Si and increase in eutectic content. In alloy 6, containing 74.82 per cent Si, I estimated that the amounts of crystallized silicon and eutectic present were almost equal. Figuring eutectic to contain 55 per cent Si, we obtain:

	Per Cent Si
50 per cent Si.....	50
50 per cent eutectic.....	27.5
Total.....	77.5

a departure of about 3 per cent from the correct amount as given by chemical analysis.

Alloy 19, containing 52.3 per cent Si, shows the same eutectic mixed with a new crystal form, FeSi. (See Fig. 1). Measurement of various photographs of this alloy show that the crystallized FeSi comprises from 10 to 15 per cent of the whole surface. In the former case:

	Per Cent Si
90 per cent eutectic.....	49.5
10 per cent FeSi.....	3.33
Total.....	52.83

In the other extreme, 15 per cent FeSi:

	Per Cent Si
85 per cent eutectic.....	46.75
15 per cent FeSi.....	5.00
Total.....	51.75

Whether one decides 10 or 15 per cent FeSi makes only about 1 per cent difference in the resultant total silicon (compare with 52.3 by chemical analysis). FeSi has a strong metallic luster and a white color. Fig. 5 is a photomicrograph of alloy 21. This alloy is estimated to contain about 34 per cent FeSi.

	Per Cent Si
66 per cent eutectic.....	36.3
34 per cent FeSi.....	11.3
Total.....	47.6

an error of about 1.5 per cent.

In ferrosilicon with silicon content ranging from 48 to 60 per cent a large number of small geodes are found. Fig. 6 shows the largest one found. In occasional pieces a whole series of small geodes were found varying from 0.5 to 1.0 mm. in diameter.

In order to investigate the contents, individual crystals were picked out carefully, avoiding as far as possible taking portions which lay directly upon the solid ferrosilicon alloy, in order not to risk contamination. The fragments gave the following analysis:

	Per Cent Fe	Per Cent Si
1.....	51.0	50.8
2.....	49.3	49.1

This corresponds closely to the compound FeSi.

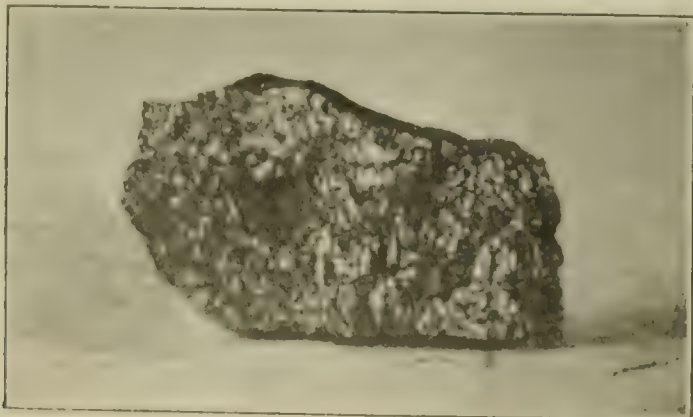


FIG. 6. LARGEST GEODE FOUND. $\times 2$.

The first matter which had to be determined was whether geode contents consisted of an actual compound, or if it were only an ordinary alloy which had assumed this form. A small blade from a geode, after etching with hydrofluoric acid, and magnified 100 times, showed individual crystals lying closely together, a homogeneous crystalline formation with no

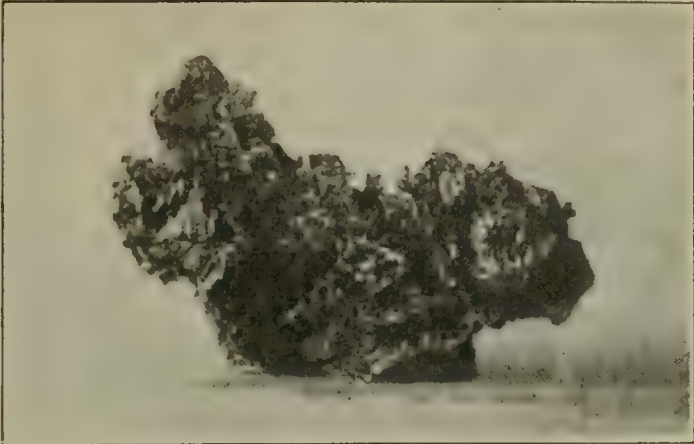


FIG. 7. LARGE GEODE IN 75 PER CENT FERRO-SILICON. NATURAL SIZE

foreign ingredients present. It is, therefore, well established that these geode contents consist of one kind of crystal, which according to the above analyses must be the compound FeSi_2 .
Fig. 7 shows a crystalline geode found in ferrosilicon about 75 per cent Si. Its analysis gave:

	Per Cent Si	Per Cent Fe
1.....	82.04	17.48
2.....	80.95	18.80

If the geodes consisted of homogeneous crystals it would correspond approximately to the compound FeSi_2 .
Microscopic examination showed at once a compound structure. After observing the section in the microscope it is seen that the geode consists of two distinct constituents—six cornered crystals, lying one on top of the other with an intermingling eutectic; the same eutectic, light gold in color, which was noticed in previous work (55 per cent Si). The maximum eutectic comprised 10 per cent of the whole. For example, suppose 10 per cent eutectic present. Then, if the crystals were to consist of pure silicon we could obtain:

	Per Cent Si
10 per cent of eutectic contains....	5.5
90 per cent assured pure.....	90.0
Total.....	95.5

Since the analysis gave only an average of 81.5 per cent Si, this hypothesis is excluded.
Assuming that in the average analysis (81.5 per cent Si and 18.5 per cent Fe) all the iron exists as a portion of the eutectic, the distribution of silicon is:

	Per Cent Fe	Per Cent Si
41.1 per cent eutectic contains.....	18.5	22.6
The chemical analysis is.....	18.5	81.5
Balance of pure silicon.....		58.9

The probability is, therefore, that the geode is more nearly constituted as follows:

	Per Cent
Free silicon.....	58.9
Unresolved eutectic.....	31.1
Eutectic surrounding the crystals.....	10.0
Total.....	100.0

Particles about 5 mm. diameter of alloys 1, 4 and 11

were treated with cold 20 per cent NaOH solution. After a lapse of one day the particles crumbled into small bits, and after a lapse of one week no more dissolved.
The weakly magnetic undissolved residue was filtered off, washed, dried, and analyzed, giving:

Sample	1	4	11
	Per Cent Si	Per Cent Si	Per Cent Si
1	54.66	54.90	55.30
2	54.45	55.20	55.25
	Per Cent Fe	Per Cent Fe	Per Cent Fe
1	45.45	45.66	44.80
2	45.30	44.97	44.80

This gives an average of 54.96 per cent Si, 45.13 per cent Fe. The caustic has, therefore, dissolved out the crystallized silicon from the alloy and left remaining an alloy which shows the same constant composition for all three samples. This is the eutectic which is not attacked by the cold caustic. According to this, the composition of the eutectic should be 55 Si, 45 Fe.
In the diagram (Fig. 1) the position of this eutectic is shown at about 60 per cent Si (atomic percentage = 75). The few investigations which they carried out upon this eutectic and the large sources of error which are attached to their work indicate that the position of the eutectic at 60 per cent Si must be wrong. The eutectic must surely not be far from 55 per cent Si and 45 per cent Fe. The curves, therefore, obtain a slightly altered appearance as shown in Fig. 8.

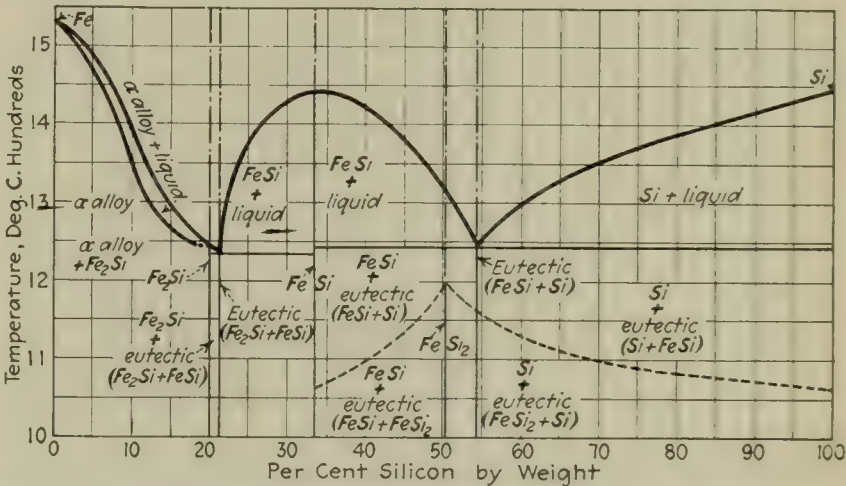


FIG. 8. EQUILIBRIUM DIAGRAM FOR IRON: SILICON ACCORDING TO LOWZOW AND HOUGEN (1919).*

The line ef becomes steeper in slope than the line fg ; also for two alloys lying equidistant from the eutectic and on opposite sides when computed in atomic percentages show a great difference in the relative proportions of eutectic with their respective Si and FeSi .
The undissolved residues from alloys 4 and 11 after one week of treatment with cold caustic were treated with warm 20 per cent NaOH for one week. The warm caustic attacks the small eutectic grains, which then fall into a powder. The powder, washed and dried, possesses greater magnetic properties than the previously discovered eutectic. The analysis gave:

	Per Cent Si	Per Cent Fe
No. 4.....	33.8	66.3
No. 11.....	33.9	65.9

This corresponds to FeSi —33.4 Si and 66.6 Fe.
The warm caustic dissolved the silicon from the eutectic and left the FeSi undissolved.

*TRANSLATOR'S NOTE: The work of T. Lowzow has established the exact composition of the eutectic FeSi and Si and has explained the formation of the compound FeSi_2 from this eutectic upon slow cooling. From interpretation of the modified equilibrium diagram the translator has drawn up this constitutional diagram. The dotted line below the solidus line merely indicates the probable manner of formation of the compound FeSi_2 and is not intended to even approximate the exact equilibrium conditions.

The specific weights of ferrosilicons given in Höngschmid's works of 1914, "Carbides and Silicides," are:

Fe ₂ Si (20% Si).....	7.0 (after Moissan) 22°C.
	6.75 (after Lebeau) 22°C.
Fe ₃ Si (25% Si).....	6.36 (after De Chalmot)
FeSi (33.33% Si).....	6.17
FeSi (50.00% Si).....	5.40 (after Lebeau)

De Chalmot gives for technical ferrosilicon the following specific gravities:

	12 per Cent Si	25 per Cent Si	46 per Cent Si
Specific gravity..	6.8	6.36	4.85

To determine specific gravity carbon tetrachloride is used; this does not attack any of the constituents of ferrosilicon. One disadvantage of carbon tetrachloride is its large temperature coefficient of expansion and high vapor tension. The specific gravity of carbon tetrachloride was determined in a Spengels pycnometer at 14.9, 17.1 and 20.1 deg. C. respectively, with parallel investigations of distilled water. Results:

Sp.gr. at 14.9 deg. C.....	1.6034
Sp.gr. at 17.7 deg. C.....	1.5982
Sp.gr. at 20.1 deg. C.....	1.5936

Ferrosilicon is permeated through its whole mass with gas and air spaces. The specific weight must, therefore, be determined in powder form. To determine this a bottle pycnometer was used. It was found absolutely necessary to work in a thermostat. A couple of investigations were made without the thermostat, with reading of the variable temperatures and corrections to the corresponding specific gravity of carbon tetrachloride; this gave very bad results because of cumulative errors. Temperature of the room was held at about 18 deg., maximum 19 deg., and the thermostat was kept constant at 20 deg. C. After filling the pycnometer with CCl₄ and fitting on the cork it was placed in the thermostat. When the pycnometer had been heated to 20 deg. the contents expanded and the overflow was driven out of the pycnometer through the capillary stem. At the moment when no more CCl₄ came out a cap was placed over the capillary and the pycnometer was dried and weighed. During the first investigations a small glass cap was used, but this did not prevent the CCl₄ from evaporating. By fitting on a small piece of rubber tubing, which was closed at one end by a small glass bulb, all evaporation of CCl₄ was prevented.

After this the weighed amount of ferrosilicon was placed into the pycnometer, filled one-third full with

TABLE I. SPECIFIC GRAVITY OF POWDERED FERROSILICON

No.	Per Cent Si	Sp.Gr.	No.	Per Cent Si	Sp.Gr.
1	93.41	2.542	12	66.25	3.453
2	77.50	2.944	13	65.70	3.560
3	76.28	3.010	14	64.10	3.602
4	76.00	3.050	15	61.95	3.780
5	75.90	3.051	16	61.40	3.857
6	74.82	3.060	17	59.70	4.102
7	72.90	3.162	18	56.01	4.260
8	72.55	3.205	19	52.30	4.200
9	72.00	3.220	20	50.90	4.342
10	71.25	3.222	21	49.10	4.630
11	70.32	3.260			

CCl₄ and shaken well in order to drive out most of the entrapped air. The remaining air was expelled by evacuation. The pycnometer was then filled with CCl₄, stoppered and set into the thermostat. The operation was continued as described above. Results are given in Table I.

These specific gravities are shown graphically in Fig. 9. The points marked 1', 2' and 3' indicate the specific

gravities of FeSi, FeSi₂ and Si respectively. Specific gravities are seen to lie fairly regular between 70 and 78 per cent Si. This is to be expected, because these alloys are produced from iron scrap and quartz and contain a very small amount of foreign constituents. No. 4 lies farthest from the curve; its analysis shows 76 per cent Si, but this determination figured from the specific weight curve should be nearer 75.2 per cent Si.

In the production of high ferrosilicon of about 75 per cent Si, very close estimations of the silicon analysis can be made in less than one hour by this specific gravity method, whereas an ordinary chemical analysis takes almost two days. This has a great commercial significance. By one step an approximate analysis can be rapidly made. If compelled to wait two days for an exact analysis there would be a risk of having the operation of the smelting furnace go wrong before being aware of it.

Poorer conditions exist with lower percentages of Si. The dotted portion of the curve represents the mean of the specific gravities. A variation from this line is to be expected since my ferrosilicon alloys were made from iron ore and quartz, naturally giving a larger opportunity for the introduction of impurities.

In order to determine if the constituent minerals would have this effect upon the specific gravities, thin sections were made upon the following samples:

Number	1	2	11	16	18	20
Per cent Si...	93.41	77.50	70.32	61.40	56.01	49.10

These were inspected in the microscope, using transmitted polarized light. In 1, 2 and 11 no minerals were found. On the other hand 16, 18 and 21 contained fairly small mineral grains in various amounts. One would expect that these were unreduced quartz; however, quartz could not be detected. Ca-Mg silicates were found, which accordingly reduce the specific gravity.

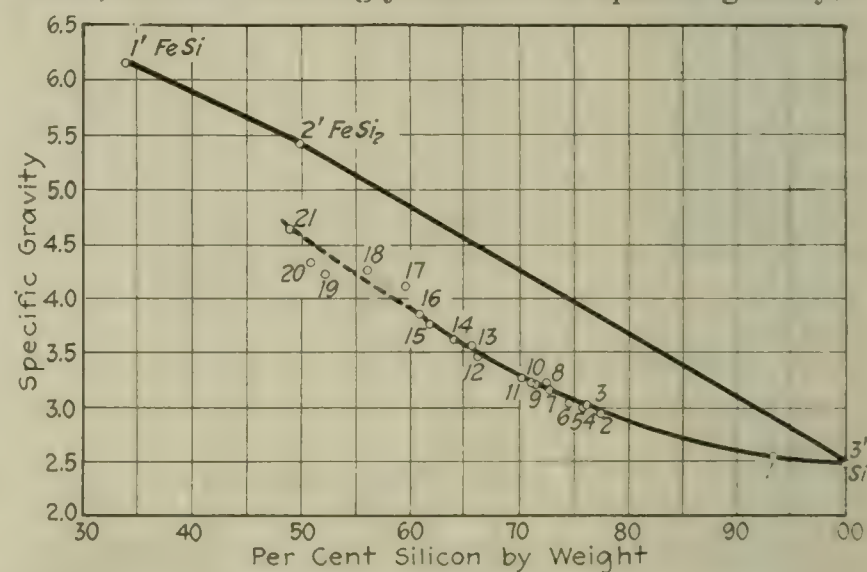


FIG. 9. SPECIFIC GRAVITIES OF POWDERED FERROSILICON

Continuing further with decreasing silicon percentages toward the eutectic (55 per cent Si), the alloy becomes continually duller in appearance. It also becomes more and more friable. No. 18 (56.01 per cent Si) is so friable that it can easily be crumbled with the fingers. Below 55 per cent Si, the alloy changes rapidly in character. Large laminated crystals of FeSi are present and impart to the alloy 50.90 per cent Si a strong metallic luster, a silver white color and great mechanical strength. Alloys which lie a few per cent to the left and up to 10 per cent to the right of the eutectic (55 per cent Si), say between 53 and 65 per cent Si, have, however, fairly little mechanical strength.

United States Export Trade in Corn Sirup
and Corn Sugar

With corn the greatest crop in the United States and a 1920 record yield of 3,199,126,000 bu. of the average farm value of 87.3c. per bu., according to the Bureau of Crop Estimates, it is of current interest to note the magnitude of the export movement in two of its many byproducts—glucose (corn sirup) and grape sugar (corn sugar).

All records were broken in the calendar year 1919 by an aggregate exportation of 255,617,709 lb. of corn sirup and corn sugar, valued at \$15,139,944, or an increase of 346 per cent in quantity and of 338 per cent in value over the 1918 shipments of 57,332,150 lb., invoiced at \$3,458,927. Little variation is shown in the average annual export price of about 6c. per lb. from 1918 to 1919. The United Kingdom ranked first as a market for these products, taking 39,345,968 lb., worth \$2,368,015, in 1918, and 159,033,298 lb., at \$9,563,339, in 1919.

From 1918 to 1919, shipments to France increased from 3,984,452 to 52,042,071 lb.; to Argentina, from 1,793,900 to 6,341,204 lb.; and to Italy from 845,537 to 5,909,980 lb. Considerable gains are also recorded in the 1919 trade with Belgium, Greece, Canada, New Zealand, the Philippines, British South Africa and other countries.

INDUSTRIES UTILIZING CORN SIRUP AND SUGAR

Corn sirup is a distinctively American product. Though less sweet than cane sugar, it can be used in many ways as a satisfactory substitute therefor. Glucose was discovered about 1800. In this country it is largely used in confectionery and in leather manufacture, in the form of an almost transparent, sirup liquid composed of dextroglucose, maltose, dextrine and water prepared from cornstarch by heating with dilute acids. It was formerly used to a large extent in brewing. For converting starch into glucose (hydrolysis), sulphuric acid is generally used. Various forms in commercial demand are "mixing glucose," used by sirup and molasses manipulators; "jelly glucose," for making jellies from evaporated apple juice or other materials; "confectioners' glucose;" "brewers' glucose," used as a substitute for malt in brewing; and "anhydrous grape sugar."

Well-made glucoses are perfectly wholesome and have a definite food value. It is said that the chief objection to their use in food preparations is due to the fact that the consumer is often misled in regard to the value of the products containing them, as glucoses are often used in the manufacture of inferior or adulterated goods. The manufacture in the United States of corn sirups for table use is highly developed, and there is an increasing domestic demand for various popular brands of uniform good quality. This demand may be partly due to the proportionately greater increase in the price of cane and maple sugar and sirups since 1917. Normally, in pre-war times, the value of cane and maple products greatly exceeded those of corn sugar and sirup, but the relative increase in price of the corn products has been very much less. Cane sugar has sold in this country as high as six times its pre-war value, while the price of glucose is only about three times greater. This is apparent in the exports of glucose amounting to 124,140,171 lb., valued at \$2,657,034, in the calendar year 1910, as compared with practically the same quantity,

Years	Glucose		Grape sugar	
	Pounds	Value	Pounds	Value
1910	124,140,171	\$2,657,034	46,791,855	\$937,391
1911	146,643,655	2,953,120	45,249,422	878,841
1912	134,842,547	3,256,550	40,328,283	906,385
1913	165,554,073	3,760,203	40,641,718	906,881
1914	127,201,099	2,895,189	35,681,124	775,036
1915	151,487,376	4,107,547	36,842,686	945,235
1916	136,379,198	3,295,823	38,684,528	993,478
1917	152,076,927	7,158,670	25,765,875	961,908
1918	42,740,417	2,552,637	14,591,733	906,296
1919	220,380,761	13,169,051	35,236,948	1,970,893
1920	124,202,985	7,806,101	9,918,320	618,897

* Nine months ended with September.

124,202,985 lb., exported in the first nine months of 1920, invoiced at \$7,806,101.

VARIATIONS IN EXPORT TRADE DURING LAST DECADE

It will be noted from the accompanying table that while the export trade in glucose (corn sirup) has been greatly extended during the last decade, 1910 to 1920, that in grape sugar (corn sugar) declined in quantity from 46,791,855 lb. in 1910 to 35,236,948 lb. in 1919, but increased in value from \$937,391 to \$1,970,893 in the same time. A still further decline in the exports of grape sugar occurred during the first nine months of 1920—9,918,320 lb., valued at \$618,897, as compared with 24,590,745 lb. invoiced at \$1,321,119 in the corresponding period of 1919.

The combined exports of glucose and grape sugar for the nine months ended September, 1920, are 134,121,305 lb., valued at \$8,424,998, or an average export price for this period of 6.3c. per lb. Corresponding exports in 1919 were 194,681,907 lb., invoiced at \$11,082,078, or 5.7c. per lb.

Tin Plate Industry and Trade in Swansea

The tin plate industry of Great Britain is confined exclusively to South Wales, with the exception of a single plant in North Wales. Of the 82 works in the Welsh tin plate industry, 65 are located within a radius of 18 miles from Swansea. That city may rightly claim, therefore, to be the center of the industry.

The following table from the report of the Royal Metal Exchange of Swansea shows the volume of the trade of the United Kingdom in tin plate, black plate and galvanized sheets for the years 1913, 1918 and 1919, and is applicable to the district of Swansea, since virtually all the tin plate and black plate, as well as the larger part of the galvanized sheets, are produced there.

	1913	1918	1919
	Tons	Tons	Tons
Exports of tin plate	494,497	223,509	289,761
Exports of black plate	71,775	4,571	32,511
Estimated home consumption of tin and black plates	255,798	226,355	229,711
Estimated output of tin black plates	822,070	454,485	551,983
Exports of galvanized sheets	762,075	8,835	186,101

Though the Welsh tin plate industry has a very important home market, the permanent success and further expansion of the industry must depend upon its export trade. Of the home trade which it had in tin plate and black plate in 1913, it recovered 229,711 tons in 1919. Of the export trade in these articles in 1913, it has recovered in tin plate 289,761 tons out of 494,497 tons; and in black plate, 32,511 tons out of 71,775 tons. That is, it has recovered 58 per cent of its pre-war tin plate export trade and 45 per cent of its pre-war black plate export trade.

Whether it will be able to recover a further appreciable per cent of its lost trade is somewhat questionable.

Porcelain Enameling Furnaces

BY C. G. ARMSTRONG*

THE art of ceramics had its beginning when primitive man took such clay as he found at hand and molded it into such shapes as fancy or needs dictated. Sun drying and accidental firing disclosed the secrets of pottery to him and the art of pottery, the forefather of enameling, had its beginning. To claim that the ceramic art was originated by any one race has been proved to be fallacious in view of the incontestable evidence that pottery was made by the Indians of Mexico and the prehistoric people of Egypt and China long before they were aware that any people lived in the world other than themselves.

Archæologists have found ruins along the Nile over 10,000 years old in which pottery played a part, but it is not until 1300 B.C. that we find any trace of glazes or enamels being applied to the pottery. The discovery of glass by the Assyrians, prior to 1300 B.C., is considered to be the beginning of the art of enameling, and the temple of Rameses III contained wonderful examples of enameling which have not been surpassed in magnificence to this day. Thus it is safe to state that enameling had its birth in Egypt.

From Egypt the art of enameling spread to Rome and was carried by the Romans to England, France and Germany at the time of their invasions of those territories.

During the early part of the eighteenth century the art of making miniature enamel pieces on gold, silver and copper assumed fair proportions, and yet we do not find any record of attempts to enamel iron or steel prior to 1840, when a method for the enameling of cast iron by the dry process was discovered. The enamel was applied only on the inside of the receptacle at first, as muffle firing was very imperfect. The muffles of that period were made of cast iron with steel base plates and were far from being satisfactory, though some very excellent pieces of work were turned out.

In 1860 the enameling of sheet iron was begun, and upon the advent of the drawing press and clay muffle in 1870 the process of porcelain enameling steel as we know it today developed into the enameling industry.

FORMULAS

The formulas used in 1850 and those of today, while fundamentally the same, have had to undergo many changes in order to produce an enamel which would have the proper physical and chemical properties to work on the modern basic sheet steels.

In this paper we shall carefully avoid the discussion of formulas, for with the forty or more variable ingredients going into a formula, eight of which on an average are used, there are possibly 76,920,000 formulas. Time is too short even to begin such discussion; furthermore, we have to deal with enameling furnaces—furnaces in which all correct formulas should work properly.

With the development of the industry in Europe and the establishment of an American enameling plant at Woodhaven, N. Y., in 1863, we arrive near home and are prepared to discuss the furnaces.

In the strictly ceramic lines of the porcelain enamel industry having to do with the preparation and applications of the enamel, progress until recently has been

fairly slow and has lagged considerably behind the development of the machinery used in forming the steel shapes for enameling. The designs of furnaces for the firing of the enamel have also been changing very slowly since the inception of the clay muffle in 1870 and until recently there has been no marked improvement. To review the development in porcelain enameling furnaces from the time when they were only a flat hot stone through the different stages of the intermittent beehive oven, cast-iron muffles, clay muffles to the modern muffles would consume too much space. Suffice it to say that since the introduction of the clay muffle no radical changes have been made, except in the placement of the flues and method of firing, until the introduction of the carborundum muffle.

TYPES OF FURNACES

Present-day furnaces may be divided into two classes as to muffle types—the semi-muffle and full muffle—and also several classes as to method of firing, or briefly, coal-fired, producer-fired, semi-producer, recuperative, oil-fired and gas-fired. The electric furnace has not entered the commercial field as yet, due to great heat losses entailed.

Various types of furnaces are used, most of the variations being in the flue system. Very elaborate flue layouts have been constructed in some furnaces with the idea of extracting as much of the available heat as possible from the gases before they leave the furnace. This, of course, is not necessarily always successful, for those flues placed in the roof and upper walls which receive their heat by radiation often are a means of extracting heat from the furnaces and causing the flue gases to leave the furnace at a much higher temperature than they would if taken out by means of shorter flues. The logical thing to do, therefore, is to use a recuperator instead of long flues, or better still use a thin or high-conductivity muffle which will keep the temperature gradient between the flues and the interior of the muffle as small as possible. This feature is conducive to economy, both as to muffle and fuel, since a lower temperature is necessary in the combustion chamber and flues in order to attain and maintain the proper enameling temperature within the muffle. There are furnaces in modern plants where the floors of the muffles are 8 to 12 in. thick with muffle walls 3 in. thick in which a temperature of 3,000 deg. F. (1,649 deg. C.) has to be maintained within the combustion chamber in order to maintain 1,600 deg. F. (871 deg. C.) in the muffle. Such a large temperature difference between the combustion chamber and muffle is not uncommon today and needless to say is not economical. A temperature difference of more than 400 deg. F. (204 deg. C.) between the flue temperature and muffle temperature is not justifiable in the light of the latest developments in porcelain enameling ovens.

FURNACE CONSTRUCTION

In taking up the construction of furnaces for firing porcelain enamel let us first discuss the simplest form, the gas furnace. As is well known, the atmosphere within a porcelain firing furnace must be oxidizing—that is, must have an excess of oxygen present and little or no reducing gases such as carbon monoxide—in order that a smooth product may be obtained. Control of the atmosphere within a gas-fired furnace is easily accomplished and for that reason semi-muffles are frequently used in these furnaces. A semi-muffle is only that part

*Chemical Engineer, Chicago Flexible Shaft Co. Paper presented before Chicago Section, American Ceramic Society, Nov. 27, 1920.

of the muffle which goes to make up the bottom and sides—that is, without a top. Such furnaces are highly efficient as to fuel consumption and are as satisfactory as the full muffle when the operation is understood. A gas-fired furnace is less expensive than any other type, due to its less bulky construction.

Oil-, coal- and producer-gas fired furnaces all fall into one general class whether recuperative or not. These furnaces all require relatively large combustion chambers and full muffle construction.

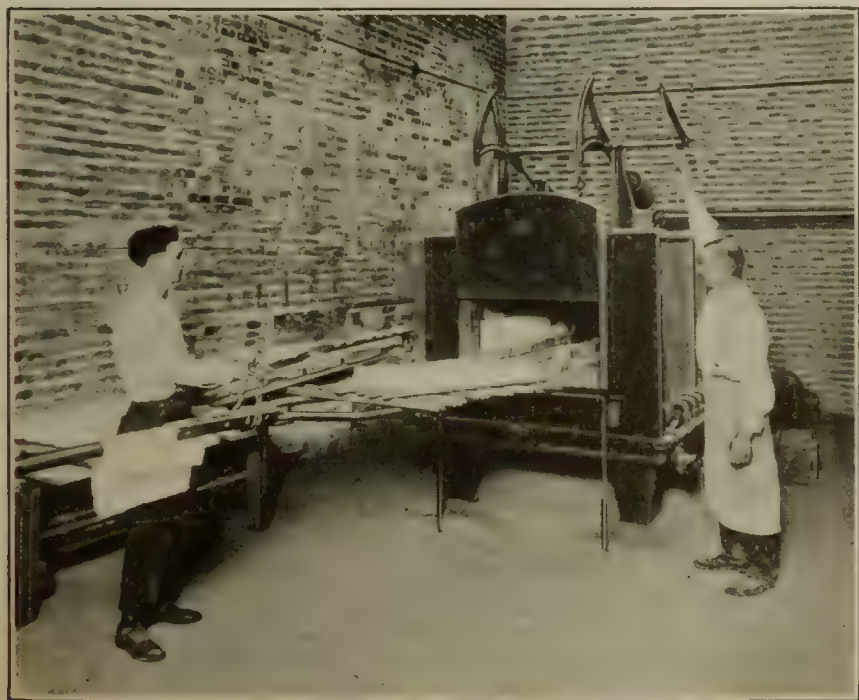
The general plan upon which all of this type are constructed is to build the combustion chamber or firebox under the rear of the furnace and erect a thick furnace floor over one long central combustion chamber, from the sides of which lateral flues lead to the flues in the wall of the furnace surrounding the muffle. This construction is surrounded by walls of refractory brick backed by several layers of red brick facing in order to conserve the heat. In such furnaces, which are exceedingly common, the temperature difference between the flue gases and the interior of the muffle is generally 800 deg. F. (427 deg. C.) or more, and to see flames emitting from the top of a 15-ft. stack attached to such furnaces is not uncommon. The heavy construction necessitated by the inherent weakness of the fireclay refractories at the temperature of an enameling furnace together with the poor thermal conductivity of these refractories results in a fuel consumption out of all proportion to the small percentage utilized in the burning of the ware. Any development in furnace design which will show a saving of several per cent in fuel will be a boon to the enameler, because his costs of production are gradually approaching his selling prices.

LATEST DEVELOPMENTS IN ENAMELING FURNACES

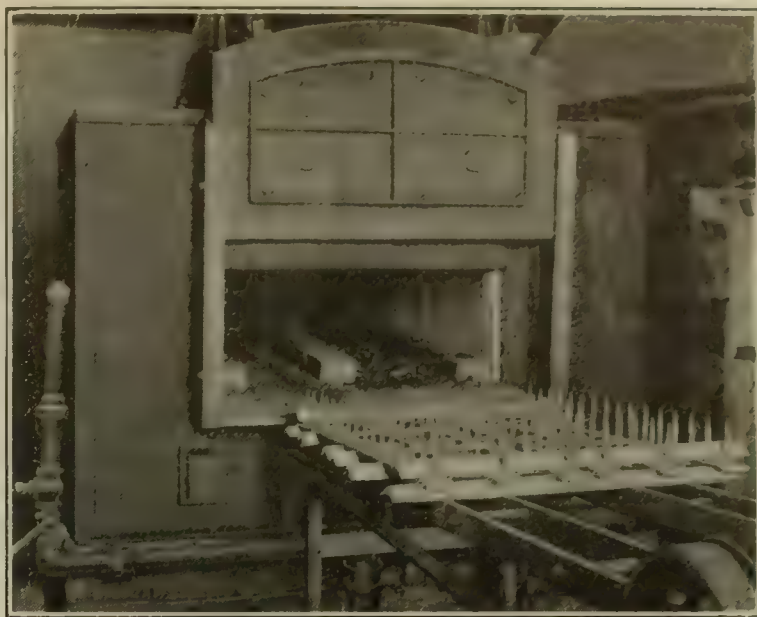
Before entering into a discussion relative to the latest developments in enameling furnaces it may be better to outline the points of weakness in the old types. For brevity we will itemize their shortcomings:

1. The weakness of the fireclay refractories at the temperature of enameling ovens necessitates the use of exceedingly heavy refractories with such mass as to require days to heat up, and definite control of the temperature of the furnace is impossible.

2. The poor conductivity of the heavy refractory muffles makes it imperative to maintain a flue temperature 800 to 1,000 deg. F. (427 to 538 deg. C.) in excess



SEMI-MUFFLE, GAS FIRED



FULL MUFFLE, GAS FIRED

of the muffle temperature, resulting in high fuel consumption and short life of the refractories.

3. Great mass and poor conductivity of refractories. From three to five days is required to bring a furnace up to heat.

4. Uniformity of temperatures—i.e., plus or minus 10 deg. F. (—12 deg. C.) within the muffles of the old type furnace are almost unknown, and loading to the door can never be practiced.

5. High flue temperatures necessitate bulky construction in order to conserve the heat.

6. Economy of operation of old type furnaces cannot be practiced except at expense of output.

7. The durability or life of the old type muffle furnace is fairly short. Constant repairs and renewals are required and overheating results in its ruin.

8. Shutdowns over Saturday afternoon and Sunday are not practicable.

Now, having listed the shortcomings of the old type furnace, let us see how these are overcome in the new furnaces, point for point:

1. The carborundum refractories used in the newer furnaces, having a mechanical strength approximately ten times that of ordinary fireclay when cold and retaining this strength to and above the temperature of the enameling furnace, 3,500 deg. F. (1,767 deg. C.), whereas the fireclay weakens, permit the construction of a furnace and muffle very much lighter. The carborundum floor may be 2 in. thick, whereas fireclay floors average 8 in., and the carborundum muffle may be 1½ in. thick, whereas fireclay must be 3 in. thick.

2. The high heat conductivity of the carborundum refractories permits the operation of the furnace with a much lower temperature in the combustion chamber and flues. The thermal conductivity of carborundum is seven times greater than fireclay, and as one-half the thickness is used fourteen times more heat is conducted through the walls of the muffle, thus permitting a temperature difference between flue gases and muffle of only 200 deg. F. (93 deg. C.). This one factor gives an average fuel saving of about 30 per cent, not to mention the lengthened life of the refractories.

3. This lightened construction permits a quicker heat—in fact five hours on an average from a cold furnace is common practice with carborundum muffles; and furthermore this permits a certain amount of temperature regulation not possible in clay muffles.

4. Lower combustion temperatures permit less bulky

constructions, conserving the heat. Another factor in the conservation of heat in modern furnaces is the use of insulating bricks, such as Silocel and Nonpareil.

5. Due to the high conductivity of the carborundum muffle the furnaces are designed to give and to deliver uniform temperatures throughout the muffle. Loading to the door is common practice, which gives an increased capacity of full 35 per cent. In one case a carborundum muffle tested with a Leeds & Northrup optical pyrometer by three people gave twenty readings running from 1,790 to 1,800 deg. F. (817 to 822 deg. C.), a variation of only 10 deg. and a temperature difference barely perceptible to the eye.

6. The output of a furnace is directly dependent on the temperatures which can be maintained within the muffle. This is easily accomplished in a carborundum muffle, due to its high thermal conductivity. A 30 per cent saving is the general average realized.

7. The life of the present-day furnaces, equipped for any system of firing and built in accordance with the latest specifications, using carborundum refractories, is apparently unlimited. In fact we have never yet had one burn out or need repairing so are not in a position to say definitely just how long they will last. One furnace was overheated to about 2,800 deg. F. without doing any damage to the muffle. It benefited the muffle by burning in the cement joints. This muffle after eight months' constant use, with shutdowns over Saturday and Sunday, is as true today as when installed.

8. Shutdowns over Saturday night and Sunday are regularly practiced by users of carborundum muffles, as five hours is sufficient time to heat up to working temperature and three hours is not uncommon with oil-fired furnaces. The fuel saving is very appreciable—in fact one user shows where he has saved the entire cost of the muffle in 120 days through fuel economy exclusive of the fuel saving due to being shut down over Sunday.

CONCLUSION

In conclusion we may summarize the comparison of the old and new type furnaces:

OLD	NEW
1. Excessive mass and character of refractories necessitates three to five days for the furnace to heat up. No definite temperature control can be practiced.	1. Light weight and refractories of high conductivity permit quick heating; five hours' time is general practice on coal, three hours on oil furnaces. Definite control of temperature is practicable.
2. Poor conductivity of refractories makes imperative high flue temperature, with resulting loss of fuel and shortened life of refractories.	2. High conductivity of refractories permits lower flue temperature, thus saving in fuel and lengthening of life of refractories.
3. Slow, careful heating, incurring large expense.	3. Rapid heating, with lessened expense.
4. High flue temperature, necessitating bulky construction to conserve heat.	4. Low flue temperature permits less bulky construction, and use of insulating material further conserves this heat.
5. Temperature difference between flue gases and muffle average 800 to 1,000 deg. F.	5. Temperature difference between flue gases and muffle average about 200 deg. F.
6. Uniformity of temperature within 10 deg. F. is unknown and full loading impractical.	6. Uniform temperature within 10 deg. F. is not uncommon and loading to door regularly practiced.
7. Fuel economy cannot be practiced.	7. Fuel economy over old type averages 30 per cent or more.
8. Life of muffle uncertain and short overheating is ruinous.	8. Life of muffle indefinitely long, overheating not injurious.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Hydrogen Peroxide.—In the manufacture of hydrogen peroxide solutions for commercial purposes, it has long been the custom to react upon barium peroxide, BaO_2 , with acids in the presence of water in various ways, thereby forming a barium salt and a solution of H_2O_2 . Acids forming normally insoluble barium salts, such as phosphoric acid and sulphuric acid, are usually employed. As is known, nitric acid may be employed for this purpose, since barium nitrate is but sparingly soluble particularly in the presence of any free nitric acid. In the formation of any of these insoluble or sparingly soluble barium salts, however, the difficulty is that it is hard to secure any complete conversion of the barium peroxide in the presence of small amounts of water—that is, under circumstances which will give a tolerably strong solution of hydrogen peroxide. ROBERT JACQUELET, of Catonsville, Md., suggests treating BaO_2 with a 2.5 per cent solution of HCl and then adding strong nitric acid which precipitates barium nitrate and releases an equivalent amount of HCl to attack a further quantity of BaO_2 . With proper operation there is no liberation of chlorine from the production of aqua regia and all the barium dioxide is utilized. The final result is a solution of hydrogen peroxide which may be of such a strength as to be the equivalent of 35 or 40 volumes of oxygen, this solution containing a small amount of dissolved barium chloride. The rest of the barium is found in the form of a crystalline nitrate, which may be subsequently utilized in known ways to reproduce barium dioxide and nitric acid. The barium nitrate, washed, pressed and dried, is a clean white powder. It may be sold as such. The hydrogen peroxide solution does not contain enough barium chloride in solution to interfere with its use for many purposes. If the operation is properly conducted, it will be stable and neutral. This solution may be treated in the usual way to obtain stronger solutions or to get pure hydrogen peroxide. (1,364,558; Jan. 4, 1921.)

Sulphuryl Chloride.—A good yield of sulphuryl chloride (SO_2Cl_2) is obtained by allowing sulphur dioxide and chlorine to react in the presence of one or more of the following catalysts: Esters which are formed from saturated aliphatic alcohols and saturated aliphatic acids containing only the elements C, H, O; triphenyl phosphate; tricresyl phosphate; eucalyptol, benzaldehyde; benzyl acetate. It is not necessary to use sunlight, ultra-violet rays or pressure with these catalysts. (1,364,738; THOMAS H. DURRANS, of Oxford, England, assignor to A. Boake Roberts & Co., Ltd., of London, England; Jan. 4, 1921.)

Method of Forming Refractory Articles.—In the manufacture of refractory shapes or abrasive stones from mixtures of silicon carbide or crystalline alumina and plastic clay it has been found necessary to use high pressure in order to extrude the mass through the dies. Unless the dies are lubricated, deformation and breakage occur. The problem of efficient lubrication may be met by mixing about 4 per cent of a saponified oil mixture known as petroleum grease with the abrasive-clay mixture before extrusion. (1,364,849; ALBERT H. ANDERSON, of Worcester, Mass., assignor to Norton Co.; Jan. 4, 1921.)

Purifying Benzanthrone.—In the production of benzanthrone—for example, by condensing anthraquinone and glycerine with the aid of sulphuric acid—the product obtained after removing water-soluble constituents is still impure. It contains unchanged anthraquinone, a red resinous substance and a material which is black when wet and brown when dry. According to LLOYD C. DANIELS of Buffalo, N. Y., halogen derivatives of the simple aromatic hydrocarbons, particularly chlorobenzene, are adapted for use

as selective solvents with this mixture. The crude benzanthrone press-cake is extracted with hot chlorbenzene. After filtering, the solution is cooled to about 15 deg. C., when the benzanthrone separates in quite pure form. When the benzanthrone is accompanied by considerable amounts of unchanged anthraquinone, it is sometimes difficult to effect a separation, owing to the formation of a eutectic containing about 11 to 12 per cent anthraquinone and 88 to 89 per cent benzanthrone. If, however, the anthraquinone is less than about 11 per cent, the separation is easily made. (1,365,024; assigned to National Aniline & Chemical Co., Jan. 11, 1921.)

Alcohols, Esters and Ketones From Petroleum-Cracking Still Vapors.—All phases of the process for utilizing the waste vapors from petroleum-cracking stills described in *CHEMICAL & METALLURGICAL ENGINEERING*, vol. 23, p. 1230, Dec. 22, 1920, are treated in a series of patents covering the research work done by CARLETON ELLIS, of Montclair, N. J.; MORTIMER J. COHEN, of New York; MATTHEW D. MANN, JR., of Roselle, N. J., and ROBERT R. WILLIAMS, of Chicago, Ill. The unsaturated hydrocarbons in the vapors are absorbed at about 20 deg. C. in H_2SO_4 of 1.8 sp.gr. The acid liquor may be treated to yield a variety of products. Alcohols (chiefly isopropyl) are obtained by diluting with water, which hydrolyzes the alkyl hydrogen sulphate. The alcohols are separated by distillation or by extraction with suitable solvents. By adding inorganic salts of organic acids, such as calcium or sodium acetate, to the acid liquor esters are found. Electrolytic oxidation of the acid liquors gives ketones and fatty acids. (1,365,043 to 1,365,053 inclusive; assigned, by mesne assignments, to Seth B. Hunt, trustee, Mount Kisco, N. Y., Jan. 11, 1921.)

Separating Nickel and Cobalt.—Nickel-cobalt ores of the type found in the cobalt district of Canada are brought into solution in the form of chlorides by any approved method. Iron is removed by treating the solution with chlorine, removing the excess of chlorine by means of air or otherwise, and then agitating with calcium carbonate or similar precipitant. If the chlorine has been completely removed, only iron is precipitated. The resulting solution, containing nickel and cobalt but free from iron, is then mixed with finely divided calcium carbonate (whiting, for example) and gaseous chlorine is bubbled through the pulp. If the solution is kept at a sufficiently low temperature, very pure black cobalt oxide is formed and practically all of the nickel remains in solution. (1,365,358; MARVIN J. UDY, of Kokomo, Ind., and OLIVER C. RALSTON, of Niagara Falls, N. Y., assignors to Hooker Electrochemical Co., Jan. 11, 1921.)

Phenols From Redwood.—Unlike most soft, resinous woods, redwood (*Sequoia sempervirens*) when destructively distilled gives a tar which contains large proportions of phenol and creosols. According to WALTER J. HUND, of Ross, Cal., one cord (4,000 lb.) of the light-wood from redwood stumps will give upon destructive distillation 50 to 60 gal. of tar (sp.gr. 1.11). This tar is then distilled. The fraction between 150 and 250 deg. C. is collected separately, giving from 20 to 25 gal. of middle oil, which is then treated with sodium hydroxide solution. Acidification of the alkaline extract gives 10 to 15 gal. of phenolic oils, which after fractionating and purifying yield 17 to 20 lb. crystalline phenol, 4 to 5 gal. cresylic acid and 2 to 3 gal. creosote. The absence of sulphur compounds and naphthalene simplifies the process. (1,365,407; Jan. 11, 1921.)

Recovering Volatile Solvents.—Vapors containing volatile solvents are treated with a mixture of sperm oil, lard oil, petroleum oil and alcohol. The solvent is subsequently separated from the absorbing agent. (1,365,791; SAMUEL S. SADTLER, of Springfield township, Montgomery Co., Pa.; Jan. 18, 1921.)

Glass.—A glass having a low coefficient of expansion and marked resistance to high and low temperatures is made from a batch consisting of a preponderance of silica, smaller amounts of boric oxide, alumina, sodium nitrate and sodium carbonate, and still smaller amounts of calcium carbonate and arsenic trioxide. (1,365,597; MAURICE A. SMITH, of Jeannette, Pa., assignor to McKee Glass Co.; Jan. 18, 1921.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Treating Gas Liquor to Form Fertilizers.—Gas liquor is freed from ammonium cyanide and sulphocyanide and rendered suitable for use as a fertilizer by adding yellow ammonium sulphide or sulphur or by treating it with air or other agent to separate sulphur from the sulphur compounds, and distilling the liquor. The cyanide is transformed into sulphocyanide which remains in the retort. (Br. Pat. 153,006; GES. FÜR LANDWIRTSCHAFTLICHEN BEDARF. and DR. I. R. MANDELBAUM, both in Munich. Jan. 12, 1921.)

Sodium Pentaborate—Boric Acid.—Boro-natro-calcite is treated with water or mother liquor and enough sulphuric acid to form calcium sulphate but without giving the mixture an acid reaction and the mixture is heated to 75 deg. C. and filtered. The filtrate is concentrated and cooled to obtain sodium pentaborate, Na_2O , $5\text{B}_2\text{O}_3$, $10\text{H}_2\text{O}$, and some boric acid remains in solution and may be recovered. The residue consists of calcium sulphate and unchanged boro-natro-calcite. It is treated with water or mother liquor and enough sulphuric acid to make the mixture acid, and is then filtered. Calcium sulphate remains on the filter, and boric acid is recovered from the filtrate. (Br. Pat. 153,007; not yet accepted; SCHOTT & GES., Jena, Germany. Jan. 12, 1921.)

Anthraquinone Derivatives and Dyes.—Condensation products, probably azomethine compounds, are obtained by heating 1-amino-2-methylantraquinone or its substitution products, or isomeric amino-2-methylantraquinone, or 2-methylantraquinone itself, with aromatic nitro compounds in the presence of alkaline reagents; primary aromatic amines may be added to the reaction mixture. The products are vat dyestuffs, and may be hydrolyzed by acids to give 1-aminoanthraquinone-2-aldehyde, or its substitution products or isomers, or anthraquinone-2-aldehyde, respectively. According to examples, condensation products are obtained by heating (1) 1-amino-2-methylantraquinone with nitrobenzene and potassium carbonate or with nitrobenzene, aniline, and potassium acetate or caustic soda; (2) 1-amino-2-methylantraquinone with *m*-nitroaniline, naphthalene, and potassium carbonate; (3) 1-amino-methylantraquinone with β -naphthylamine, nitrobenzene and potassium carbonate; (4) 4-*p*-toluido-1-amino-2-methylantraquinone, nitrobenzene, aniline, and potassium acetate; (5) 1:5-diamino-2-methyl-antraquinone, nitrobenzene, aniline, and potassium carbonate; (6) 3-amino-2-methylantraquinone, nitrobenzene, aniline, and potassium carbonate; (7) 2-methylantraquinone, nitrobenzene, aniline, and potassium carbonate. Examples are also given of the preparation of 1-aminoanthraquinone-2-aldehyde, 4-*p*-toluido-1-aminoanthraquinone-2-aldehyde, 1:5-diaminoanthraquinone-2-aldehyde, 3-aminoanthraquinone-2-aldehyde, and anthraquinone-2-aldehyde from these condensation products. (Br. Pat. 153,055; L. CASELLA & Co., Frankfort-on-Main, Germany. Jan. 12, 1921.)

Catalyst for Synthetic Ammonia.—Catalysts for use in the synthesis of ammonia are prepared by heating, preferably to a temperature below 500 deg. C. in a neutral atmosphere, simple cyanides of the metals, iron, nickel, cobalt and chromium, or complex cyanides of such metals, not containing a cyanide or alkali or alkaline earth metal, or in which the molecular proportion of such cyanide to the heavy metal cyanide is less than 2:1; by the use of these catalysts the synthesis of ammonia can be carried out at a temperature below 400 deg. C. and while using a pressure less than 100 atmospheres. Suitable initial compounds are ferrous cyanide, ferrocyanhydric acid, ammonium ferrocyanide, triammonium-potassium-ferrocyanide, potassium-ferrous-ferrocyanide (Everitts' salts), potassium-ferric-ferrocyanide (Williamson's violet). It is advantageous to add to initial materials not containing alkali or alkaline earth metals, a proportion of a compound of such metal, potassium nitrate for example, but the relative proportions here indicated must not be exceeded. (Br. Pat. 153,290; not yet accepted; NORSK HYDRO-ELEKTRISK KVAELSTOFKIESEL-SKAB, Christiania, Jan. 12, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Engineering Foundation and Industrial Research

Industrial research on a nation-wide scale, in which engineering organizations, universities, factories, individuals and private laboratories and other organizations are co-operating, is under way, according to the annual report of Engineering Foundation, prepared by the chairman, Charles F. Rand.

Describing the Foundation as a permanent national agency "for the furtherance of research in science and engineering, or for the advancement in any other manner of the profession of engineering and the good of mankind," Mr. Rand outlines a broad field of activity in which the Foundation, profiting by the lessons of the war, is working.

Highway research, experimentation in the fatigue phenomena of metals, mental hygiene in industry, industrial personnel research, psychological tests for engineering students, industrial education in training, and tests of mechanical equipment are among the projects which the Foundation's effort embraces.

The Foundation, according to Mr. Rand, now has an endowment of \$500,000. One anonymous gift of \$200,000 has been received and one individual, it is stated, has offered to give \$50,000 if nine other men would make equal gifts.

To avoid a possible deficit of \$16,000 by 1922 Edward D. Adams of New York assumed this contingent liability. Mr. Adams' liability has now been canceled, the financial requirements for the work in hand having been provided by the increased income from endowment. The Foundation is raising a fund of many millions to promote industrial research in America and hopes this year to reach the five million dollar mark.

Many new projects with design to foster research and thus help maintain this country's industrial supremacy are under consideration by Engineering Foundation. Among the specific researches suggested are: Cryogenics, particularly research in characteristics of gas mixtures in relation to liquefaction and separation of gases for industrial purposes; electrical insulation; colloidal lubricants and fundamental principles of lubrication; fundamental study of laws of crystallization of metals, atomic structures and other metallurgical problems; improvement of utilization of all kinds of fuels; principles of heat transfer; landslides; ceramics; hydraulics; industrial education and training; and social industrial engineering.

"Establishment and operation of a large hydraulic laboratory has been suggested as an appropriate undertaking for Engineering Foundation," declares the report. "It has also been proposed that the Foundation establish and conduct an Engineering Research Institute and Laboratory, to supplement the university training of promising research men, to provide place and means for research by engineers and inventors and for limited co-operative research by the industries, and to house models, apparatus and drawings of historic interest in connection with engineering research. The proposed laboratories could be made partly self-sustaining, but very large funds would be needed for their establishment and to supply the deficiencies in income.

"Another suggestion is that Engineering Foundation conserve research byproducts of engineering works. Engineering works frequently involve studies of special problems or in themselves constitute full-sized experiments, which could be made to yield important data. Sometimes the engineers in charge do not perceive the opportunity, not having been trained in research work. More often the possibilities are realized, but means, men and time cannot be used because of the commercial urgency for getting the project completed with minimum expenditure. Occasionally experimental work is undertaken in accordance with a well conceived plan,

but the exigencies of the main operation sooner or later interfere, or the information is gained but never made available; a greater familiarity with research methods and a broader conception of the problem could, with small additional expense, have secured much more valuable results and have made them more generally useful."

Kelly-Springfield Tire Co. Moves to Cumberland

After a survey of the entire country the Kelly-Springfield Tire Co. selected a 100-acre site along the Potomac at Cumberland, Md., for a model plant to have a capacity of 10,000 tires a day, including 1,500 truck tires. The business of the old plants at Akron, Ohio, Wooster, Ohio, and Buffalo, N. Y., will be transferred to the new factory, which will be ready for operation about April 1.

The new location is most satisfactory with respect to transportation, labor, raw materials, water and power. Three trunk line railroads serve the plant, and the location has a 10 per cent freight differential over Akron. An abundant coal supply is available within eleven miles.

The main building has a floor area of twenty acres. The main wing, 760 x 120 ft., two stories, is joined by five wings, each 305 x 60 ft. From receipt of raw material to shipment of finished product, one progressive movement is maintained in the process of manufacturing. Machinery includes three 90-in. calenders, the largest ever built, and two pumps with an approximate capacity of 6,000,000 gal. each. Power is furnished for six 750-hp. boilers. Future expansion is provided for in every phase of the layout.

The laboratory or experimental building, two stories, 300 x 55 ft., is said to be the only one in the industry in which a complete standard tire can be built. It contains the most modern equipment for chemical and mechanical development.

Plans for Chicago Convention of American Mining Congress

The twenty-fourth annual convention of the American Mining Congress and the National Exposition of Mines and Mining Equipment will be held in Chicago, Oct. 17 to 22 inclusive, with convention headquarters at the Congress Hotel. The Coliseum has been reserved for the exposition which will include exhibits of: Coal byproducts, chemicals, non-metalliferous substances, petroleum, oil shale, cement and cement products, raw and manufactured products, byproducts, smelting equipment, flotation and milling equipment.

Among the national conferences to be held during the convention will be those on Taxation, Production and Cost, Labor, Transportation, Standardization, Flotation, Gold Production, the Commercial Development of Byproducts, the Development of Non-Metalliferous Ores, National Finance, Mine Management and Handling of Men, Mineral Tariffs, etc. National leaders will discuss the present-day tendency toward government control of industry.

Crescent Refractories Co. Merger

Following the annual stockholders' meeting of the Crescent Refractories Co. of Curwensville, Pa., announcement was made of a merger of the George S. Good Firebrick Co. and the Clearfield Clayworking Co. with the Crescent Refractories Co.'s properties. Consolidation of these properties brings together three important Clearfield County fireclay and coal holding properties.

The output of the plants now operated by the corporation reaches 240,000 brick per day and marks another step forward in fireclay industry of this region.

New Jersey Clay Workers Defer Annual Meeting

At a meeting of the executive committee of the New Jersey Clay Workers Association and Eastern Section of the American Ceramic Society at Metuchen, N. J., March 5 it was voted to pass by the annual meeting of the organization, originally planned for January, but at which time it was impossible to arrange for the gathering. The next meeting will be held in June at Trenton, and it is proposed to make this midsummer gathering an important event. A committee has been appointed to arrange the details of the convention and fix a definite date. Another committee was selected to draft a set of new bylaws for the organization, to conform more closely to the constitution of the American Ceramic Society. Plans were also discussed for the new official publication of the organization, to be known as the *New Jersey Ceramist*, which will be issued quarterly. Charles Howell Cook, Trenton, chairman of the executive committee, presided at the meeting, with R. H. Minton, vice-chairman, acting in his stead prior to adjournment. Among those present were Abel Hansen, Perth Amboy, chairman of the association; Prof. George H. Brown, Rutgers College, secretary and treasurer; Charles A. Bloomfield, councilor, and representatives from the Mercer County and Raritan River sections.

Muscle Shoals Fight to Continue

Failure on the part of Congress to approve the \$10,000,000 item in the sundry civil bill intended for the continuation of the work on the Wilson dam at Muscle Shoals by no means ends the fight on this proposition. The development of Muscle Shoals and the disposition to be made of the nitrate plants at that point furnished the subject for acrimonious controversy throughout the greater part of the session of Congress which just has closed. Despite the approval of the Fixed Nitrogen Corporation bill by the Senate on Jan. 14, further progress of the measure was blocked in the House. This was comparatively easy because the amendments attached by the Senate would have made the proposed corporation almost unworkable.

CONTROVERSY OVER WILSON DAM APPROPRIATION

No sooner had the fight over the Fixed Nitrogen Corporation bill lulled than there arose the fight to appropriate for continuing work on the dam. The Committee on Appropriations of the House refused to include the item in this bill. Efforts to insert it on the floor were unsuccessful. The Senate, however, put the appropriation into the measure and retained it by decided majorities on two record votes. For a time it seemed that the sundry civil bill, carrying more than \$400,000,000, would fail of passage because of the controversy over the Muscle Shoals item. It was not until the closing hours of the session that the matter finally was settled when Senator Underwood withdrew his opposition, stating that there was nothing to be gained by causing the bill to fail. Each side to the controversy alleged that powerful lobbies were at work. The "fertilizer trust" and "the powder trust" were declared to be behind one lobby, while the other side said that the Alabama Power Co. was sponsoring the lobby which was supporting the item. Senator Underwood, in one of his statements on the floor of the Senate, said:

Seventeen million dollars was allocated for the purpose of building it; a large portion of that money has already been spent; and to abandon the project is to throw that money away. The testimony of the greatest engineers in America confirms the statement that this is an excellent undertaking; an undertaking that will safely return to the Government the money invested. It comes in the usual way, with an estimate from the Government to carry on the work; and the reason it is defeated is because a lobby, representing special interests, fighting for their own pocketbooks, regardless of the national defense and the interests of the national Government, have injected their fangs into the body of this legislation and torn this appropriation out of it. There is no man who knows the conditions that have confronted this proposal but that knows that is a fact. I will not call the names now, but if their names are wanted or if it is ever desired to investigate this question in the future I can name the men who have haunted the Capitol and the hotels in the city of

Washington lobbying against this proposition because they thought it might interfere with their private business, putting their own dollars above the integrity of the Government of the United States, its honor and its safety.

Senator Lenroot, of Wisconsin, was the most active opponent of the appropriation. He declared it to be a foray on the part of the Government into the field of private enterprise. He asserted that the Alabama Power Co. would be the chief beneficiary of the improvement.

Senator Underwood met this charge by stating that chemical and other industries would quickly locate at Muscle Shoals, once that the power became available, as they had done at Niagara Falls. He pointed out that at first there was much doubt expressed as to whether use could be found at Niagara Falls for 60,000 hp. His whole contention is that the development of this water power, which is capable of producing more power than is the present diversion on the American side at Niagara Falls, would be of immeasurable benefit to the country as a whole. He characterized it as unthinkable that the Government should throw away its investment of \$100,000,000 in view of the value of the project to the industries and in the matter of the national defense.

WORK ON DAM TO BE DISCONTINUED

In view of the failure to appropriate for continuing the work, the Corps of Engineers has issued instructions that all work be discontinued except in two cases where a great sacrifice would be involved were the work to stop at this time. At Jackson Island the work will continue until the cofferdam can be removed. There will remain about \$1,000,000 of the existing appropriation, which will be sufficient to look after the maintenance work until August, 1922, which is the earliest date that an appropriation is likely to be made available.

Chemical Warfare Service Criticized and Defended

The efforts of the War Department to develop chemical warfare prior to and following the armistice are criticized scathingly in one of the final reports by the select committee on expenditures in the War Department, of which Representative Graham of Illinois is chairman. An opposite position on chemical warfare is taken by the minority members of the committee.

In the majority report it is stated that nearly all the chemical warfare equipment which the United States used in the war was purchased from the Allies. This, it is said, applied to gas itself except in the latter months of the war. The report further states that American-made equipment did not reach France in time to help win the war.

The minority declares that the principal purpose of the majority is to "find something on which to base the criticism of the administration of our armies" and "is biased, erroneous and totally misleading" and "an example of ingratitude to those who bravely did their duty in the nation's great crisis." It is claimed that most of the criticism will fall of its own weight and that consequently no effort will be made to refute each of the allegations.

Civil Service Examination

An open competitive examination for pyrotechnic assistant is announced by the United States Civil Service Commission. A vacancy at Picatinny Arsenal, Dover, N. J., at \$1,872 a year, is among those to be filled from this examination. Applicants must have graduated from a four years' high school course (or its equivalent) and have had at least one year's experience along the line of pyrotechnic material. Experience in flying and acquaintance with the present equipment and devices used by the aircraft divisions of the War Department for signal work are desirable, but not essential. Applications will be received on Form 1312 until the hour of closing business on April 5, 1921.

Vanadium Plant Closed

The Chemical Products Co., of Denver, Col., engaged in the production of vanadium, with radium as a byproduct, has discontinued operations indefinitely. The cause given is the poor market for vanadium.

University of Wisconsin Chemistry Students to Make Their Own Chemicals Next Summer

To reduce the cost of chemicals needed for research work in various scientific departments of the University of Wisconsin, the chemistry department will give a new course in the manufacture of organic chemicals during the summer session under the direction of Prof. Glenn S. Skinner. There is only one other institution giving a course of this nature in the country, it is claimed.

All scientists in the university have been asked to leave their orders for chemicals with Prof. Skinner and as far as is possible these orders will be filled by his course.

Only eight advanced students will be admitted to the course and they will work from nine to ten hours a day and will receive about 40c. an hour for their work. Only the most promising graduates and upper classmen will be selected for the work, with the view of giving them intensive training in practical organic chemistry and experience in larger scale operations.

Co-operative Work on Ceramics Planned

An arrangement for co-operative work between the Bureau of Mines and several of the associations of brick manufacturers is being planned, it is understood. It seems probable that the Bureau of Standards also is to be a party to the contract. The proposition involves obtaining a substantial sum which will make possible experimentation in a number of the fundamental problems encountered in the making of brick. The associations concerned are: The Face Brick Manufacturers Association, the American Common Brick Manufacturing Association, the National Paving Brick Manufacturers Association, and the Hollow Building Tile Manufacturers Association.

British Optical Glass and Scientific Instrument Bill

A bill which contains the following features has been prepared by the British Optical Instrument Manufacturers Association for consideration in Parliament:

1. No optical glass or scientific instruments to be imported into this country for a period of, say, seven years, except under license.
2. Such licenses only to be granted in respect of goods which are not being made in Great Britain in the required quantities or of the required quality.
3. An expert licensing committee to be set up.
4. The optical instrument manufacturers are prepared, in order to guarantee reasonable prices, to submit to a control of profits.

New Sulphite Pulp Mill for British Columbia

H. S. Taylor, chief engineer of the Mead Engineering Co., has made an examination of the site and timber limits of the Prince Rupert Lumber Co. of Prince Rupert, B. C., which has recently formed a subsidiary company, known as the Prince Rupert Pulp & Paper Co. The company is arranging for the erection of a sulphite pulp mill at a cost of \$1,000,000 and it has made satisfactory arrangements with the city council with regard to taxation and water privileges.

British Columbia Oil Refinery to Resume Operations

C. M. Rolston, local manager for the Imperial Oil Co., Vancouver, B. C., has announced that arrangements have been made with California oil interests for the delivery of 600,000 bbl. of crude oil during the present year, and as soon as this oil commences to arrive the refinery at Ioco, near Vancouver, will be restarted. It was expected that the refinery would remain idle until June, when delivery of oil from Mexico had been arranged for.

Bureau of Standards Standard Samples

Renewal 5d of the exhausted standard iron sample C and renewal 10c of the exhausted standard bessemer steel 0.4 carbon are now ready for distribution with provisional certificates. The price of these standards is \$2 per 150 g. and samples will be shipped by parcel post C.O.D. upon application to the Bureau of Standards, Washington, D. C.

Pottery Firm Reduces Working Force

The Coors Pottery Co., of Golden, Col., manufacturer of chemical porcelain, recently laid off about sixty employees.

Book Reviews

ELECTROLYTIC DEPOSITION AND HYDROMETALLURGY OF ZINC. By *Oliver C. Ralston*; 201 pages, illustrated. New York: McGraw-Hill Book Co. Price \$3.

The author has concisely covered this interesting subject in an up-to-date little book. It is only in the last seven years that the electrolytic method has been a commercial success. As pointed out by E. P. Mathewson at the February meeting of the American Institute of Mining and Metallurgical Engineers (New York), electrolytic zinc production has now reached a stage where the furnace methods are doomed to extinction. While the electrolytic refining of zinc products and the precipitation of zinc from chloride solutions after chlorinating of zinc ores are discussed, most of the text is devoted to the electrolytic precipitation of zinc from sulphate solutions obtained by leaching roasted sulphide ores in dilute sulphuric acid. The latter method is the only one now on a commercial scale.

The author points out that the "roasting department is not merely a place in which zinc sulphide ores can be roasted to make zinc soluble, with little care or thought, but that careful control is necessary to prevent spoiling the ore for leaching purposes and in order to keep the plant supplied with just the right amount of sulphuric acid." The leaching and purification cycles are explained, and the steps required to remove the harmful impurities are covered at length. Detailed discussion is given of tank-house practice, including the effect of current density, temperature, acidity, circulation and impurities upon the nature of the zinc deposit and upon current and energy efficiencies. Much emphasis is rightly placed on the necessity of a pure electrolyte. Many references are given to various plants such as the Judge, the Anaconda (Great Falls) and the Trail plant in British Columbia. The two latter are the most important commercially and are referred to repeatedly by the author to explain details of operation and equipment. For those interested in this growing electrochemical process the book will serve as a ready and modern reference.

CHARLES H. ELDRIDGE.

* * *

PROCEEDINGS OF THE CHICAGO MEETING OF THE INDUSTRIAL RELATIONS ASSOCIATION OF AMERICA. Industrial Relations Association of America, 564 Main St., East Orange, N. J. 592 pp. Price \$5.

The standard method of dealing with proceedings of technical societies is to put them on the bookshelf in the expectation of referring to them at some future time, quite frequently with the result that the paper turns yellow with age but the margins are unsullied with finger marks. But this volume of the proceedings of the Chicago meeting of the Industrial Relations Association of America simply refused to be handled in this way. Those who attended the meeting must have devoted at least four or more days' time to it and expended a corresponding sum of money. The unnamed person who compiled the record of the proceedings has contrived to commit to print so much of the spirit of the gathering and of the worthwhile discussion that for the price of a room for one night in a Chicago hotel anyone may have a fairly good knowledge of what happened. The reviewer has been carrying the volume around for weeks, knowing he should write his review but wanting always to get time to read some, because every page he had scanned had had something of interest. The principal speakers dealt with incentives and production, linking up the worker with the finished product, the foreman, organized labor, what the worker, and what the management wants. There were sectional meetings on banks, chemical industries, department stores, lumber, metal trades, packing industries, railroads and the steel industries. Of subject meetings, there were about thirty, running the gamut of the alphabet from Americanization to wage levels, so that everyone interested in industrial relations is sure to find something useful to him and to make him resolve that, if he can arrange it, he will attend the next meeting of the association.

T. T. READ.

Personal

Dr. JAMES ROWLAND ANGELL was elected president of Yale University by the Yale Corporation at its meeting on Feb. 20.

Dr. RAYMOND F. BACON spoke at the meeting of the Southern Naval Stores Association at Georgia Tech., Atlanta, Monday, March 14, on the possibilities of developing a pine oil and rosin industry with modern research.

ROBERT R. DREISBACH has resigned as chemical engineer with the Dow Chemical Co. to accept a position with The Barrett Co., Frankford, Pa., in connection with production and development work.

J. CLAIRE EVANS, vice-president of the Denver Fire Clay Co., was in New York City and other Eastern points recently on business.

• ANDREW M. FAIRLIE will lecture before the Franklin Institute, Philadelphia, on March 16 on "Recent Developments in the Manufacture of Sulphuric Acid."

E. A. GOODHUE, who has been a teaching fellow in chemistry at the California Institute of Technology for a year, has resumed his duties as instructor of chemistry at the University of Vermont, Burlington, Vt.

ROBERT W. HILTON, formerly manager of the Ault & Wiborg dye plant at Norwood, Ohio, is now in charge of the company's ink works.

JOSEPH S. REICHERT, for the past two years supervisor of production in the edible products department at the Ivorydale plant of Procter & Gamble Co., Cincinnati, Ohio, has accepted the appointment as professor of general and industrial chemistry at the University of Notre Dame, Notre Dame, Ind.

Dr. H. ROSSBACHER, who was formerly chief chemist of the Chicago Paving Laboratory, is now research chemist for the Western Electric Co.

C. C. SMITH, assistant secretary of the American Petroleum Institute, has resigned to accept a position as manager of the New York office of James B. Berry's Sons Co., Inc. Mr. Smith was made assistant secretary of the Institute at the time of its organization. Prior thereto he had been assistant secretary of the National Petroleum War Service Committee. In both positions he rendered conscientious and intelligent service, and leaves his work with the Institute with the esteem and confidence of the staff and the board of directors. Mr. Smith will continue to be assistant treasurer of the Institute.

E. R. WILES, who until last fall was in the employ of Cosden & Co. as assistant chemist in charge of analytical work, is now chief chemist of the Southern Oil Corporation at its refinery at Yale, Okla.

At the annual general meeting of the Faraday Society, London, the following officers were elected to serve for the coming year: President, Prof. A. W. Porter; vice-presidents, W. R. Cooper, Prof. C. H. Desch, Dr. J. A. Harker, Emil Hatschek, Prof. T. M. Lowry, Dr. E. H. Rayner and Dr. G. Senter.

Obituary

JOHN D. PENNOCK, general manager of the Solvay Process Co., died suddenly on March 11 at Syracuse, N. Y., upon his return from a vacation in South Carolina. Mr. Pennock was born at Morristown, Vt., in 1860, was graduated from Harvard in 1883, and was an instructor in chemistry there during the following year.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, March 14, 1921.

The recent acquisition of German territory and industries by the Allies has caused an increased call for several important chemicals which had recently been bought from Germany. It now seems probable that the Allies will control German exports and seize a substantial amount of them and consumers who thought that they had bought wisely from Germany at lower prices than procurable here were greatly perturbed over this action. Among the items in demand were *bichromates*, *oxalic acid*, *caustic potash*, *muriate of potash* and *chlorate of potash*.

Aside from this sudden change the chemical industry in general has reflected the economic conditions which prevail in every important trade at present. The movement, while fair in some commodities, has been sluggish in others and buyers still are contented to operate on a conservative basis pending improvement, which they feel is not a long way off. While there has been some increase noted in the sales of large producers, the demand is far below normal and rumors are current regarding a further decrease in production. The cost of some of our basic chemicals is now so low that further downward revisions in prices without a proportionate reduction in the cost of manufacturing might prove quite ruinous.

Pressure of resale material has been felt at intervals and the need of ready cash has occasionally caused dealers to sacrifice values to insure an immediate sale. It seems reasonable to believe that with the restricted production now in effect and the gradual absorption of spot stocks the situation will eventually right itself. Some inquiries have reached the market from textile mills, but it seems that tanneries are still idle buyers. Paper mills have taken on bleaching powder for near-by and future shipments. Soap-makers have shown an added interest in oils and fats, but have not been purchasing chemicals to any noticeable extent. Glassmakers appear to be well covered by standing contracts and the call from these interests is sufficient to keep dense soda ash in light supply.

EXPORT BUSINESS DULL

The export business remains dull. Inquiries for miscellaneous chemicals are in the market quite frequently, but the deflation of exchange rates has prevented business. Another great barrier to foreign trade is the credit situation. Foreign buyers require ninety days credit and our banks are unwilling to discount these drafts. Supplies of chemicals in foreign hands are not believed to be heavy. Liquidation has been going on in foreign countries as well as in America.

There is a strong feeling of confidence in the new administration at Washington. Industry is looking forward to a sound constructive policy and an expansion of confidence ought to be reflected in exchange rates. This in itself should serve as a great remedy to the present depression.

Domestic prime white *arsenic* is quoted at 10@11c. per lb., according to quantity and time of delivery. Resale lots of foreign material have reached the market at somewhat under this figure, while prompt shipments from abroad were quoted at 8c. per lb. Prominent sellers are looking for a marked improvement in the consuming demand, as some of the leading insecticide manufacturers have not covered their requirements. Sales of *muriate of potash* have been reported from \$60@\$70 per ton, basis 80 per cent, delivered. The inside price records a decline and rumors were heard that sales had been made at further price reductions. Competition between foreign and domestic sellers is having a depressing influence and the tendency of price is described as easy.

Resale transactions in solid *caustic soda* during the week were reported at figures ranging from \$3.60@\$3.75 per 100

lb. Rumors were current that isolated lots under stress pressure sold below the inside price, but sellers as a rule gave \$3.60 as the minimum trading figure for spot material. Although an occasional carlot of *soda ash* was sold at \$2 per 100 lb., most dealers were not inclined to shade \$2.10 and some sellers were asking up to \$2.15. The inquiry for double bags has remained very quiet and the market was quoted nominal at \$2.10 per 100 lb. Ash in barrels seemed to be most in demand and sales were reported as high as 2½c. per lb. Offerings were very light in all directions and the tone of the market appeared quite firm. Foreign *prussiate of soda* had a depressing influence on spot quotations and prices declined from 15c. to 14c. per lb. The buying power was not accentuated and consumers preferred to operate on a hand-to-mouth basis. Factors in domestic prussiate were not eager to quote owing to the quiet extent of inquiries, but intimated they would meet any competition if the occasion required.

Sharp reductions were announced in prices on *methanol* by producers. Pure methanol is now quoted at \$1 per gal. in tank cars, the 95 per cent at \$1.12 per gal. in barrels, and the Columbian spirits at \$1.35 in barrels. *Ethyl alcohol* is in easy supply at \$4.75@5 per gal. Denatured is moving in small lots, while prices are somewhat irregular, with a range from 42@54c. per gal., depending on the formula.

COAL-TAR PRODUCTS

Some improvement in trading could be noticed in the coal-tar products market during the past week. The degree of improvement is not very great, however, as consumers still look for lower prices and will come into the market only for short time supplies. Prices have shown an easy tendency and shading is practiced in various quarters. Intermediates have moved in better volume and prices have shown no radical changes. Consumers of *aniline oil* seem to be in good supply and while stocks are plentiful prices are fairly steady at 22@26c. per lb. A fair movement is reported in *beta naphthol* at 34@40c. per lb. The market on *paranitraniline* is not very active, but prices are steady at 90c.@\$1.05 per lb. The crude products, such as *benzene*, *naphthalene* and *phenol*, have shown a greater activity of late. *Naphthalene flake* prices are steady at 8½@9c. per lb. and trading is said to be in fair volume in most quarters. There is little activity in the market for *para-dichlorbenzene*. The consuming demand is of a light routine nature and prices are holding steady on a basis of 15@20c. per lb. The demand for *diphenylamine* continues along routine lines and for quantities only sufficient to meet present needs. There has been no recent change in the price level at 60@70c. per lb., depending on quantity.

RUBBER

The tone of the crude rubber market was slightly easier, and while intimations were made that prices could have been shaded in some quarters no actual changes were recorded. *Spot ribbed smoked sheets* were offered freely at 17½c. per lb., but inquiries were few and commanded but little attention. *First latex spot* was named at 19½c. per lb. asked and 19¼c. on firm bids. Futures on *ribs* were subject to little demand. April, May, June sellers were asking 19¼c., but as far as could be ascertained no business was done. July-September was also a dull affair and remained quoted at 22½c. per lb. October, December sellers were few. Trading in general during the week was of an extremely small volume and little encouragement was offered in any direction.

WAXES

The market for crude *beeswax* was quiet, but prices held fairly steady basis. African crude was quoted from 17@19c. per lb., depending upon quality and seller, with the Brazilian at 23@25c. per lb. Refined beeswax was nominal at 27@30c. per lb. Prices on *carnauba wax* varied but little during the past week, reflecting a steady position at primary markets. The higher grades on the spot are in rather light supply and prices named are more or less nominal. Offerings of the common sorts are plentiful and slight irregularity in prices is named by importers. For No. 3 North Country quotations held at 18@19c. per lb.

Demand for *Japan wax* was routine only, but with importations smaller prices were well maintained at 19@20c.

per lb. The tendency of prices in the market for *paraffine wax* was downward during the past week. New business placed was not up to expectations, the export inquiry being particularly slack. Refiners offered scale wax, 124-126 deg. melting point, in carlots for immediate shipment at 2½c. per lb. and it was reported that actual business had been placed at this figure. Fully refined, 130 deg. melting point, was nominal at 6c. per lb.

COMPARATIVE LIST OF GENERAL CHEMICALS

Article	January, 1921	February 1921	March 1921
Acetic acid, glacial.....	\$0.10	\$0.10	\$0.09
Muriatic acid.....	.0185	.0175	.0145
Oxalic acid.....	.18	.17½	.15
Tartaric acid.....	.39	.33	.32
Ammonia alum, lump.....	.04½	.04½	.04½
Potash alum, lump.....	.05½	.05½	.05½
Alumina sulphate, iron free.....	.03½	.03	.03
Alumina sulphate, comm.....	.02½	.02½	.02½
Salammoniac white.....	.10½	.08	.07½
Arsenic white powd.....	.11	.10	.09
Barium chloride, ton.....	75.00	70.00	65.00
Bleaching powder.....	.03½	.03	.02½
Carbon tetrachloride.....	.11	.12	.10
Cobalt oxide.....	4.00	4.00	3.00
Copper sulphate.....	.06½	.06½	.05½
Cream of tartar.....	.40	.32	.30
Epsom salt, U.S.P.....	.03	.02	.02½
Formaldehyde.....	.18½	.18	.17½
Glauber salt.....	.01½	.01½	.01½
Lead arsenate, paste.....	.11	.11	.11
Nickel salt, single.....	.13	.13	.13
Bichromate potash.....	.19	.15	.13
Carbonate potash.....	.11	.10	.08
Caustic potash, 88-92%.....	.14	.13	.10
Muriate potash, ton.....	75.00	75.00	60.00
Nitrate potash.....	.11½	.11½	.09½
Permanganate potash.....	.70	.55	.45
Prussiate potash, yellow.....	.32	.26	.28
Acetate soda.....	.05½	.05½	.05½
Soda ash light.....	.0190	.0210	.0210
Benzoate soda.....	.75	.75	.70
Bicarbonate soda.....	.09½	.08½	.08
Caustic soda, solid.....	.03½	.04	.0360
Chlorate soda.....	.11	.10	.10
Cyanide soda.....	.18	.19	.20
Fluoride soda.....	.19	.17	.13
Nitrate soda.....	.0285	.0285	.0280
Nitrite soda.....	.06½	.06½	.06
Prussiate soda.....	.17	.16½	.14
Salsoda.....	.02	.02	.0190
Silicate soda 60 degree.....	.0290	.0290	.03
Silicate soda 40 degree.....	.01½	.0115	.01½
Sulphide soda.....	.05½	.05½	.05
Sulphite soda.....	.04	.04	.04
Tin oxide.....	.50	.48	.45
Zinc chloride.....	.11½	.11½	.11
Zinc sulphate.....	.03½	.03½	.03½

The Iron and Steel Market

PITTSBURGH, March 11, 1921.

An analysis of the American Iron and Steel Institute's report covering the steel ingot production of thirty steel companies in February indicates that the rate of steel ingot production by the whole industry in February was about 25,200,000 gross tons per annum, or about 48 per cent of the actual productive capacity. The Steel Corporation operated at an average slightly above 75 per cent and the independents at slightly above 25 per cent. The Steel Corporation's rate this week is lower, about 60 per cent, while the independents are probably a trifle under 25 per cent.

If all that has occurred in production were to be ascribed to the influence of the price-cutting campaign inaugurated by independents early in February it could be said that the independents did not improve their position, while the Steel Corporation lost very considerably in production. The corporation operated at about 90 per cent in January, while the independents operated at about 28 per cent. However, both the corporation and the independents were in line for decreasing production if prices had remained steady, as there was very little buying and old orders were being worked out. The fair conclusion is that the price cutting saved the independents from any considerable decrease in operations, while it caused the Steel Corporation's operations to decrease at a greater rate than would otherwise have been the case. All observation tends to show that the Steel Corporation has not lost any customers to independents by the price cutting, but that its customers have in many cases been moved to curtail or shut off their receipts of steel from the corporation.

STEEL CORPORATION TONNAGE

The Steel Corporation's unfilled tonnage obligations at the end of February, as reported yesterday, amounted to 6,933,867 tons, the smallest amount since late in 1919. The de-

crease during February was 639,297 tons, this comparing with decreases of 574,958 tons in January and over 800,000 tons in each of the two preceding months. The February decrease was 51 per cent of the month's capacity, while shipments in February may be estimated at 75 per cent of capacity, making the net bookings the difference between these, about 24 per cent. The net bookings would be made up of total bookings minus cancellations, but there is no reason to suppose there were any cancellations of consequence. That matter seems to have been taken care of in the Dec. 31 statement. That the corporation had any bookings when the independents were cutting prices and the corporation was rigidly adhering to the price schedule is explained by the fact that the corporation's customers value a place on the corporation's order books. In 1920 their allotments saved them a great deal of money on account of independents having advanced their prices far above the corporation level.

STEEL PRICES

Perhaps there is a new trend in steel prices. Certainly the independent steel market is not moving in regular form pursuant to there having been a break a month ago. Prices should either be continuing to sag at this time or should have developed a definite level showing signs of strength, and neither of these is the case. On the whole the lowest prices being done by independents are not noticeably lower than those of a week ago, while there certainly is no market stability. Some extreme low prices that were spoken of a week or two ago as a possibility are not now mentioned, as, for instance, 1.85c. for bars.

As to the attitude of steel buyers, that is perfectly clear. The buyers as a class are not interested. It is not a case of prices not having gone down sufficiently to suit buyers, for the buyers do not know at what price they could place really attractive orders. The mills have been quite willing to listen to bids, whether or not they would accept them, but the bids have not been made. In circles outside the steel industry it is being suggested that the Steel Corporation should reduce its prices, there being the apparent assumption that this would bring buyers into the market. There is no basis in steel market experience for any such assumption.

As to the attitude of the independent steel producers, there is some disposition to withdraw from the price-cutting operation, though there is no definite movement back to the old, or Steel Corporation, schedule. There is merely a chance that such a movement may occur.

Finally, as to the Steel Corporation's attitude, the corporation has not reduced prices or wages. It has been well settled that the corporation would not reduce one without the other. The corporation refuses to be influenced by what the independents have done. It elects to be independent.

ELIMINATION OF THE 12-HOUR WORKDAY

From Judge Gary's statement made early this week it may be deduced as a probability that the Steel Corporation will act upon the wage matter in about thirty days and that the action will involve elimination of the 12-hour workday. If this long-expected change is made the balance of probability is that there will not be straight substitution of an 8-hour shift. There have always been strong objections to that course, two of the objections being that eight hours is too short a time from start to finish, and that most of the men are not in continuous employment during their hours on duty. The difficulty has been to arrange for continuous operation with a system that lies between straight two shifts and straight three shifts. That a compromise ground is being sought is evidenced by the fact that the committee in charge of the matter, composed of no less than the presidents of subsidiary companies, has been hard at work and cannot yet report.

There is a possibility that the corporation may make a change in rates and working conditions that will not reduce the wage cost of producing a ton of steel, and in that event price reductions would not necessarily accompany the change.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.	-	-	\$0 55 - \$0 60	
Acetone.....lb.	\$0 13 -	\$0 13½	13½ -	14
Acid, acetic, 28 per cent.....100 lbs.	3.00 -	3.25	3.50 -	3.75
Acetic, 56 per cent.....100 lbs.	6.00 -	6.25	6.50 -	6.75
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	9.00 -	9.50	10.00 -	10.50
Boric, crystals.....lb.	.14½ -	.15	.15½ -	.16
Boric, powder.....lb.	.15½ -	.16½	.17 -	.18
Citric.....lb.	-	-	.46 -	.48
Hydrochloric.....100 lb.	1.60 -	1.70	1.75 -	2.00
Hydrofluoric, 52 per cent.....lb.	.15 -	.16	.16½ -	.18
Lactic, 44 per cent tech.....lb.	.10 -	.11	.11½ -	.12
Lactic, 22 per cent tech.....lb.	.04½ -	.05½	.06 -	.07
Molybdic, C. P.....lb.	4.00 -	4.50	4.50 -	5.00
Muriatic, 20 deg. (see hydrochloric).....lb.	-	-	-	-
Nitric, 40 deg.....lb.	.06½ -	.07	.07½ -	.07½
Nitric, 42 deg.....lb.	.07½ -	.08	.08½ -	.08½
Oxalic, crystals.....lb.	.15 -	.15½	.16 -	.17
Phosphoric, Ortho, 50 per cent solution, lb.	.15 -	.15½	.16 -	.16½
Picric.....lb.	.30 -	.32	.35 -	.40
Pyrogallol, resublimed.....lb.	-	-	2.30 -	2.40
Sulphuric, 60 deg., tank cars.....ton	-	-	-	-
Sulphuric, 60 deg., drums.....ton	-	-	14.00 -	15.00
Sulphuric, 66 deg., tank cars.....ton	18.00 -	19.00	-	-
Sulphuric, 66 deg., drums.....ton	21.00 -	22.00	22.50 -	23.00
Sulphuric, 66 deg., carboys.....ton	-	-	-	-
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 -	24.00	-	-
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 -	26.00	26.50 -	27.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 -	35.00	40.00 -	-
Tannic, U. S. P.....lb.	-	-	1.15 -	1.25
Tannic (tech.).....lb.	.45 -	.47	.48 -	.50
Tartaric, crystals.....lb.	-	-	.34 -	.38
Tungstic, per lb. of WO.....lb.	-	-	1.00 -	1.20
Alcohol, Ethyl.....gal.	-	-	4.75 -	5.00
Alcohol, Methyl (see methanol).....gal.	-	-	-	-
Alcohol, denatured, 188 proof.....gal.	-	-	.44 -	.50
Alcohol, denatured, 190 proof.....gal.	-	-	.51 -	.54
Alum, ammonia lump.....lb.	.04½ -	.04½	.04½ -	.05
Alum, potash lump.....lb.	.05½ -	.06	.06½ -	.07
Alum, chrome lump.....lb.	.15 -	.13½	.14 -	.14½
Aluminum sulphate, commercial.....lb.	.02½ -	.02½	.02½ -	.03
Aluminum sulphate, iron free.....lb.	.03 -	.03½	.03½ -	.03½
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07 -	.07½	.07½ -	.08
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 -	.32	.33 -	.35
Ammonium carbonate, powder.....lb.	.10 -	.11	.11½ -	.12
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	.07½ -	.08	.08½ -	.08½
Ammonium chloride, granular (gray sal-ammoniac).....lb.	.09 -	.09½	.09½ -	.10
Ammonium nitrate.....lb.	.08 -	.08½	.09 -	.10
Ammonium sulphate.....100 lb.	2.90 -	3.00	3.10 -	3.20
Amylacetate.....gal.	-	-	4.00 -	4.25
Amylacetate tech.....gal.	-	-	3.25 -	3.50
Arsenic oxide, (white arsenic) powdered lb.	.09 -	.09½	.10 -	.10½
Arsenic, sulphide, powdered (red arsenic) lb.	.14 -	.14½	.15 -	.15½
Barium chloride.....ton	65.00 -	70.00	75.00 -	80.00
Barium dioxide (peroxide).....lb.	.18 -	.19	.19½ -	.22
Barium nitrate.....lb.	.10 -	.10½	.10½ -	.11
Barium sulphate (precip.) (blanc fixe).....lb.	.04½ -	.05	.05½ -	.06
Bleaching powder (see calc. hypochlorite).....lb.	-	-	-	-
Blue vitriol (see copper sulphate).....lb.	-	-	-	-
Borax (see sodium borate).....lb.	-	-	-	-
Brimstone (see sulphur, roll).....lb.	-	-	-	-
Bromine.....lb.	.40 -	.41	.42 -	.45
Calcium acetate.....100 lbs.	2.00 -	2.05	-	-
Calcium carbide.....lb.	.04 -	.04½	.04½ -	.05
Calcium chloride, fused, lump.....ton	27.00 -	29.00	30.00 -	32.00
Calcium chloride, granulated.....lb.	.01½ -	.01½	.02 -	.02½
Calcium hypochlorite (bleach'g powder) lb.	.02½ -	.02½	.03 -	.03½
Calcium peroxide.....lb.	-	-	1.00 -	1.10
Calcium phosphate, monobasic.....lb.	-	-	.15 -	.16
Camphor.....lb.	-	-	.75 -	.77
Carbon bisulphide.....lb.	.08 -	.08½	.09 -	.09½
Carbon tetrachloride, drums.....lb.	.10 -	.10½	.11 -	.12
Carbonyl chloride (phosgene).....lb.	-	-	.75 -	1.00
Caustic potash (see potassium hydroxide).....lb.	-	-	-	-
Caustic soda (see sodium hydroxide).....lb.	-	-	-	-
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.09 -	.09½	.10 -	.10½
Chloroform.....lb.	-	-	.38 -	.40
Cobalt oxide.....lb.	-	-	3.00 -	3.10
Copperas (see iron sulphate).....lb.	-	-	-	-
Copper carbonate, green precipitate.....lb.	.22 -	.23	.24 -	.25
Copper cyanide.....lb.	-	-	.50 -	.60
Copper sulphate, crystals.....lb.	.05½ -	.05½	.06 -	.06½
Cream of tartar (see potassium bitartrate).....lb.	-	-	-	-
Epsom salt (see magnesium sulphate).....lb.	-	-	-	-
Ethyl Acetate Com. 85%.....gal.	-	-	1.00 -	1.00
Ethyl Acetate pure (acetic ether 98% to 100%).....gal.	-	-	-	-
Formaldehyde, 40 per cent.....lb.	.17½ -	.17½	.17½ -	.18
Fusel oil, ref.....gal.	-	-	4.00 -	4.50
Fusel oil, crude.....gal.	-	-	2.50 -	2.75
Glauber's salt (see sodium sulphate).....lb.	-	-	-	-
Glycerine, C. P. drums extra.....lb.	-	-	.19 -	.20
Iodine, resublimed.....lb.	-	-	3.75 -	3.85
Iron oxide, red.....lb.	-	-	.10 -	.20
Iron sulphate (copperas).....100 lb.	1.15 -	1.25	1.50 -	1.75
Lead acetate.....lb.	-	-	.14½ -	.16
Lead arsenate.....lb.	.11 -	.12	.12½ -	.13
Lead nitrate.....lb.	-	-	.15 -	.20
Litharge.....lb.	.08½ -	.09	.09½ -	.10
Lithium carbonate.....lb.	-	-	1.25 -	-
Magnesium carbonate, technical.....lb.	.10½ -	.11	.11½ -	.12
Magnesium sulphate, U. S. P.....100 lb.	2.25 -	2.75	-	-
Magnesium sulphate, commercial.....100 lb.	-	-	1.70 -	2.00
Methanol, 95%.....gal.	-	-	1.02 -	1.05
Methanol, Colombian spirits.....gal.	-	-	1.25 -	1.30
Nickel salt, double.....lb.	-	-	.12 -	.12½
Nickel salt, single.....lb.	-	-	.13 -	.13½
Phosgene (see carbonyl chloride).....lb.	-	-	-	-
Phosphorus, red.....lb.	.45 -	.46	.47 -	.50
Phosphorus, yellow.....lb.	-	-	.35 -	.37
Potassium bichromate.....lb.	.13 -	.13½	.14 -	.14½

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$.35 - .40	\$0.30 - \$0.35
Potassium bromide, granular..... lb.	.35 - .40	.20 - .40
Potassium carbonate, U. S. P..... lb.	.08 - .08½	.05 - .50
Potassium carbonate, crude..... lb.	.08 - .10	.09 - .10
Potassium chlorate, crystals..... lb.	.10 - .11	.11 - .15
Potassium cyanide..... lb.	.10 - .11	.45 - .50
Potassium hydroxide (caustic potash)..... lb.	.10 - .11	.12 - .13
Potassium muriate..... ton	60.00 - 70.00	—
Potassium iodide..... lb.	.09½ - .09½	2.75 - 3.00
Potassium nitrate..... lb.	.45 - .46	.10 - .12½
Potassium permanganate..... lb.	.50 - .52	.48 - .50
Potassium prussiate, red..... lb.	.28 - .29	.53 - .55
Potassium prussiate, yellow..... lb.	—	.30 - .32
Potassium sulphate (powdered)..... per unit	—	— 2.25
Rochelle salts (see sodium potas tartrate)	—	—
Sal ammoniac (see ammonium chloride)	—	—
Salt soda (see sodium carbonate)	—	—
Salt cake..... ton	—	30.00 - 33.00
Silver cyanide..... oz.	—	1.25 - 3.8½
Silver nitrate..... lb.	2.10 - 2.15	2.20 - 2.50
Soda ash, light..... 100 lb.	2.20 - 2.30	2.40 - 2.60
Soda ash, dense..... 100 lb.	.05½ - .05½	.06 - .06½
Sodium acetate..... lb.	2.60 - 2.75	3.00 - 3.25
Sodium bicarbonate..... 100 lb.	.08 - .08½	.08½ - .08½
Sodium bichromate..... lb.	7.00 - 7.50	8.00 - 11.00
Sodium bisulphate (nitre cake)..... ton	.05½ - .05½	.06 - .06½
Sodium bisulphate powdered, U.S.P..... lb.	.08½ - .08½	.08½ - .09
Sodium borate (borax)..... lb.	1.90 - 2.00	2.25 - 2.50
Sodium carbonate (sal soda)..... 100 lb.	.10 - .10½	.10 - .11
Sodium chl rate..... lb.	.20 - .22	.23 - .30
Sodium cyanide, 96-98 per cent..... lb.	.13 - .13½	.14 - .14½
Sodium fluoride..... lb.	3.60 - 3.70	3.80 - 4.00
Sodium hydroxide (caustic soda)..... 100 lb.	—	.03½ - .04
Sodium hyposulphite..... lb.	2.80 - 3.00	3.00 - 3.00
Sodium nitrate..... 100 lb.	.06 - .06½	.06½ - .07
Sodium nitrite..... lb.	.30 - .31	.32 - .34
Sodium peroxide, powdered..... lb.	.04½ - .04½	.05 - .05½
Sodium phosphate, dibasic..... lb.	.14 - .14½	.14½ - .14½
Sodium potassium tartrate (Rochelle salts)..... lb.	1.25 - 1.35	1.40 - 1.50
Sodium prussiate, yellow..... lb.	.03 - .03½	.03½ - .03½
Sodium silicate, solution (40 deg.)..... lb.	1.75 - 2.00	2.25 - 2.50
Sodium silicate, solution (60 deg.)..... lb.	.05 - .05½	.05½ - .06
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	.04 - .04½	.04½ - .05
Sodium sulphide, crystal, 60-62 per cent (conc.) lb.	.16 - .16½	.16½ - .17
Sodium sulphite, crystals..... lb.	.07 - .07½	.07½ - .08
Strontium nitrate, powdered..... lb.	16.00 - 20.00	—
Sulphur, crude..... ton	.08 - .08½	.08½ - .09
Sulphur dioxide, liquid, cylinders..... lb.	—	2.25 - 3.10
Sulphur (sublimed), flour..... 100 lb.	—	2.00 - 2.75
Sulphur, roll (brimstone)..... 100 lb.	.18 - .19	.40 - .42
Tin bichloride, 50 per cent..... lb.	.16 - .18	.19 - .20
Tin oxide..... lb.	.11 - .11½	.11½ - .12
Zinc carbonate, precipitate..... lb.	.45 - .49	.50 - .60
Zinc chloride, gran..... lb.	.12 - .13	.13½ - .14
Zinc cyanide..... lb.	.09 - .09½	.09½ - .10
Zinc dust..... lb.	.03½ - .03½	.04 - .05
Zinc oxide, XX..... lb.	—	—
Zinc sulphate..... lb.	—	—

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 - \$1.15
Alpha-naphthol, refined..... lb.	1.45 - 1.50
Alpha-naphthylamine..... lb.	.38 - .40
Aniline oil, drums extra..... lb.	.22 - .26
Aniline salts..... lb.	.28 - .32
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1.00
Benzaldehyde U.S.P..... lb.	1.00 - 1.50
Benzidine, base..... lb.	.95 - 1.05
Benzidine sulphate..... lb.	.80 - .90
Benzoic acid, U.S.P..... lb.	.65 - .70
Benzoate of soda, U.S.P..... lb.	.65 - .70
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.30 - .35
Benzene, 90%, in drums (100 gal.)..... gal.	.28 - .32
Benzyl chloride, 95-97%, refined..... lb.	.30 - .35
Benzyl chloride, tech..... lb.	.25 - .30
Beta-naphthol benzoate..... lb.	3.50 - 4.00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.34 - .40
Beta-naphthylamine, sublimed..... lb.	2.25 - 2.40
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 - .18
Ortho-cresol, in drums (100 lb.)..... lb.	.23 - .25
Cresylic acid, 97-99%, straw color, in drums..... gal.	.95 - 1.00
Cresylic acid, 75-97%, dark, in drums..... lb.	.90 - .95
Cresylic acid, 50%, first quality, drums..... gal.	.60 - .65
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	1.20 - 1.30
Dimethylaniline..... lb.	.55 - .65
Dinitrobenzene..... lb.	.30 - .32
Dinitrochlorobenzene..... lb.	.25 - .30
Dinitronaphthalene..... lb.	.33 - .35
Dinitrophenol..... lb.	.40 - .45
Dinitrotoluene..... lb.	.27 - .30
Dip oil, 25%, tar acids, car lots, in drums..... gal.	.38 - .40
Diphenylamine..... lb.	.60 - .70
H-acid..... lb.	1.30 - 1.50
Meta-phenylenediamine..... lb.	1.25 - 1.30
Monochlorobenzene..... lb.	.14 - .16
Monothylaniline..... lb.	1.75 - 2.00
Naphthalene crushed, in bbls. (250 lb.)..... lb.	.08 - .08½
Naphthalene, flake..... lb.	.08½ - .08½
Naphthalene, balls..... lb.	.09½ - .10
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.18 - .25
Ortho-amidophenol..... lb.	3.20 - 3.75
Ortho-dichlor-benzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.75 - .80
Ortho-nitro-toluene..... lb.	.20 - .24
Ortho-toluidine..... lb.	.25 - .30
Para-amidophenol, base..... lb.	1.90 - 2.00
Para-amidophenol, HCl..... lb.	2.10 - 2.20

Para-dichlorobenzene..... lb.	.15 - .20
Paranitroaniline..... lb.	.90 - 1.05
Para-nitrotoluene..... lb.	.90 - 1.05
Para-phenylenediamine..... lb.	1.90 - 2.00
Para-toluidine..... lb.	1.30 - 1.60
Phthalic anhydride..... lb.	.55 - .60
Phenol, U. S. P., drums (dest.), (240 lb.)..... lb.	.12 - .14
Pyridine..... gal.	2.00 - 3.50
Resorcinol, technical..... lb.	1.85 - 2.00
Resorcinol, pure..... lb.	2.30 - 2.50
Salicylic acid, tech., in bbls. (110 lb.)..... lb.	.22 - .23
Salicylic acid, U. S. P..... lb.	.25 - .27
Salol..... lb.	.85 - .95
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.28 - .32
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.16 - .18
Sulphanilic acid, crude..... lb.	.30 - .35
Tolidine..... lb.	1.35 - 1.45
Toluidine, mixed..... lb.	.40 - .45
Toluene, in tank cars..... gal.	.28 - .32
Toluene, in drums..... gal.	.30 - .35
Xylidines, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.42 - .45
Xylene, pure, in tank cars..... gal.	.45 - .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.30 - .30

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.24 - \$0.26
Beeswax, refined, light..... lb.	.27 - .28
Beeswax, white pure..... lb.	.40 - .45
Carnauba, Flora..... lb.	.68 - .70
Carnauba, No. 2, North Country..... lb.	.30 - .32
Carnauba, No. 3, North Country..... lb.	.18 - .19
Japan..... lb.	.19½ - .20
Montan, crude..... lb.	.07 - .08
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.04½ - .04½
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.03 - .03½
Paraffine waxes, refined, 118-120 m.p..... lb.	.04½ - .05
Paraffine waxes, refined, 125 m.p..... lb.	.05½ - .05½
Paraffine waxes, refined, 128-130 m.p..... lb.	.06 - .06
Paraffine waxes, refined, 133-135 m.p..... lb.	.07½ - .07½
Paraffine waxes, refined, 135-137 m.p..... lb.	.08½ - .09
Stearic acid, single pressed..... lb.	.12 - .12
Stearic acid, double pressed..... lb.	.12½ - .12½
Stearic acid, triple pressed..... lb.	.13½ - .13½

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.70
Pine oil, pure, dest. dist..... gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75
Pine tar, ref., thin, sp.gr. 1.080-1.060..... gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970..... gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.37
Pinewood creosote, ref..... gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl..... 280 lb.	\$6.25 - .
Rosin E-I..... 280 lb.	6.25 - .
Rosin K-N..... 280 lb.	6.25 - .
Rosin W. G.-W. W..... 280 lb.	6.50 - .
Wood rosin, bbl..... 280 lb.	6.75 - .
Spirits of turpentine..... gal.	.61 - .
Wood turpentine steam dist..... gal.	.55 - .
Wood turpentine, dest. dist..... gal.	.54 - .
Pine tar pitch, bbl..... 200 lb.	— 7.00
Tar, kiln burned, bbl. (500 lb.)..... bbl.	— 14.50
Retort tar, bbl..... 500 lb.	15.00 - 14.75
Rosin oil, first run..... gal.	.45 - .
Rosin oil, second run..... gal.	.48 - .
Rosin oil, third run..... gal.	.60 - .

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41
70-72 deg., steel bbls. (85 lb.)..... gal.	.39
68-70 deg., steel bbls. (85 lb.)..... gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30

Crude Rubber

Para-Upriver fine..... lb.	\$0.17 - \$0.18
Upriver coarse..... lb.	.13 - .14
Upriver cauchó ball..... lb.	.14 - .14½
Plantation—First latex crepe..... lb.	.19½ - .
Ribbed smoked sheets..... lb.	.17½ - .
Brown crepe, thin, clean..... lb.	.18 - .
Amber crepe No. 1..... lb.	.20 - .

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.08½ - \$0.09
Castor oil, AA, in bbls..... lb.	.10 - .10½
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.08 - .08½
Cocoonut oil, Ceylon grade, in bbls..... lb.	.09½ - .10
Cocoonut oil, Cochín grade, in bbls..... lb.	.10 - .10½
Corn oil, crude, in bbls..... lb.	.08½ - .08½
Cottonseed oil, crude (f. o. b. mill)..... lb.	.04½ - .05
Cottonseed oil, summer yellow..... lb.	.07 - .
Cottonseed oil, winter yellow..... lb.	.08 - .
Linseed oil, raw, car lots (domestic)..... gal.	.67 - .68
Linseed oil, raw, tank cars (domestic)..... gal.	.60 - .
Linseed oil, boiled, car lots (domestic)..... gal.	.69 - .70

Olive oil, commercial.....	gal.	\$2 20	—	\$2.50
Palm, Lagos.....	lb.	.07½	—	.07½
Palm, Niger.....	lb.	.06½	—	.06½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.06	—	.06½
Peanut oil, refined, in bbls.....	lb.	.11½	—	.12
Rapeseed oil, refined in bbls.....	gal.	1.05	—	1.10
Rapeseed oil, blown, in bbls.....	gal.	1.15	—	1.20
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07½	—	.07½
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.04½	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.45	—	\$0.47
Yellow bleached menhaden.....	gal.	.47	—	.....
White bleached menhaden.....	gal.	.49	—	.....
Blown menhaden.....	gal.	.84	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	.....
Blanc fixe, dry.....	lb.	.05	—	.05½
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.16
Chalk, domestic, extra light.....	lb.	.05	—	.05½
Chalk, domestic, light.....	lb.	.04½	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04½	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mires.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Fla.....	net ton	25.00	—	.....
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	35.00	—	40.00
Graphite, Ceylon lump, first quality.....	lb.	.08	—	.09
Graphite, Ceylon chip.....	lb.	.07	—	.08
Graphite, higher lubricating grades.....	lb.	.11	—	.40
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.65	—	.....
Shellac, orange superfine.....	lb.	.70	—	.....
Shellac, A. C. garnet.....	lb.	.57	—	.....
Shellac, T. N.....	lb.	.55	—	.....
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	14.00	—	15.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	40.00	—	50.00
Talc, California talcum powder grade.....	ton	20.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	.....	.....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	80-100	.....	.....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	45-50	.....	.....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	.....	—	55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	.....	.....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	.....	.....
Magnesite brick, 9-in. straight.....	net ton	100	.....	.....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105	.....	.....
Magnesite brick, soaps and splits.....	net ton	120	.....	.....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65-70	.....	.....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56-61	.....	.....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	50-60	.....	.....

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.15	—	.....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.15	—	.16
Ferromanganese, 76-80% Mn, domestic.....	gross ton	90.00	—	95.00
Ferromanganese, 76-80% Mn, English.....	gross ton	90.00	—	95.00
Spiegeleisen, 18-22% Mn.....	gross ton	38.00	—	40.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.00	—	2.50
Ferrosilicon, 10-15%.....	gross ton	50.00	—	55.00
Ferrosilicon, 50%.....	gross ton	85.00	—	90.00
Ferrosilicon, 75%.....	gross ton	145.00	—	150.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.50	—	.55
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	7.00	—	.....
Ferrovandium, 30-40% of contained V.....	lb.	5.00	—	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.50	—	.55
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.50	—	.55
Coke, foundry, f.o.b. ovens.....	net ton	5.50	—	6.50
Coke, furnace, f.o.b. ovens.....	net ton	4.50	—	5.00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00	—	16.00
Fluorspar, lump, f.o.b. Heathden, New Mexico.....	net ton	17.50	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	—	25.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.35	—	.40
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.16	—	.....
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.16½	—	.....
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	—	3.25
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	.....
Zircon, washed, iron free.....	lb.	.03	—	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.00 @ 12.25
Aluminum, 98 to 99 per cent.....	28.3 @ 28.5
Antimony, wholesale lots, Chinese and Japanese.....	5½ @ 5½
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and bl cks.....	.35
Monel metal ingots.....	.38
Monel metal, sheet bars.....	.40
Tin, 5-ton lots.....	27.00
Lead, New York, spot.....	4.00
Lead, E. St. Louis, spot.....	3.95 @ 4.00
Zinc, spot, New York.....	7.00
Zinc, spot, E. St. Louis.....	4.85

OTHER METALS

Silver (commercial).....	oz.	\$0.54½
Cadmium.....	lb.	1.40
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.65
Cobalt.....	lb.	4.50
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	70.00
Iridium.....	oz.	275.00 @ 300.00
Palladium.....	oz.	65.00
Mercury.....	75 lb.	47.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	20.50
Copper bottoms.....	28.00
Copper rods.....	19.00 @ 20.00
High brass wire and sheets.....	17.75
High brass rods.....	15.75
Low brass wire and sheets.....	20.75
Low brass rods.....	20.75
Brazed brass tubing.....	29.50
Brazed bronze tubing.....	34.75
Seamless copper tubing.....	22.50
Seamless high brass tubing.....	21.50

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York					
	Current	One Year Ago	Cleveland	Chicago		
Copper, heavy and crucible.....	10.00 @ 10.25	18.50	10.00	10.50		
Copper, heavy and wire.....	9.00 @ 9.25	16.50	9.50	9.50		
Copper, light and bottoms.....	7.50 @ 8.00	14.50	9.00	8.50		
Lead, heavy.....	3.00 @ 3.50	7.25	4.00	4.00		
Lead, tea.....	1.75 @ 2.00	5.25	3.00	3.00		
Brass, heavy.....	5.00 @ 5.50	9.50	7.00	10.00		
Brass, light.....	4.00 @ 4.25	8.00	5.00	5.50		
No. 1 yellow brass turnings.....	4.00 @ 4.25	9.50	5.50	6.00		
Zinc.....	2.50 @ 3.50	5.00	3.00	3.50		

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	*Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes.....	\$3.73	\$3.80	\$3.47	\$3.58	\$3.37	\$3.58	\$3.47
Soft steel bars.....	3.93	3.70	3.52	3.34	3.27	3.48	3.52
Soft steel bar shapes.....	3.93	3.70	3.52	3.48	3.27	3.48	3.52
Soft steel bands.....	4.33	4.65	4.22	6.25	.....	.....	.....
Plates, ½ to 1 in. thick.....	3.93	4.00	3.67	3.78	3.57	3.78	3.67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

SAND SPRINGS—The Oklahoma Tanning & Mfg. Co., has acquired local property consisting of two factory buildings with adjoining site, and will remodel and equip the structures for a leather tannery. It is proposed to develop a total output of about 5,000 hides per day, with necessary plant extensions as required. Uley Holderman is president.

BATESVILLE—The White River Manganese Co., 567 Bway, Gary, Ind., will install considerable new machinery in connection with its development work on manganese properties at Batesville. Preliminary work has been commenced on a tract of over 100 acres, and it is proposed to establish a plant with daily output of about 50 tons. Washing and concentrating machinery will be purchased at an early date. William G. Rinehart is president and manager.

Florida

MIAMI, FLA.—The Moore Haven Sugar Corp., recently organized with a capital of \$1,000,000, has taken over the plant and property of the Moore Haven Syrup Co., Moore Haven, Fla., consisting of a total of 8 mills on a tract of 450 acres of land. The plant will be remodeled to manufacture clarified raw sugar and byproducts, and new machinery will be installed for this purpose. It is proposed to develop the mills to a point of consumption of about 600 tons of sugar cane per day. The work, including machinery installation, is estimated to cost in excess of \$500,000. E. C. George, Moore Haven, is president and general manager; John C. Grambling, Miami, is secretary and treasurer.

Indiana

KOKOMO—The Kokomo Steel & Wire Co., Citizens' Trust Bldg., has awarded a contract to the Indiana Bridge Co., Muncie, for the rebuilding of its steel works, recently destroyed by fire with loss estimated at about \$300,000, including machinery.

ALEXANDRIA—The Lippincott Glass Co., Greenwood Bldg., Cincinnati, Ohio, manufacturer of chimneys, globes, etc., has commenced the construction of a large tenpot furnace at its plant at Alexandria. It is proposed to place the new furnace in operation at the earliest possible date.

Kentucky

LOUISVILLE—The Standard Sanitary Mfg. Co., Pittsburgh, Pa., manufacturer of sanitary earthenware products, is completing plans for the erection of a new unit at its Louisville works, to be 1 story, 75 x 200 ft., to be used for the manufacture of chinaware specialties, as handles, fittings, etc. It is proposed to have the pottery in operation at an early date.

Louisiana

ST. ROSE—The Petroleum Export & Import Corp., subsidiary of the Carson Oil Co., 29 South La Salle St., Chicago, Ill., is perfecting plans for the erection of a number of buildings on local site for a new oil refinery. The plant will cost about \$500,000, with equipment. A battery of 20 storage tanks will be constructed, contract for which has been let to the William Graver Tank Corp., Chicago, Ill. A power plant, boiler house, pumping plant, machine shop and mechanical buildings will also be constructed. A factory for the manufacture of tin containers will be erected in conjunction with the works. Edward B. Carson is president of the parent company.

Maryland

BALTIMORE—The Prudential Oil Corp., Curtis Bay, is perfecting plans for the construction of its new local oil refinery, estimated to cost close to \$1,000,000 with machinery. As preliminary to the work the

company has filed plans for the construction of a series of steel oil tanks, with total capacity of about 275,000 bbl. The tankage system will cost about \$75,000.

Massachusetts

HOLYOKE, MASS.—The Julid Paper Co. is reported to be planning for the rebuilding of the portion of its works destroyed by fire March 4, with loss estimated at \$200,000.

NATICK—The Natick Tag & Label Co. has acquired the plant of the Natick Machine Co., Royal Arcanum Bldg., and will use the property in connection with its operations.

New Jersey

NEWARK—Keiner & Co., Inc., recently incorporated with a capital of \$125,000, has acquired the plant of the Newark Paving Co., comprising a series of 1-story buildings on a tract bounded by Adams, Parkhurst and Harper Sts. and Ave. F, for the establishment of a new plant for the manufacture of tanning extracts. The property aggregates about 20,000 sq. ft., and about one-half of this space will be utilized at the present time. Equipment will be installed at an early date, including a leather finishing department. The lease covers a period of five years with option to purchase. The company is headed by Erich G. Keiner, Wilmington, Mass.; Irving Willner, 18 Waverly Ave., and Jacob Lubetin, 164 Market St., both of Newark.

GARWOOD—The American Amino Corp. is operating at its new plant at Matawan, N. J., and will produce a line of intermediates at this works. It will be operated in conjunction with the Garwood factory.

MAURER—The Barber Asphalt Paving Co., Land Title Bldg., Philadelphia, Pa., has filed plans for the erection of a new brick and steel building at its local asphalt works to cost about \$101,000, to replace one of the sections of the plant recently destroyed by fire. Construction is under way on another large building at the refining plant to cost about \$306,000; contract for this latter structure was let to the White Construction Co., 95 Madison Ave., New York.

New York

BROOKLYN—The Novocal Chemical Co., 2923 Atlantic Ave., is taking bids for extensions and improvements in its plant to cost about \$35,000. The company has recently filed plans for extensions and betterments in another department of the works to cost \$110,000. William C. Winter, 100 Van Sickler Ave., is architect.

BROOKLYN—The J. Lackner Co., 308 Seventh Ave., Long Island City, manufacturer of paper specialties, has filed plans for extensions and improvements in its plant to cost about \$18,000.

TONAWANDA—The J. Spaulding & Sons Co., 484 Broome St., New York, manufacturer of fiber products, has preliminary plans under way for the erection of a new plant at Tonawanda, to consist of a series of 1-story buildings, with one 5-story structure. The factories will be 105 x 300 ft., 60 x 180 ft., and 50 x 200 ft. George F. Hardy, 309 Bway., New York, is engineer.

North Carolina

MORGANTOWN—The Burke Extract Co., manufacturer of tanning extracts, is planning for a number of extensions in its plant. It is proposed to install new machinery to increase the present output from 80 to 160 bbl. of tanning materials per day.

WAYNESVILLE—The Natural Abrasive Mining Co. of America, recently organized, has plans under way for the development of extensive properties in this section. The company has secured options on about 700 acres of land, containing mica, feldspar, abrasives and other minerals, and will conduct operations in these materials. A number of small plants in this district will be taken over and enlarged.

Pennsylvania

PITTSBURGH—The Standard Sanitary Mfg. Co., manufacturer of sanitary earthenware products, has filed plans for the erec-

tion of a new 2-story brick and steel addition on Ontario St. near Preble Ave., Northside, to cost about \$50,000.

CURWENSVILLE—The Crescent Refractories Co., with local refractory manufacturing plant, has been merged with the George S. Good Fire Brick Co. and the Clearfield Clay Working Co., Clearfield, Pa., both manufacturers of similar products. The total output of the present plants will be about 275,000 refractory bricks and shapes per day.

GREENSBURG—The McKee Glass Co. has resumed production at its plant after a shutdown for about two months. It is proposed to increase production until normal is reached.

Texas

WACO—The Waco Producers' & Refining Co. has awarded a contract to R. E. Whitlock, Dallas, Tex., for the erection of a new refinery at South Bosque, near Waco, to cost about \$75,000. It is planned to develop a daily output of about 300 bbl.

RANGER—T. S. Hudleston and associates have organized a new company to build a plant near Belton, Tex., for the manufacture of crockery and other pottery products. The company has acquired a site for the plant, as well as neighboring kaolin properties for raw material supply. The factory is estimated to cost about \$200,000 with machinery.

MEXIA—The Mexia Refining Co. is planning for the construction of a new oil refinery with initial capacity of about 1,000 bbl. per day.

FREEPORT—The Freeport Sulphur Co. is planning for the construction of a new asphalt plant, to be operated in conjunction with its present local works.

HOUSTON—The Humble Oil & Refining Co. has arranged for note issue of \$25,000,000, the proceeds to be used in part for proposed extensions, betterments, operations, etc. W. S. Farish is vice-president.

SAN ANTONIO—C. L. Witherspoon and associates are planning for the erection of a new oil refinery in the vicinity of Somerset, Tex., with daily output of about 1,000 bbl. A site has been selected.

Virginia

PEARISBURG—The Tazewell Brick Co. is planning for extensions and improvements in its plant at Tip Top, Va. The company was recently incorporated with a capital of \$75,000. C. L. King is president.

STAUNTON—The Farmers' Marl Co., recently organized with a capital of \$150,000, is planning for the development of extensive marl properties in this section. A plant will be established and equipped for a daily output of about 40 tons of material. The company holds leases to about 40 acres of land. C. J. Johnne is president.

Washington

SPOKANE—The Washington Brick, Lime & Sewer Pipe Co. has acquired a tract of land on Monroe St., totaling about 65,000 sq. ft., as a site for the erection of a new brick plant. It is estimated to cost about \$75,000. Construction will be inaugurated at an early date.

New Companies

THE INTERNATIONAL CHEMICAL CO., 13 West Saratoga St., Baltimore, Md., has been incorporated with a capital of \$150,000 to manufacture chemical products. The incorporators are S. F. Acree, Wade A. Gardner and Carlyle Barton, Baltimore.

THE L. G. NESTER CO., Clayville, N. J., has been incorporated with a capital of \$50,000 to manufacture surgical glassware specialties. The incorporators are Lyman G. Nester, William H. Hennis and A. C. Rosenberger, Clayville.

THE PHENIX MINERAL PRODUCTS CORP., New York, N. Y., has been incorporated with a capital of \$100,000 to manufacture brick, ceramic tile and glassware products. The incorporators are J. and A. Levy, and H. M. Johnson, 26 Liberty St.

THE JOHN C. DOW LEATHER CO., Boston, Mass., has been incorporated with a capital of \$50,000 to manufacture leather products. The incorporators are Charles W. Dow, Frederick S. Murphy and John C. Dow, 117 Eastern Ave., Lynn, Mass.

THE NORTH AMERICAN PETROLEUM CO., 2 West South Water St., Chicago, Ill., has been incorporated with a capital of \$100,000 to manufacture oil products. The incorporators are Philip LaMantia, Joseph V. LaMantia and W. E. Gladstone.

THE ATLANTIC RUBBER ACE Co., New Brunswick, N. J., has been incorporated with a capital of \$100,000 to manufacture rubber goods. The incorporators are Louis J., Edward L. and Conrad Sebott, 390 George St.

THE GARRETT PAPER CORP., Newton Square, Pa., has been incorporated with a capital of \$30,000 to manufacture paper goods. C. E. Hand, Wyncote, Pa., is treasurer.

THE MARBO METAL PRODUCTS CORP., Calvert Bldg., Baltimore, Md., has been incorporated with a capital of 10,000 shares of stock without par value. The incorporators are Francis H. Stevenson, James A. Curtis and William H. Hill.

THE UNITED STATES PULP PRODUCTS CORP., Boston, Mass., has been incorporated under Delaware laws with a capital of \$1,750,000 to manufacture pulp and paper products. The incorporators are Lindsey Hooper, Boston; Ernest L. Fox and L. G. Rowe, Newark, N. J.

E. BURNHAM, INC., 138 North State St., Chicago, Ill., has been incorporated with a capital of \$250,000 to manufacture chemicals and byproducts. The incorporators are Gerald, M. and Edward Burnham.

THE BALDWIN PAPER MILLS, INC., New York, has been incorporated with a capital of \$10,000 to manufacture paper goods. The incorporators are S. S. Himmel, H. Brownstein and H. E. Goldberg, 261 B'way.

THE EASTERN OIL & REFINING Co., Indianapolis, Ind., has been incorporated with a capital of \$45,000 to manufacture refined oils. The incorporators are N. E. Carter, Daniel Hecker and B. H. Campbell, Indianapolis.

THE UNION CHEMICAL WORKS, 10 New York Ave., Union Hill, N. J., has filed notice of organization to manufacture chemicals and byproducts. The company is headed by Joseph B. Kreste.

THE BLANDFORD PAPER BOX CORP., Elmira, N. Y., has been incorporated with a capital of \$100,000 to manufacture paper boxes and other containers. The incorporators are Herbert Blandford, Harold S. Mathews and Emil Jackson, Elmira.

THE OKLAMAR Co., 300 Continental Bldg., Baltimore, Md., has been incorporated with a capital of \$100,000 to manufacture refined oils and kindred products. The incorporators are F. Craig Morton, Horace T. Smith and H. Webster Smith.

THE KENT AVENUE CHINA Co., Brooklyn, N. Y., has been incorporated with a capital of \$100,000 to manufacture chinaware, pottery, etc. The incorporators are R. Deibel, J. H. Schwartz and M. Bergman, 1245 46th St.

F. PETER DEUGLER, INC., 190 North State St., Chicago, Ill., has been incorporated with a capital of \$85,000 to manufacture chemicals and byproducts. The incorporators are J. C. Alten, C. C. Taylor and F. Peter Deugler.

THE CRYSTAL SHADE Co., Wheeling, W. Va., has been incorporated with a capital of \$15,000 to manufacture porcelain goods. The incorporators are G. D. Foller, Harry E. Simpson and Frank McConnell, Wheeling.

THE PRUDENTIAL ALLOYS & CHEMICAL Co., 14 Lewis St., Newark, N. J., has filed notice of organization to manufacture chemicals and affiliated products. The company is headed by Herman Rubin, 56 Boyd St.

THE ROSE CLAY PRODUCTS CORP., Philadelphia, Pa., has been incorporated with a capital of \$100,000 by Ernest R. and A. R. Rosse, Philadelphia; and Joseph R. Rosse, Essington, Pa.

THE VERIBEST CHEMICALS, INC., New York, N. Y., has been incorporated with a capital of \$100,000 to manufacture chemicals and byproducts. The incorporators are S. Lyons, E. F. Rapp and B. M. Kaplan, 23 West 112th St.

THE NON-ALCOHOLIC PRODUCTS Co., 9 South 22d St., Irvington, Newark, N. J., has filed notice of organization to manufacture chemicals and affiliated products. William L. Zucker, 31 Ridgewood Ave., heads the company.

THE DI BELLA GLASS Co., Scott Depot, W. Va., has been incorporated with a capital of \$10,000 to manufacture glassware. The incorporators are John Di Bella, T. Pine and E. A. Taylor, Scott Depot.

THE GAUER-LAWSON Co., 1202 Webster Ave., Chicago, Ill., has been incorporated with a capital of \$5,000 to manufacture rubber goods. The incorporators are George A. Gauer, Frank B. Lawson and John F. Rau.

THE JOSEPH PETRY PRINTING INK Co., New York, has been incorporated with a capital of \$25,000 to manufacture printing

and marking inks. The incorporators are J. G. Snyder, A. W. Vanness and Joseph Petry, 261 West 27th St.

THE UNIVERSAL SPECIALTY Co., 975 West Side Ave., Jersey City, N. J., has filed notice of organization to manufacture chemical products. The company is headed by Gustav Levy.

THE UNITED STATES BOILER COMPOUND Co., 180 North Dearborn St., Chicago, Ill., has been incorporated with a capital of \$10,000 to manufacture boiler compounds for water treatment. The incorporators are M. Black, M. and John L. Fox.

THE E. M. JAVITZ & SON CORP., New York, N. Y., has been incorporated with a capital of \$10,000 to manufacture chemicals and affiliated products. The incorporators are J. Schanzenbach, A. and E. M. Javitz, 1 Hudson St.

THE PENN PAINT Co., Pittsburgh, Pa., has been incorporated with a capital of \$25,000 to manufacture paint, oils, varnish, etc. C. D. Miller, 732 Whitney Ave., Wilkesburg, Pa., is treasurer.

THE H. & J. BREWER Co., Springfield, Mass., has been incorporated with a capital of \$96,800 to manufacture chemicals and affiliated products. The incorporators are Clinton E. Bell and G. E. Sheldon, Springfield, Mass.; and V. A. Converse, Longmeadow, Mass.

THE MCLEOD LEATHER & BELTING Co., Greensboro, N. C., has been incorporated with a capital of \$200,000 to manufacture leather products. The incorporators are E. D. Broadhurst, Greensboro; W. T. McLeod and J. A. Schachner, both of Charlotte, N. C.

THE BISON PLATE & WINDOW GLASS CORP., Buffalo, N. Y., has been incorporated with a capital of \$100,000 to manufacture glass products. The incorporators are G. F. Wallace, F. E. Trautman and E. J. Lienert, Buffalo.

THE CHIANAL CHEMICAL Co., 52 Hartford St., Newark, N. J., has filed notice of organization to manufacture special chemical products. The company is headed by John E. O'Sullivan.

THE OLYMPIC DISC RECORD CORP., 101 East Fayette St., Baltimore, Md., has been incorporated with a capital of \$2,500,000 to manufacture composition products. The incorporators are D. L. Warner, Evan D. Llewellyn and Leslie E. Mihm.

THE AIMES MFG. Co., Jersey City, N. J., has been incorporated with a capital of \$100,000 to manufacture chemicals, byproducts, drugs, etc. The incorporators are William D. P. Aimes and S. Walter Silverman, Philadelphia, Pa.; and Irving Solm, Bayonne, N. J.

Capital Increases, Etc.

THE GREAT EASTERN PAPER Co., INC., 377 Broadway, New York, N. Y., has filed notice of increase in capital from \$30,000 to \$100,000.

THE CELLULOID Co., 290 Ferry St., Newark, N. J., is arranging for an increase in capital from \$6,000,000 to \$10,098,000.

THE FRONTIER BRASS FOUNDRY, 818 Elmwood Ave., Niagara Falls, N. Y., has filed notice of change of name to the Frontier Bronze Corp.

THE VICTOR CHEMICAL WORKS, 343 South Dearborn St., Chicago, Ill., has filed notice of increase in capital from 55,000 shares to 100,000 shares of stock, no par value.

THE ATLANTIC PAINT Co., Charleston, S. C., has filed notice of increase in capital from \$20,000 to \$75,000.

THE REMINGTON PAPER & POWER Co., Watertown, N. Y., has filed notice of change of name to the Hanna Paper Corp., at the same time increasing its capital from \$300,000 to \$2,500,000 for expansion.

THE C. G. WINANS Co., 126 Frelinghuysen Ave., Newark, N. J., manufacturer of salt products, has filed notice of increase in capital from \$80,000 to \$160,000.

THE VULCANIZED RUBBER Co., 251 Fourth Ave., New York, N. Y., has filed notice of dissolution of its New York charter, to organize under Maine laws with a capital of \$1,500,000.

THE E. J. KNAPP CANDLE & WAX Co., Free St., Syracuse, N. Y., has filed notice of increase in capital from \$317,500 to \$1,025,000.

THE INTERNATIONAL FOLDING PAPER BOX Co., 396 South Second St., Brooklyn, N. Y., has increased its capital from \$50,000 to \$250,000.

ELBERT & Co., 27 William St., New York, N. Y., manufacturer of oils, has increased its capital from \$50,000 to \$100,000.

Industrial Notes

CELLULOID ZAPON Co. announces the opening of a Philadelphia office at 520 Walnut St., in charge of B. O. Clausen.

MEIGS, BASSETT & SLAUGHTER, INC., consulting engineers, of Philadelphia, are making a survey of the Old Hickory plant near Nashville, Tenn., for the Nashville Industrial Corp.

ADAMSON MFG. Co., East Palestine, O., has added a new department for manufacturing all kinds of storage, pneumatic and pressure tanks, welded pipe, battery casings, evaporators, condensers and a large line of arc-welded products adaptable to the chemical industry.

THE FANSTEEL PRODUCTS Co., INC., announces that since Jan. 27, 1921, the main office has been located at North Chicago, Ill.

THE JOSEPH DIXON CRUCIBLE Co., Jersey City, N. J., has recently brought out a graphite evaporator plate which is recommended as a substitute for the ordinary laboratory sand bath.

EDW. R. LADEW Co., INC., of New York City, tanner and leather belt manufacturer, has closed its sales office at Charlotte, N. C., and transferred its Southern headquarters to 95 South Forsyth St., Atlanta, Ga. An ample stock of belting and leather specialties will be carried, with the usual facilities for special work and engineering service.

WESTERN FELT WORKS announces the completion and equipment of its new buildings at 4031 Ogden Ave., Chicago, Ill.

The metallic arsenic plant at the HOSKINS PROCESS DEVELOPMENT Co., Chicago, was partly destroyed by fire on Wednesday, Jan. 11. The property was covered by insurance and is being rebuilt.

CHAIN BELT Co., Milwaukee, Wis., announces that George J. Blanton, who for the past four years has been connected with the engineering sales department, has been made New York district manager. Before joining the company in 1917 Mr. Blanton was associated with the General Electric Co. for eight years, three years of which were spent in Schenectady, N. Y., and five in the Milwaukee office.

CONVEYORS CORP. OF AMERICA announces that E. D. Kellogg has recently been appointed New Jersey representative in the northern half of the state. His headquarters will be at the Eastern office, New York City. This company also announces that S. D. Inman has been placed in charge of the engineering and design of its American Trolley Carrier, monorail conveying equipment for handling coal, ashes, sand, gravel and like bulky materials from railway car to pile, bin or bunker. Announcement is also made that the Power Equipment Co., 131 State St., Boston, has been appointed as New England representative for the sale of its American Trolley Carrier, monorail equipment for handling coal, ashes, sand, gravel and other loose bulky materials. Colwell & McMullin, 79 Milk St., Boston, are the New England representatives for its American Steam Ash Conveyor.

C. H. WHEELER MFG. Co., Philadelphia, Pa., has opened a branch sales office in the Leader-News Bldg., Cleveland, O., with W. K. Eicher in charge.

HAZARD ADVERTISING CORP. announces its removal to more spacious offices at 7 East 42nd St., New York City, which was made necessary because of the steady increase in the volume of the company's business.

COLORADO FELDSPAR, FLINT & MICA Co., Denver, Col., is planning to establish a crushing and grinding mill at Golden, Col.

AMERICAN WRITING PAPER Co. announced a new scale of prices on Feb. 1. In the list price reductions up to 20 per cent are announced. The average figure, however, is about 15 per cent below January prices. The lines affected by the reduction include practically all papers made by the company except certain specialties.

N. B. PAYNE & Co., New York, dealers in electric cranes and hoists, have extended their lines of material handling machinery to include the portable conveyors of the A. C. Warner Co., Philadelphia; Chicago Automatic Coal Elevators and McKinney-Harrington Package Pilers and Car Loaders. Edmund Otto is now connected in this branch of their business.

THE QUIGLEY FURNACE SPECIALTIES Co., INC., announces that owing to the general development of its business, it has disposed of the metals department. The General Alloys Co., under the management of H. H. Harris, formerly in charge of the metals department, will continue with the sales of Q-alloys. The General Alloys Co. can be reached at either 122 South Michigan Ave., Chicago, Ill., or 26 Cortlandt St., New York City.

New Publications

BOOKS

THE CHEMISTS' YEAR BOOK, 1920. Edited by F. W. Atack, assisted by L. Whin-yates. 5th ed., 1,136 pp. in two volumes. New York: Longmans, Green & Co., 1920. Price, \$7 net.

Since 1915 these volumes have been issued annually in a form resembling the German Chemiker Kalendar. From year to year revisions have been made and new material has been added. In the present edition the 180-page section on "Physico-Chemical Constants" has been completely revised by Dr. G. Barr of the British National Physical Laboratory. As a reference book for general data and analytical methods it will be found convenient and comprehensive. Both editorial and mechanical make-up merit special commendation.

A DICTIONARY OF CHEMICAL TERMS. By James F. Couch, chemist, Bureau of Animal Industry, Department of Agriculture. Pp. 204. New York: D. Van Nostrand Co., 1920. Price, \$2.50.

With the rapid growth and increasing specialization of chemistry new terms are often introduced in one branch of the science which are unfamiliar to workers in other fields. The chemist who tries to keep out of the rut by so planning his reading as to cover a broad field outside of his own specialty is often confronted with a new term or with a puzzling use of a common one. For the purpose of settling just such questions as those which have been suggested above Mr. Couch has unified the complex and scattered terminology of pure and applied chemistry, and presented the material in a form which lies somewhere between that of a standard English dictionary and that of an encyclopædia. Terms from related sciences which are likely to be met with are also defined, so that the book furnishes an excellent aid to study or reading any branch of chemistry or chemical engineering.

FROM NEWTON TO EINSTEIN. By Benjamin Harrow, Ph.D. Pp. 74. New York: D. Van Nostrand Co., 1920. Price, \$1.

This little book presents in a very readable manner a summary of the changes which have taken place in our conception of the universe from Newton's time to the recent much-heralded verification of Einstein's theories. While entirely popular in style this book might serve as an introduction to a phase of physical chemistry, which is increasing in importance.

THE ENGINEERING INDEX, 1919. Pp. 528. New York: The American Society of Mechanical Engineers, 1920. Price, \$4.

Covering as it does articles appearing in over 650 engineering and related publications this volume should be in the hands of all those who refer to the engineering literature. In securing the 12,000 items in this index the engineering staff reviewed approximately 1,100 periodicals, reports and other publications (in ten different languages) received regularly during the year by the Engineering Societies Library, New York.

CRAIN'S MARKET DATA BOOK AND DIRECTORY OF CLASS, TRADE AND TECHNICAL PUBLICATIONS. Chicago: G. D. Crain, Jr., 417 S. Dearborn St., 1921. Price, \$5.

This book has been compiled primarily as a reference book for advertisers. The general field for advertising is divided into related groups or industries. For each of these a short summary is given, covering statistics as to size and importance, manufacturing operations involved (if an industry) and a review of materials and equipment required. This is followed by a list of publications serving this particular group, including circulation, type page, page rates and other matter of interest to advertisers. The industries treated include, among others: Brick and clay products; cement, lime, sand, gravel and other quarry products; chemical industries; gas; iron and steel, metal working; meat packing and byproducts; fertilizers; petroleum; paint and varnish; glass; paper; leather; sugar; rubber.

EXPORTER'S GAZETTEER OF FOREIGN MARKETS 1920-21. Compiled and edited by Lloyd R. Morris. Pp. 789, maps and tables. New York: American Exporter, 1920. Price, \$10.

A vast quantity of up-to-date information on foreign markets has been gathered from scattered primary sources and arranged by countries under the main geographical divisions. For each country the book gives such data as: Area and population; commerce, statistics on industries and production; rivers, post offices, telegraphs, telephones and railroads; money, weights and measures; language; local advertising media; shipping routes; consular represen-

tatives, customs tariff and regulations; cable rate; mail time, and similar matters. Maps of the principal countries are included. Foreign currencies and measurements have been converted into American equivalents.

BIBLIOTHECA CHEMICO-MATHEMATICÆ: Catalogs of works in many tongues on exact and applied science, with a subject index compiled and annotated by H. Z. and H. C. S. These two volumes have 127 plates, which contain 247 portraits and facsimiles. Published by Henry Sotheran and Co., 140 Strand, W. C. 2, London, England. Price £3 3s.

HUMAN ENGINEERING, by Richard H. Mulliner, has just been issued. It is published by Mulliner Bros., 445 South Warren St., Syracuse, N. Y.

LABORATORY EXERCISES IN GENERAL CHEMISTRY, by William Martin Blanchard. Second edition. Published by D. Van Nostrand Co., N. Y. Price \$1.25.

STANDARD TESTS FOR REAGENT CHEMICALS, by Benjamin L. Murray. Published by D. Van Nostrand Co., N. Y. Price \$3.

PAMPHLETS

NEW BUREAU OF STANDARDS PUBLICATIONS: Circular 32, Standards for Gas Service; Circular 99, Carbonization of Lubricating Oils; Scientific Paper 399, Metallographic Etching Reagents: I—for Copper, by Henry S. Rawdon and Marjorie G. Lorentz; Scientific Paper 402, Use of Ammonium Persulphate for Revealing the Macrostructure of Iron and Steel, by Henry S. Rawdon; Scientific Paper 404, Magnetic Reluctivity Relationship as Related to Certain Structures of a Euctetoid-Carbon Steel, by C. Nusbaum, W. L. Cheney and H. Scott; Tech. Paper 173, Tests of Bond Resistance Between Concrete and Steel, by W. A. Slater, F. E. Richart and G. G. Scofield; Tech. Paper 178, Steel Rails From Sink-Head and Ordinary Rail Ingots, by George K. Burgess; Tech. Paper 179, Electric-Arc Welding of Steel: I—Properties of the Arc-Fused Metal, by Henry S. Rawdon, Edward C. Groesbeck and Louis Jordan; Tech. Paper 180, Causes and Prevention of the Formation of Non-condensable Gases in Ammonia Absorption Refrigeration Machines, by E. C. McKelvy and Aaron Isaacs.

NEW BUREAU OF MINES PUBLICATIONS: Petroleum Refineries in the United States, Tenth Annual Report of the Director of the Bureau of Mines to the Secretary of the Interior for the Fiscal Year Ended June 30, 1920; Bull. 117, Structure in Paleozoic Bituminous Coals, by Reinhardt Thiessen; Bull. 189, Bibliography of Petroleum and Allied Substances in 1918, by E. H. Burroughs; Bull. 191, Quality of Gasoline Marketed in the United States, by H. H. Hills and E. W. Dean; Tech. Paper 251, Ventilation in Metal Mines, a Preliminary Report, by Daniel Harrington; Tech. Paper 255, Chlorination of Natural Gas, by C. W. Jones, V. C. Allison and M. H. Meighan; Tech. Paper 264, Storage Battery Locomotives, by L. C. Ilsley and H. B. Brunot; Tech. Paper 271, State Mining Laws on the Use of Electricity in and About Coal Mines, by L. C. Ilsley.

ANNUAL REPORT OF THE DIRECTOR OF BUREAU OF FOREIGN AND DOMESTIC COMMERCE to the Secretary of Commerce for the Fiscal Year Ended June 30, 1920.

NEW U. S. GEOLOGICAL SURVEY PUBLICATIONS: "World Atlas of Commercial Geology" Part I, Distribution of Mineral Production; I: 7, Secondary Metals in 1919, by J. P. Dunlop (Mineral Resources of the U. S., 1919, Part I), published Jan. 31, 1921; I: 8, Chromite in 1919, by J. S. Diller (Mineral Resources of the U. S., 1919, Part I), published Feb. 4, 1921; I: 28, Copper in 1918, by B. S. Butler (Mineral Resources of the U. S., 1918, Part I), published Sept. 28, 1920; I: 29, Lead in 1918, by C. E. Siebenthal (Mineral Resources of the U. S., 1918, Part I), published Jan. 6, 1921; II: 5, Sodium Compounds in 1919, by Roger C. Wells (Mineral Resources of the U. S., 1919, Part II), published Nov. 16, 1920; II: 6, Potash in 1919, by W. B. Hicks and M. R. Nourse (Mineral Resources of the U. S., 1919, Part II), published Dec. 8, 1920; II: 7, Strontium in 1919, by George W. Stose (Mineral Resources of the U. S., 1919, Part II), published Dec. 9, 1920; II: 8, Gypsum in 1919, by Ralph W. Stone (Mineral Resources of the U. S., 1919, Part II), published Dec. 28, 1920; II: 9, Mineral Waters in 1919, by Arthur J. Ellis (Mineral Resources of the U. S., 1919, Part II), published Jan. 21, 1921; II: 10, Sand and Gravel in 1919, by R. W. Stone (Mineral Resources of the United States, 1919, Part II), published Jan. 5, 1921; II: 12, Foreign Graphite in 1919, by Arthur H. Redfield (Mineral Resources of the U. S., 1919, Part II), published Feb. 5, 1921.

IMPERIAL MINERAL RESOURCES BUREAU has issued pamphlets on "Asbestos" and "Bismuth."

THE EXTRACTION OF POTASH FROM LOW-GRADE ALUNITE FROM MARYSVALE DISTRICT, UTAH, by Thomas Varley and W. Spencer Reid. Bull. 13 published by the Utah Engineering Station, Department of Metallurgical Research.

FOURTH ANNUAL REPORT of the United States Council of National Defense, for the fiscal year ended June 30, 1920.

DEPARTMENT OF LABOR AND INDUSTRY has issued a bulletin on "What Pennsylvania Is Doing for Safety and Safety Codes," by Dr. Clifford B. Connelley, and "Report of the Activities of the Industrial Board."

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29. Headquarters will be at the Hotel Rochester.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17.

AMERICAN PAPER & PULP ASSOCIATION will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

HARVARD ALUMNI CHEMISTS' ASSOCIATION will meet Tuesday noon April 26 at Rochester, N. Y., for luncheon.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

NATIONAL PETROLEUM CONGRESS will meet at the Hotel Baltimore, Kansas City, Mo., March 22 to 25.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

REFRACTORIES MANUFACTURING ASSOCIATION will hold a meeting at the Hotel Pennsylvania, New York City, March 17 to 19.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27 to 29.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, N. Y., April 11 to 14.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
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ALAN G. WIKOFF
R. S. MORRINE
CHARLES N. HULBERT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

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Number 12

A Chance

To Try Again

THE Army appropriation bill, including among other things money for the Chemical Warfare Service, failed of enactment because it was pocket-vetoed by the President at the close of the last Congress. In many respects this is an unfortunate thing, as it leaves the new Congress with one added burden—namely, the provision for routine affairs of the Army for the next fiscal year. However, the cloud has a silver lining which is not hard to see, for it gives all of us another opportunity to boost the cause of chemical warfare again and with some hope that more adequate provision will be made for this branch of the Army.

Chemical industry is in many ways intensely interested in chemical warfare. A new aspect of this interest has recently become more conspicuous than ever before in the numerous claims against the Government for the after-effects alleged by those who have been gassed. There are nearly a million claims against the Government now pending in the War Risk Insurance offices. Nearly a quarter of these allege serious after-effects from gas. The intangible nature and the rather novel symptoms involved make it particularly difficult to settle these claims generously yet justly. The importance of this to chemical industry is obvious, for if the Government begins making adjustments for effects of gas every industrial establishment handling chlorine, phosgene, chlorpicrin and other toxic commodities of modern organic chemical activity will be confronted by unfounded claims for damage especially in states where industrial commissions look after workmen's compensation legislation. Chemical industries will, of course, not wish to dodge any right and proper responsibility in these matters, but at the same time it cannot safeguard itself too carefully against precedent that may be established by unreasonable generosity of the Government. One way to do this is to insure proper funds for study of these problems by C. W. S.

On many scores chemical industry and professional men generally will want to see all of the research and development work of chemical warfare properly advanced during the coming year. The only way to insure this is to see that Chemical Warfare Service gets the needed appropriations. That service originally asked for only about 2 per cent of the total sum which Congress proposes to grant for Army maintenance and operation. Yet this service is vital to every branch of the Army and without co-operation of this service every other branch is potentially useless against an enemy well prepared for chemical warfare. It is none too soon for all of us to emphasize these points to our representatives in Congress. In redrafting the Army bill for the new Congress at least double the amount

provided by the bill passed in the last Congress is essential. C. W. S. asked for eight and one-half million dollars. The Secretary of War cut this to four and one-half million before submitting the estimates to Congress, and Congress pared still further to one and one-half million. On this last basis the service can barely keep from slipping backward in mechanical plant and can do but a fraction of the needed research. It can make practically no masks at all. This would be a shameful condition. With \$3,000,000 the engineering facilities of the service can be maintained, a small amount of research and development work can be continued with a skeleton organization and a reserve supply of masks of each of the newer types needed can be made to replace obsolete forms now in hand. Surely that is the least which we can demand of the service during the coming year.

Research Opportunities of the South

DR. RAYMOND F. BACON, Director of the Mellon Institute of Industrial Research of the University of Pittsburgh, delivered a convincingly forceful address on "The Strengthening of Industries by Research and Experimental Engineering Work" at Macon, Ga., on March 15, before the leading representatives of Georgia's industries, at a meeting called to establish an industrial experiment station to be connected with the Georgia School of Technology of Atlanta. The convention was the sequel to the trip of inspection made last November by a party of Georgian manufacturers, accompanied by Governor DORSEY and Dr. K. G. MATHESON, president of Georgia Tech, who visited the important industrial centers of the North, and, while in Pittsburgh, familiarized themselves with the system of industrial research in successful operation at the Mellon Institute. It is reported that the Macon meeting was the largest gathering of industrial leaders ever held in the South, and it is understood that plans have been formulated to interest all lines of manufacturing in the project and to raise funds for the proposed industrial research establishment at Atlanta, to serve Georgia and that section of the South. The chambers of commerce and other civic organizations throughout the state are enthused and have indorsed the idea without exception, and the supporters of the plan have reason to believe that there soon will be a "Mellon Institute" in the Gate City of the South.

Dr. BACON's discourse was impressive in indicating the accomplishments of properly planned, systematically executed industrial research. He related the rôle played by scientific investigation in the development of the petroleum, cotton oil, sulphur, hydrometallurgical, and iron and steel industries; and he pointed to naphtho-py-
rolysis, hydrogenation and flotation as three of the

greatest results of industrial research. It was brought out by Dr. BACON that approximately \$25,000,000 is being spent annually by our industrialists in the conduct of laboratory chemical research, that probably an equivalent sum is being expended for unit experimental plant and factory investigational work, that several of our largest corporations are investing as much money in research as they are laying out for advertising, and that about \$50,000,000 is being saved each year through the application to manufacturing of the findings of scientific inquiry. The sum of \$400,000 was spent last year in carrying on industrial research at the Mellon Institute, where there are now forty-eight distinct technosubjects under study and eighty-three expert research chemists at work thereon.

Dr. BACON made particular reference to the opportunities which exist in the South, and especially in Georgia, for using research in the upbuilding of industry, especially in connection with wood products, textiles and vegetable oils. The field of problems invites investigational exploration, and the Georgia School of Technology provides the port of embarkation for the expedition.

The Chemistry Of Olfactics

A CORRESPONDENT of the London *Daily Mail* lately contributed a note on some curiosities of smelling. He found three or four hens pecking over a rubbish heap on which some calcium carbide had lately been thrown, and while the place reeked of acetylene the hens did not seem to mind it. He observes that the sense of smell of birds is generally slight, that their olfactory bulbs are very small, and that in some, such as the frigate bird, the nostrils are obliterated. On the other hand, regarding man, he declares that the half-savage Ainu of north Japan can track game like a dog, by the nose alone. JAMES MITCHELL, the English blind deaf-mute, recognized his friends when they came into a room, simply by their smell. Dean BUCKLAND, the geologist, when riding once with some friends and the party lost their way and were overtaken by night, alighted from his horse, picked up a handful of earth, smelled it, and at once declared they were near Uxbridge. He knew the geology of the land and the smell of the soil.

Of dogs the *Mail* correspondent says that the opinion prevails that they are better able to follow scent on a dull, damp day than in the bright sunlight when dry air prevails, but that even this cannot be put down as a hard and fast rule. Scent may be good in the morning and bad in the afternoon, and *vice versa*, and hounds that are at fault in the morning may run hard later in the day. The powers of scent of such dogs as setters and retrievers vary greatly at different times. On a September afternoon, he says, a famous hunter shot and wounded no fewer than ten partridges, which were running in that condition, although his retriever could not find any of them. He then waited until the cool of the evening, brought her back to the same spot, and within ten minutes she had tracked down every one of the birds.

"Why," the correspondent asks, "are cats so strangely fond of valerian? Why are stoats and weasels attracted by the oil of musk?" The answer is probably entangled in sex phenomena, while his declaration that a vixen with her cubs hardly leaves any

scent behind her has at least the odor of a kind of provision of nature. When he asks, "Why are rats so keen on aniseed and rhodium?" we acknowledge ourselves beaten, more particularly in regard to rhodium. If they have such a passion for rhodium they can hardly be indifferent to platinum, and an ex-president of the Electrochemical Society suggests a real use for rats in this connection. He proposes that they be used in prospecting for platinum and as an aid to detectives in locating stolen crucibles. We wonder what the London writer wrote that the printer mistook for rhodium!

But where is the chemistry of all these curious reactions? What is scent, anyway? What happens when we smell? What are the carriers of odor? What reactions take place on the sensitive plates in the nostrils where the nerve termini are embedded in lipoid substance? What's the use in talking big about chemistry when nobody can tell us of the process of smelling? How many atoms must a molecule contain to have the olfactory quality? And how many carbon atoms mark the limit of this quality? The cellulose molecule seems to have no odor. Has it too many carbon atoms to produce the phenomenon? If we only knew how many carbon atoms the cellulose molecule contains we should know a lot more than we do now. Dr. THOMAS H. DURRANS, an English investigator, has expressed the opinion that odor is due to unsatisfied bonds within the molecule. That may be true, but the rest of us do not seem to know enough either to confirm or to deny it. The subject is unstudied, and it needs attention.

The Ways and Habits of Micro-organisms

IT WAS during convocation week at Chicago in December last that Dr. SIMON FLEXNER made his famous presidential address at the meeting of the American Association for the Advancement of Science. He called it "Twenty-five Years of Bacteriology: a Fragment of Medical Research," and we commend it to our readers as a model of scientific literature. It was published in the December 31, 1920, issue of *Science*. He began with the meeting of the German Society of Naturalists and Physicians in 1895, when the announcement was made of the conquest of diphtheria by an antitoxin. Establishing that as a landmark, he proceeded to lead up to it by a historical introduction, not for the purpose of giving dates and mentioning names, but to give, which he succeeded in doing, a clear picture of the state of the art at the time. Then followed a discussion on the high lights of what has been done since. It is a very illuminating essay, with the theory and application of science made remarkably clear.

We have published articles on the uses of micro-organisms in industrial chemistry, but we want more. We need more industrial biochemistry. The fermentation of ethyl alcohol from sugar is studied and available, but we do not know enough about the production of glycerol by a similar process or of the zymotic production of amyl alcohol from protein substances—e.g., from the germs of grains. We have hardly lifted the cover of this great treasure store of industry as yet. Elsewhere we have expressed the hope that some day the chemical factory will be as greatly desired in a neighborhood as a public library or a school. That will be when we work more delicately than we do now;

when we let the microbes do our work for us. They require great cleanliness to keep the strains pure, but when the conditions are favorable they scorn union hours or minimum wages or overtime, and they work while we sleep. The time is ripe for some FLEXNER of industrial chemistry to give us such a paper on biochemical technology or chemical biotechnology, whichever you please. True, FLEXNERS are scarce, but we are not keen about names. It is the work we are after.

Hours of Service

In the Steel Industry

THE iron and steel industry expects the United States Steel Corporation to present within a few weeks a solution of the difficult problem of the hours of service in the industry. Many years ago it became the custom in some departments to have men on duty twelve hours a day seven times in the week. Fortnightly, when the day and night shifts changed places, there was a twenty-four-hour spell. The practice was due partly to competition among manufacturers and partly to the willingness of the labor, chiefly foreign born, to work very long hours. In the Steel Corporation's annual report for 1912 it was stated that the corporation was observing the six-day week. This was accomplished by having a twenty-four-hour interval each week in the production of ingots and by giving men at blast furnaces a day off in the week in rotation. Thus the twenty-four-hour spell for a given man every fortnight was eliminated. The corporation's practice in this matter has not been universal, and at any rate the twelve-hour day has remained except at a few works.

Usually the problem has been considered as involving simply a choice between two twelve-hour shifts and three eight-hour shifts, since the machinery works continuously. Many of the men do not, but the precise time at which they may be required cannot always be predetermined, and it is requisite for full utilization of the plant equipment that the men who do not have to work continuously be subject to instant call. Many of the men prefer the long hours with the attendant pay in preference to a much shorter day with but a slight diminution in the daily earnings. The social workers recognize, as do others, the advantage to the country of shorter hours on duty and of more Americanization, but they have been disposed to place the whole task before the employers. The desire for a shorter day with opportunity in leisure hours for recreation and self-improvement, with the employee bearing a reasonable part of the expense, has not been inculcated in the minds of these workmen.

When the demand for pig iron and steel products is heavy, as in 1920 when buyers bid from three to five times the pre-war price for many classes of steel, a large curtailment in the supply would occur if the hours were shortened, because additional men could not be obtained. When, as at the present time, the iron and steel industry is faced with the necessity of producing cheaply and economically in order to make a market, without which there would be no employment at all, it is essential that the operation of production be efficient. Every man must do a fair day's work for a fair day's pay. The economics of the situation will not countenance any other condition. There is a horrible example in the case of the railroads, whose payrolls as recently constituted included about 1,950,000 persons. At five persons to a bread-winner that

meant 9.2 per cent of the population dependent on the railroad payrolls. Such a division of the sum total of the work of the people is impractical, and the iron and steel industry would be committing partial suicide, if use of such a term be permitted, if it adopted a system that did not provide a full day's work for each man on the payroll.

To leave all work to be done as it is done now and have three men per twenty-four hours instead of two men to perform the services is impractical on economic grounds, but hitherto the problem has been regarded as a mere choice between two shifts and three shifts. In view of the fact that a committee composed of presidents of subsidiary companies of the Steel Corporation has been hard at work on the subject it is a fair presumption that an elimination of the twelve-hour day is being sought by substitution of a system that will be much less inefficient on economic grounds than an eight-hour period of service, with general methods of operation unchanged. When no solution of the vexed problem has hitherto been proposed that seems economically sound, and when the Steel Corporation evidently finds the task so difficult, it is idle to speculate as to what will be the outcome of the present study, but from all the circumstances it seems fair to conclude that within a short time a system will be put into actual operation that will eliminate unduly long hours of service and yet will provide that each man does a fair day's work, so that the country will not be devoting an undue amount of its total time to the production of pig iron and steel. It is now committing such an economic crime in the case of railroading and coal mining, and would be including a third in the case of the building trades if the unions in that line had their way. The country could not stand such a collection of crimes, its duty being to reduce, not increase, the number.

Science in the Public Service

THE National Research Council is contributing splendidly to the cause of chemistry and chemical industry by the exhibit which it is showing of the relation between chemistry and both peace-time and war-time industrial products. This exhibit, prepared largely by the Chemical Warfare Service, strikingly portrays the close relationship of explosives and material for chemical warfare to the peace-time products of the dye, pharmaceutical and other organic chemical industries. Taking coal, salt, sulphur and air, which remind us of the alchemists' elements, this exhibit shows the diversity of product which modern chemical industry furnishes for the comfort and protection of mankind. It makes one believe that the ancient alchemist was nearer the truth than most histories of chemistry would lead us to believe when he considered air, water, earth and fire as the elements. Certainly the number of truly basic substances of industry is fewer than we commonly believe, and the interrelation of industry is much closer than modern commercial practice would show.

It is to be hoped that the purpose of this exhibit will be generously realized in the education of legislators, professional men and the general public. Particularly we should like to see a keener appreciation of the great importance both in peace and in war times of that effort which is basic to the Chemical Warfare Service.

Readers' Views and Comments

Fundamentals Essential to Soundness of Steel Rails

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your issue of Jan. 26, 1921, you published a communication from George F. Comstock, metallurgical engineer of the Titanium Alloy Manufacturing Co., headed "Relationship Between Segregation and Rail Failures." On the face of it Mr. Comstock has made out a very good argument for the titanium-treated rail, but so much more data as to the service conditions of the various tests quoted are necessary before an engineer or metallurgist could draw intelligent conclusions that the whole argument loses much force and as it stands is possibly misleading.

Mr. Comstock also makes one statement of fact that I must take direct exception to. I quote: "Theoretically there is no question that the sink-head process is effective in eliminating pipe in ingots, but piping can be controlled also by care in ordinary methods of ingot manufacture. For instance, in a recent rolling of standard titanium-treated rails, the top discard averaged 8.3 per cent from the ingot, and by keeping the silicon content of the steel below 0.10 and pouring slowly, the piped rails were kept down to 4.5 per cent as determined by the nick-and-break test on every ingot. No special molds or hot-tops were used."

Does he mean by "sink-head" process the putting of a sink-head on an ordinary big-end-down ingot? This is admittedly valueless, as the sink-head only hides the secondary pipe or shrinkage, which at times occurs down in the bottom 20 per cent of the ingot. The only true value of a sink-head in producing physically sound steel is when it is used in conjunction with a big-end-up or inverted ingot mold. This has been clearly explained by Dr. H. M. Howe and so many others that it need not be reopened to argument. I feel that Mr. Comstock committed a great error in referring to sink-head ingots without stating whether the mold was big end up or big end down, thus making a statement that is at least indefinite and may readily damage the cause of physically sound steel.

As a matter of fact, the big-end-up ingot with the refractory sink-head has been in use even in this country on the highest quality sound steel products for twenty years or more, and its use is constantly growing until last year over a million tons of ingots were cast this way. This can therefore hardly be considered "theoretical."

Mr. Comstock speaks of eliminating pipe. Pipe is the volumetric shrinkage of steel when going from the molten to the solid, and of course cannot be prevented. It can only be so controlled that it will appear in a small portion by weight of the upper end of the ingot. It can only be eliminated by cropping the piped portion of the ingot.

I quote further from Mr. Comstock: "But piping can be controlled also by care in ordinary methods of manufacture."

In my understanding the only things that the steel maker can do to control pipe in ordinary methods of manufacture, using a standard big-end-down ingot, are:

First: To only partly deoxidize or not to deoxidize the steel, thus forming blowholes all through the ingot instead of pipes. Unless the object is to produce a coarse steel sponge, this is inadmissible.

Second: To roll the ingot before solidification has completely taken place, according to the plan suggested by Talbot. This produces so-called "cokey," gray or soft centers, a condition prohibited in all ordnance and high quality steel, and now prevented in the latest rail specifications. (A.R.E.A. 1920, Par. 31.)

Note B of these specifications says: "The steel must be well deoxidized and the waste products eliminated before teeming," thus definitely prohibiting the use of a steel that will form blowholes. It is only by the doing of one or the other, possibly both, of these indefensible things that ingots could be produced in ordinary molds that would give a yield of 91.7 (8.3 per cent top crop) with only 4.5 per cent of the rails showing pipe on the nick-and-break test.

It is probable that in making these estimates of percentage of crop necessary to reach sound metal Mr. Comstock has fallen into the error that so many metallurgists and the writers of so many specifications also fall into—viz., that the visual examination of the fracture of a finished part is sufficient to detect physical flaws in the metal and insure soundness.

An examination of the fracture in a nicked and broken rail does not reliably show up a cokey center, although the longitudinal fracture of the bloom from which the rail was rolled does. Hence this is where the inspection for physical soundness should be made, and it can be made at this point without interfering in any way with manufacture or adding to cost. When this is done, inspection will catch the deeply hidden flaws which at present slip by on the inspection only of the finished product and later cause such dangerous breaks as transverse fissures, shattered zones and split rail heads.

The fundamentals essential to the soundness of steel rails are:

First: That the bath of metal be thoroughly deoxidized before teeming, so that no chemical reaction can taken place during solidification.

Second: That the metal be cast in an ingot mold whose inside dimensions are enough greater at the top than at the bottom to prevent internal bridging.

Third: That the ingot after teeming be kept in substantially a vertical position, either in mold or soaking pit, until solidification is complete.

Fourth: That a refractory sink-head be used on all ingots.

Mr. Comstock holds that titanium promotes soundness in that it is the best of all known deoxidizers, and that is of course his argument in the letter in question, for he says: "We have found, moreover, that no titanium-treated rail is ever segregated if the treatment has been properly made, so that there is a small residual content of titanium." This implies the complete deoxidation of the steel, as otherwise there could be no residual titanium. An important question from a commercial stand-

point which might be discussed in this connection is this:

Can steel, such as rail steel, be completely deoxidized with titanium alone when the silicon is kept down to 0.10 per cent, and what is the cost per ton of doing this? I am asking this because as I mix with steel makers I find that they are only using titanium as a partial deoxidizer in such products as sheet bar and plates, possibly others of the same class, and its effect thus used is only to deepen the location of the blowholes which form in all open steel ingots. This only hides the flaws more deeply in the steel and makes them harder for the buyer of the steel to find, but the user ultimately does find them when the part breaks in service or fails by corrosion. In my opinion this is a false and uneconomical use of titanium, though it may be commercially profitable today. Its true use, if it is to be of any permanent value in the steel industry, is either as a deoxidizer or alloy, and not as a "dope."

Segregation is always present in all ingots. It is an inherent condition in all steel which forms by selective freezing, and hence Mr. Comstock's statement that no properly titanium-treated rails ever show segregation is of course not literally true. The thing which should be said of titanium is that it retards and minimizes segregation, and this is also true of many other deoxidizers. For this reason, and also because a thoroughly deoxidized bath prevents blowholes and concentrates the entire volumetric shrinkage of the steel in one pipe cavity, deoxidation is the first fundamental essential to soundness. Mr. Comstock ought to agree with me here. Use of a big-end-up mold with a deoxidized bath of metal automatically locates all pipe and much unavoidable segregation in the upper part of the ingot, where it can be cropped and discarded, and hence the big-end-up mold is the second essential to soundness. Use of the sink-head with the first two makes it possible to crop all pipe and dangerous segregation with less than 10 per cent of the ingot weight, and therefore it is a commercial essential. Holding the ingot vertical until solid prevents cokey centers and the extremely dangerous flaws that are attendant thereto, and is therefore essential to soundness. It is my opinion that cokey centers cause more breaks in rails than all other defects put together, chemical segregation included.

Mr. Editor, I wish to call attention to your editorial of Nov. 17, 1920, headed "Why Not Turn the Mold Over?" and most positively state in support of the ideas contained there that as long as rail makers and rail users continue to compromise with the "big-end-down mold fetish," as they are still doing today, they will continue to get rails full of dangerous hidden flaws. Furthermore, if they will turn the mold over and employ the three other fundamentals essential to soundness, they can get uniformly sound rails and at no appreciably greater cost.

GEORGE A. DORNIN,

Gathmann Engineering Co.

Consulting Engineer.

Mr. Comstock's Reply

To the Editor of Chemical & Metallurgical Engineering

SIR:—In regard to the service results on titanium-treated rail, it should be understood that these were not from special tests conducted by the Titanium Alloy Manufacturing Co., with all conditions carefully controlled. They were purchased by the railroads at a

slight increase in cost above that for ordinary rails, and naturally were placed in track where the service conditions were severe so that this increase in cost might be repaid in service. If Mr. Dornin or any other interested person will take the trouble to refer to the published records of the American Railway Engineering Association he will readily see that the tonnages involved are large enough to make the various results thoroughly practical and representative of actual track conditions. It is hard to see any justification for the charge that my argument was possibly misleading, since the results originated with the railroads themselves, which would naturally be most interested in placing the titanium-treated rails where they would be exposed to service conditions more severe than the average.

Most of Mr. Dornin's criticisms seem to be the result of the brevity of my former letter, but it should be remembered that that was just a letter and not an exhaustive paper on the subject. When I mentioned the sink-head process, I of course meant this process properly used; it was not necessary to state this in detail, as my letter was in reference to Dr. Burgess' articles, where all these details were mentioned. I reiterate that piping can certainly be controlled by the way the steel is poured into the molds. In the rolling mentioned (with a top discard averaging 8.3 per cent) the ingots were completely deoxidized and not rolled with liquid centers, yet only 4.5 per cent of the rails showed pipe on the nick-and-break test. The inspection for pipe was, of course, made in the usual, standard manner specified for the nick-and-break test, and by the regular inspectors accustomed to this test. There is no question that pipe can be accurately determined in this way. There is absolutely no reason why a soft center in a rail should be confused with unsoundness, and there is no published evidence known to me that a soft center ever did a rail any harm or caused a transverse fissure, a shattered zone or a split head. I have examined quite a number of failed rails, and have carefully studied all other reports of such examinations that I could find, and have never found any case of trouble caused by a soft center. Most failed rails, on the other hand, are segregated and have a hard center.

In reply to Mr. Dornin's question about deoxidizing rail steel, our experience with thousands of tons of this steel shows that it can be deoxidized completely by the usual manganese addition, silicon in an amount giving from 0.06 to 0.10 per cent in the final steel, and 13 lb. of ferrocen-titanium per ton. The cost of ferrocen-titanium is 10c. per lb., making the actual cost of the treatment \$1.30 per ton, in rail steel. In soft steel, such as for sheet-bar and plates, this is probably not true. In this class of material experience shows that effervescing steel gives the best results, so that titanium is generally used in it as a partial deoxidizer and cleanser. This use is giving improved results in many mills, which is a stronger argument for using it than mere opinion. In most of this steel a good clean surface is the important point, and it has yet to be shown that a good surface implies hidden defects causing breakage or corrosion in service.

The quotation from my letter about "no properly titanium-treated rails ever showing segregation" is another instance where a phrase isolated from its context may have an unintended meaning. In connection with the table and paragraph where this statement occurred

in my letter, it should be apparent that by "segregated rail" I meant one with over 12 per cent segregation of carbon between the upper corner of the head and the junction of head and web.

I have always been a supporter of the Gathmann mold, and believe that its use will produce better ingots with less waste than the ordinary molds produce; but it is the deoxidation of the steel, and not the type of mold used, that controls or minimizes segregation, which when uncontrolled is the cause of more rail failures than any other defect.

GEORGE F. COMSTOCK.

Metallurgical Engineer,
Titanium Alloy Manufacturing Co.

Easy Money From Peat

To the Editor of Chemical & Metallurgical Engineering

SIR:—I happen, unfortunately, to be the "Charlie" you mention so many times in your story on "Easy Money From Peat" in your issue of Feb. 2, and can say that every word in it is the truth. If your gentleman would have stayed or waited until called back by the Professor after being ordered out of the basement and witnessed the second demonstration quickly staged by the inventor you would have had a complete story and not part of one. What I saw accidentally, as I could not very well be ordered out with the others, though it was against the Professor's wishes to have me stay, I could not very well write, as I would not like to sign my name to it, as it might be going too far. I resigned that evening as secretary and treasurer of the company, so you might imagine what I saw was not very pleasant. George and myself happen to be too honest young men full of ambition; and as the Professor promised us a lot and we having no knowledge of chemistry, we took a chance, thinking the Professor and his process were straight.

EDITOR'S NOTE. For obvious reasons the name of our correspondent is omitted. The communication is valuable, however, in support of the statements made in our article. It has been brought to our attention that some of our readers believed the article to be a figment of the imagination, but we wish to assure them that it was a statement of fact.

Research, a Capital Investment or an Operating Expense?

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with a great deal of interest and approval what is written under the caption "Research, a Capital Investment or an Operating Expense?" in your issue of Feb. 2. On some of my advertising matter I have carried for a number of years the following: "Money expended for professional advice is capital invested, and should be so entered on the books." Credit for this eminently safe and sane dictum is given to the *India Rubber World*.

It seems to me that a great many managers of industrial enterprises fall into two very serious economic errors. The first is that of considering an expenditure as synonymous with expense, while the second is that of regarding a reduction of expenditures as necessarily an economy. England's great Prime Minister Disraeli years ago said: "True economy does not consist in a reckless reduction of expenditures; on the contrary, such a course almost inevitably results in increased expense—there can be no economy where there is no efficiency."

If there ever was a time when it would be profitable

to display a wise liberality in expenditures to promote industrial efficiency, to increase the buying power of money by a careful inspection of all material bought, and, above all, by a rigid supervision showing how material is used, this is the time above all other times. In the case of fuel, for instance, selling as it does at such enormously high prices, what economies might be effected if its use were under the continuous supervision of competent fuel engineers!

It appears, though, that the editor of *Drugs, Oils and Paints* was about right when he said many years back: "It would seem that the average American manufacturer prefers to go to his ruin on his own responsibility rather than to go to success by the aid of outside help." Going still further back, one Lucius Æmilius Paulus said in 165 B.C.: "I would call that man more proud than wise who attempted to do everything by his own unaided judgment."

Since the days of this old Roman men have probably grown more proud. Have they, in matters of industrial efficiency, grown very much wiser?

Baltimore, Md.

WILLIAM N. BERKELEY.

The Hargreaves-Bird Electrolytic Cell

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read J. B. C. Kershaw's description of the Hargreaves-Bird cell, as appearing in your issue of Jan. 12, 1921, with interest, as certain of the information contained therein is new to me. But I would particularly refer to his remark that "this company has been operating under the war conditions of inflated prices." I have always taken interest in so-called derelict companies and processes, and I have been fortunate enough in being able to show, on more than one occasion, that such companies and processes have been wrongly described. A very large number of experts considered the Hargreaves-Bird cell was a failure and pointed to the misfortunes of the Electrolytic Alkali Co., Ltd., as a proof of their theory, and it seems to have annoyed them considerably to find that their views have been proved incorrect. Some of them, unfortunately, are not generous or broadminded enough even now to admit that they were wrong.

In September, 1916, the Ministry of Munitions decided, after going into details of cost, that a fair price for bleaching powder made under a certain process was £10 per ton, but because our process was more efficient the price they would pay us would be £7 10s. per ton. The Ministry of Munitions did not alter that price until January, 1918. During this period it is obvious that the cost of labor, raw material, etc., increased to a considerable extent, and it was only by continuous improvement that we were able to maintain the margin of profit. Had we been able to sell our bleaching powder on the open market we should have got, during the latter part of this period, anything from £25 to £40 per ton. Further, we were pleased to assist in making certain poison gases, and we did this at net cost of labor and material, plus a small percentage, which percentage was very much below our standing charges. Obviously, therefore, there was no profit for our organization under this head.

The above will show that the prices we got for our products, to say the least of it, were not inflated prices.

ELECTRO BLEACH & BY-PRODUCTS, LIMITED,

S. HUTCHINS,

Managing Director.

Middlewich, Cheshire, England.

Atoms and Metals

Summary Outline of Modern Views of the Ultimate Constitution of Matter — Nature of Forces Existing Between Atoms in Gas, Liquid and Crystalline or Amorphous Solid as Affecting the Commonly Measured Physical Properties of Metals

BY ZAY JEFFRIES AND R. S. ARCHER

Research Bureau, Aluminum Company of America

DEVELOPMENT of metallographic science is evident in the direction of a thorough study of the constitution of matter. The microscope has revealed structures in metals unsuspected by the naked eye, and has made intelligible much of the behavior of metals which was formerly quite mysterious. The range of the microscope is limited, however. We know in many cases that structural changes are taking place on a scale so minute as to lie beyond the resolving power of the microscope and yet are producing revolutionary changes in the properties of the metal. Since the study of the structure of metals with the microscope has yielded results of such great practical value, we may expect that the extension of this study to those details of structure which lie beyond the resolving power of the microscope will result in a corresponding extension of our useful knowledge of metals.

In the complete analysis of structure we are concerned with the ultimate particles of matter—the electron, atom and molecule. It is not sufficient merely to recognize that such particles exist and that the atom is an extremely small particle of matter which is the unit of chemical combination. We must gain some appreciation of the actual sizes of these particles, of their properties, and their relations with one another. In this way a mental picture can be formed of the manner in which metals are built up and of the mechanism of the changes in structure and properties which affect their utility. The knowledge of the ultimate particles which is now available is not enough to make our pictures entirely complete and accurate, but it is enough to make them useful.

CONSTITUTION OF ATOMS

The electron has the smallest mass of any particle of which we have any knowledge. The word "electron" was first suggested in 1891 by Dr. G. Johnstone Stoney as a name for the natural unit of electricity, or a unit electrical charge (4.77×10^{-10} electrostatic units). It is now almost universally applied to certain very small particles which possess a definite mass and carry a single negative electric charge. It is quite possible that the mass of the particle is entirely of electrical origin, and that the unit electrical charge actually constitutes the particle. The mass of the electron is about $\frac{1}{1836}$ that of the lightest known atom—namely, the atom of hydrogen. Assuming that this mass is entirely of electrical origin, it can be calculated that the radius of the electron is about 2×10^{-13} cm. Experimental evidence shows that the size of the electron is actually of this order of magnitude, which is very small as compared with the diameter of an atom. Because of their negative charges, electrons are to be regarded as repelled by each other and attracted by positive electrical charges.

It is now considered quite certain that atoms are built up of negatively charged electrons grouped about positively charged nuclei.¹ The charge on the nucleus of an atom is exactly balanced by the negative electrons surrounding it, so that the atom as a whole is electrically neutral. Independent methods of experiment have estimated the exact number of electrons in the atoms of the various elements. If the elements are arranged in the order of increasing atomic weight and numbered consecutively from 1 to 92, with a few omissions, the numbers thus assigned are called the *atomic numbers* of the elements. According to this conception the atom of each element has a number of electrons equal to its atomic number; thus hydrogen has 1, helium 2, iron 26 electrons, etc. Fundamentally, different kinds of atoms owe their individuality to their positively charged nuclei; the charge on the nucleus evidently determines the number of electrons which will be held about it by electrostatic attraction. These electrons will naturally group themselves into some most stable arrangement which must be different for different numbers of electrons. Atoms of the various elements differ therefore in the character of their nuclei, and the number and arrangement of electrons.

ATOMIC MASS AND VOLUME

The mass of an atom is due almost entirely to its nucleus. A hydrogen atom contains only one electron, having a mass approximately only $\frac{1}{1836}$ that of the atom, while the atom of uranium, which contains 92 electrons, has a mass about 236 times that of the hydrogen atom. In the latter case the contribution of the negative electrons to the total mass is still more insignificant. The total mass of the atom increases with the charge on the positive nucleus, but not in a perfectly regular manner.

The actual mass of the hydrogen atom has been determined and has a value of 1.662×10^{-24} g.; its atomic weight is 1.008. If we imagine a hypothetical element with an atomic weight of unity, the mass of its atom would be 1.643×10^{-24} g. The actual mass of the atom of any chemical element is the product of its atomic weight by the mass of this hypothetical atom. For example, the mass of an iron atom = $55.84 \times 1.643 \times 10^{-24} = 9.174 \times 10^{-23}$ g.

The size of an electron is known to be very small as compared with the volume dominated by the atom of which it is a part.² The radius of the latter volume is probably of the order of 50,000 times the radius of the electron. It is believed that the heavy posi-

¹Langmuir and Lewis have recently developed a general hypothesis regarding the positions of electrons in atoms and molecules which promises to be very far reaching. For a clear exposition of this theory see "The Langmuir Postulates," by Ellwood Hendrick, *CHEM. & MET. ENG.*, vol. 21, p. 73, July 15, 1919.

²"The Electron," R. A. Milliken, Chicago University Press.

tively charged nucleus of the atom is still smaller than the electron. An atom consists, therefore, chiefly of empty space. It is possible to project one atom through another without striking the nucleus or any of the electrons in much the same way that a comet might shoot through our solar system, without striking the sun or any of the planets.

In view of the open nature of its structure, an atom cannot be said to possess a definite volume, in the sense of a space inclosed by a bounding surface, but in any given material we can determine the volume per atom, which we may for convenience call the volume of the atom, always recognizing that we mean merely the volume dominated by the atom, or its "sphere of influence." In this sense it is quite simple to calculate the volume of an atom from its mass and the density of the element. Taking iron again for an example, the density is 7.87 g. per c.c. The number of atoms in 1 c.c. is then

$\frac{7.87}{9.176 \times 10^{-23}}$; the reciprocal of this number is the volume per atom, and figures 1.166×10^{-23} c.c. This calculation depends of course on the value taken for the density of iron, which varies with the temperature, pressure, and arrangement of the atoms—i.e., physical form. Therefore the volume of an atom in this sense is not a constant property of the atom like its mass. A set of numbers representing the relative volumes occupied by atoms is obtained by dividing the atomic weights of the elements by their densities when in the solid state. Physically, the number thus obtained gives the volume in cubic centimeters of an atomic weight in grams (gram-atom) of the solid element, and is called the *atomic volume* of the element.

VISUALIZING THE SIZE OF ATOMS

It is difficult to imagine the size of such small objects as atoms. Tungsten, for example, which has a specific gravity of slightly over 19, requires about 100,000,000 atoms as they are normally spaced at room temperature to make a linear inch. A 1-in. cube of tungsten would, therefore, contain about 1,000,000,000,000,000,000,000,000 or (10^{24}) atoms.

We are in the habit of visualizing all objects in terms of things which we can see with the unaided eye—e. g., we make a map of as large an area as the continent of North America and reduce it to such an extent that we can see its general geographical characteristics on one page, or one map. On the other hand, we magnify objects too small to be seen with the unaided eye to such an extent that we can see the photograph or other physical likeness with the unaided eye. We cannot visualize the size of an atom, owing to its smallness, but we can gain some idea of the ratio between atomic dimensions and one of the smallest units which can be readily seen with the unaided eye—namely, 0.01 in. Let us suppose that instead of atoms we have spheres 0.01 in. in diameter. Let us further suppose that we make up a cube composed of 10^{24} of these spheres closely packed. This cube would be 1,000,000 in. on a side, or over 15 miles. Consequently, the diameter of a tungsten atom is to 1 in. as 0.01 in. is to 15 miles, and the space dominated by a tungsten atom is to 0.000001 cu.in. as 0.000001 cu.in. is to 225 cubic miles. This comparison may be equally difficult to comprehend, but it at least calls strikingly to our attention the very small dimensions of the atoms.

INTERATOMIC FORCES

Atoms exert upon each other both attractive and repulsive forces. Thus, metallic iron is an aggregate of crystals built up of atoms arranged in a definite manner, and any attempt to separate these atoms from each other, as by the application of a tensile load, is opposed by the cohesion of the metal, which results from the attraction of the atoms for each other. If a small tensile load such as 3,000 lb. per sq.in. is applied, the distances between atom centers in the direction of the load increase by a certain amount in accordance with the elastic modulus—in the case in point, 0.01 per cent. On removal of the load the atoms return to their original positions.

Similarly the atoms are moved closer together by hydrostatic pressure, resisting the pressure because of the repulsive forces between them. When the pressure is released these forces restore the atoms to their original positions.

Atoms of a solid are thus held in equilibrium positions by a balance of their forces of attraction and repulsion. On being forced closer together the repulsive forces increase more rapidly than the attractive forces and the resultant force is a repulsion which varies approximately as the displacement of the atoms from their equilibrium positions. When the atoms are pulled farther apart than their equilibrium positions, the resultant force is attractive and again is approximately proportional to the displacement of the atoms from their equilibrium positions.

At all temperatures above absolute zero the atoms of the solid elements are in a state of vibratory motion about their equilibrium positions. The frequency of vibration is on the order of 6×10^{12} cycles per second, and does not vary greatly with the temperature; the amplitude of vibration does increase with the temperature, however, thereby increasing the kinetic energy of the particles. In fact, *temperature* is a term used to indicate the mean kinetic energy of the particles of a body.

All of the common properties of a body change with the temperature except the mass. This must be due to the changing motion and energy of the atoms, since the specific properties of the atom itself do not appear to be affected by temperature. The property of radioactivity, for example, seems to be a characteristic property of certain atoms and does not vary with temperature. Similarly, the spectra of the elements exhibit an independence of temperature, again indicating constancy in the properties of the atom.

The phenomenon of crystallinity is evidence of a natural orderly arrangement of atoms. A crystal is made up of atoms held together by attractive forces which must necessarily be exerted in definite directions to give rise to the geometrical symmetry of the crystal. No element is known which does not occur in crystalline form, both in the pure state and in chemical combination with other elements. The X-ray spectrometer is constantly giving proof that many substances, once considered amorphous, are in reality crystalline and are built up of atoms arranged in definite and repeating patterns.³

This property of exerting force *directionally* is therefore a characteristic property of atoms, and because

³Important results derived during the last decade by X-ray analysis will be discussed in a later contribution on the structure of metals.

of the directional quality of the forces between atoms, the crystalline form is the normal form of matter in the solid state.

MOLECULES

Certain groups of atoms held together by atomic forces constitute molecules. Hydrogen, for example, consists of discrete particles, which we call molecules, each one made up of two hydrogen atoms. Hydrogen in the atomic state is an extremely active substance, combining with explosive violence with many elements, such as oxygen and chlorine. When the atoms of hydrogen unite with each other in pairs to form hydrogen molecules, the attractive forces about the atoms are largely satisfied. Molecular hydrogen is accordingly a very inert gas. Hydrogen molecules have little attraction for each other, as is shown by the very low boiling point of liquid hydrogen. It can be mixed with oxygen at ordinary temperatures without any reaction taking place. But when the mixture is heated some of the molecules are dissociated by the thermal impacts, and the atoms thus freed start the chemical reaction. The heat liberated continues the process of dissociation so that the reaction rapidly becomes complete.

Equal volumes of gases under similar conditions of temperature and pressure contain equal numbers of molecules (Avogadro's law). From this law the number of atoms to the molecule of a gas can be determined by measuring the density of the gas under definite conditions of temperature and pressure. Such measurements show that the molecules of the non-metallic elements in the gaseous form contain two or more atoms, with the exception of the inert gases of the helium group, which are monatomic. Atoms of the rare gases apparently do not exert sufficient attractive force to combine into molecules. Vapors of the metals also contain only one atom to the molecule.

Atoms of such elements as oxygen and chlorine exert upon each other definite attractive forces which cause them to unite in pairs to form fairly inert molecules. These molecules, as long as they are undissociated, behave very much like the atoms of the rare gases. The attractive forces of the atoms are so nearly satisfied by their combination with each other that the molecules do not condense to form liquids until low temperatures are reached.

Molecules of such chemical compounds as exist in the gaseous state must of course contain two or more atoms. As a rule the molecular formula is the simplest that can be written—that is, the molecule contains only one atom of that element which is present in the lowest atomic concentration. Molecular formulas of water vapor and hydrochloric acid, for example, are H_2O and HCl , instead of some multiple such as H_4O_2 or H_2Cl_2 . The attractive forces which make the atoms of these elements, hydrogen, oxygen and chlorine—unstable and disposed to double up in pairs—are satisfied by the chemical combination with each other.

In the accompanying Fig. 1 is shown schematically the arrangement of

the sodium and chlorine atoms in a crystal of sodium chloride, as determined by the X-ray spectrometer. Each sodium atom represented by a black circle is surrounded by six equidistant chlorine atoms represented by white circles. Similarly each chlorine atom is surrounded by six equidistant sodium atoms. If solid sodium chloride is heated sufficiently, evaporation takes place, the atoms leaving the surface in pairs in the form of sodium chloride molecules. It is evidently not possible to say which of six similarly related chlorine atoms will pair off with any particular sodium atom in the process of evaporation. The molecule of sodium chloride does not exist, as such, in the solid state.

In sulphur crystals the atoms are found to be arranged in a lattice structure in groups of eight. It is significant that these groups contain the same number of atoms as are found in the molecules of sulphur vapor. It seems certain that these groups of eight atoms must retain their identity throughout the changes of melting and boiling.

From the two examples just given it is apparent that the definition of a molecule in the solid state is difficult. In many substances like sodium chloride there is apparently no unit which can be called a molecule unless we call the whole crystal a molecule. Metallic elements all fall in this class. On the other hand, in sulphur and in a large number of chemical compounds, the solid crystal contains certain groups of atoms which may be regarded as molecules.

CHEMICAL FORCES

It has been customary to distinguish rather sharply between the chemical force called "affinity" and the physical forces of cohesion, adhesion, surface tension, etc. On considering the structure of the sodium chloride crystal, it is evident that the forces which are responsible for the cohesion of the crystal are the chemical forces, or the "affinity," between the sodium and the chlorine atoms. This is merely one example of a large mass of evidence which is forcing us to the conclusion that the physical and chemical forces between atoms are of the same nature and that there is no justification for a sharp distinction between them.⁴

The chemical forces which hold atoms together in the form of distinct molecules are very definite in respect to the number of atoms held in combination. An atom's combining capacity is expressed by the term valence; hydrogen possesses unit combining capacity, it is always held to have a valence of 1. Furthermore, the valence of hydrogen is considered to be positive, while that of the elements with which it combines is considered to be negative, at least in respect to hydrogen. Any element which can replace hydrogen in its compounds is also said to have a positive combining capacity. Oxygen is the standard for negative valence, having a combining capacity of 2, since one atom of oxygen combines with two atoms of hydrogen. These are simply the ordinary rules of valence, into which it is not necessary to go at further length here.

Simple molecules formed in accordance with these rules often combine with one another to form more complex compounds; typical examples are hydrated salts, and silicates. The numbers of molecules of each kind involved in these combinations are quite definite, but are not indicated by the ordinary rules of valence.

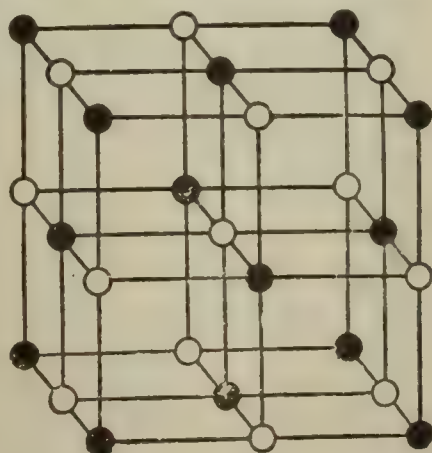


FIG. 1. SIMPLE CUBIC ARRANGEMENT STRUCTURE OF SODIUM CHLORIDE CRYSTAL

⁴"The Constitution and Fundamental Properties of Solids and Liquids," Irving Langmuir, *Journal, American Chemical Society*, 1916 and 1917.

There is nothing in the valence of the elements to account for the number of molecules of water in definite hydrates $\text{NaCl} \cdot 2\text{H}_2\text{O}$; $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$; $2\text{FeCl}_3 \cdot 12\text{H}_2\text{O}$; $2\text{FeCl}_3 \cdot 7\text{H}_2\text{O}$; $2\text{FeCl}_3 \cdot 5\text{H}_2\text{O}$ and $2\text{FeCl}_3 \cdot 4\text{H}_2\text{O}$. Ferric chloride forms a number of distinct hydrates, an illustration of a general tendency for molecules to combine with each other in several different ratios, each definite but apparently unrelated to the valences of the constituent elements or to each other.

Compounds of this type are usually limited to the solid state. Any attempt to volatilize a hydrated salt results in the decomposition of the compound, the water molecules and the salt molecules leaving the solid separately. There is no such thing as a distinct molecule of the hydrate itself, consisting of a definite number of atoms. The "molecule" in the solid state is the entire crystal, which is built up of its simple constituent molecules arranged in definite space lattices. The numbers of the different kinds of molecules which combine with each other in such arrangements depend upon geometrical considerations and not upon any definite combining capacity or valence characteristic of each molecule.

PRIMARY AND SECONDARY VALENCE

The forces which cause atoms to combine in definite proportions to form distinct molecules may for convenience be termed "primary valence" and the forces which unite these molecules into crystalline aggregates may be called "secondary valence" or "residual valence."

Secondary valence forces may serve to unite like molecules as well as unlike molecules. Thus, ice is built up of H_2O molecules. Two atoms of hydrogen are held to one oxygen atom in this group by primary valence. These molecules are then united by secondary valence in the crystal of ice. Ice is here not regarded as a distinct chemical compound, but merely as a different form of water; its formation from H_2O molecules is, however, a phenomenon of the same type as the formation of crystals of $\text{NaCl} \cdot 2\text{H}_2\text{O}$ from NaCl and H_2O molecules. The forces are equally chemical in nature.³

Molecules of the elements are primary valence compounds. The valence of an element toward other elements does not tell us how many atoms combine to form the molecule, but other considerations lead us to classify the forces involved as primary valence forces. The very existence of the molecule as a discrete particle passing probably unchanged through solid, liquid and gaseous states is typical of a primary valence compound. The heat of formation of molecules from like atoms is of the same order of magnitude as in the case of molecules formed from unlike atoms—that is, chemical compounds. The heat of formation of molecular hydrogen from atomic hydrogen, for example, is about 80,000 calories per gram-molecule. Heat evolved in reactions due to secondary valence is in general very much smaller and corresponds in magnitude with heats of fusion and evaporation.

Elements in the solid state are normally crystalline aggregates of the molecules of which they are constituted when in the gaseous state. Sulphur crystals are built up of molecules containing eight atoms each. Metallic elements are, as far as is known, monatomic in the gaseous state; accordingly the unit of which crystals of solid metals is constituted is an atom. The forces holding these atoms together are similar in kind to those uniting the molecules of sulphur in crystal-

line sulphur and the molecules of water in ice, the forces of secondary or residual valence.

COMPOUNDS BETWEEN METALS

Metals frequently form definite chemical compounds which are important structural constituents in alloys. It is a conspicuous characteristic of these compounds that their compositions are seldom indicated by the rules of primary valence. Probably the most important compounds of this class are Fe_3C and CuAl_2 . It is of course possible to write structural formulas after the manner of organic chemistry in which the ordinary rules of valence are satisfied. Thus the constitution



of CuAl_2 might be represented by the formula $\text{Al} = \text{Al}$. This would indicate that the crystals of this compound are built of molecules as units in the space lattice. It is probable that such is not the case, but that the units of the crystal lattice are the atoms of copper and aluminum arranged in definite and repeating patterns in which the atoms of copper and aluminum are not interchangeable. Since atoms of a pure metal do not combine with each other to form molecules, it seems quite likely that the atoms of two metals, which though different are nevertheless of generally similar chemical characteristics, likewise do not form primary valence molecules. Neither is the formation of intermetallic compounds accompanied by the large heat evolutions which so often accompany primary valence reactions. Furthermore, no intermetallic compounds are known to exist in the gaseous state, except for such feebly metallic compounds as the hydrides of antimony, arsenic and bismuth. These hydrides are composed of discrete molecules whose constitution is represented satisfactorily by the simplest possible formula based on the ordinary rules of valence. Therefore, the majority of intermetallic compounds seem to be secondary valence compounds whose compositions are determined by geometrical considerations such as the sizes of the atoms and the directional properties of their force fields, just as in the case of the hydrates discussed above.

MECHANISM OF SOLIDIFICATION

Liquids as well as solids must be held together by secondary valence forces. Gases consist of molecules in such a violent state of thermal agitation that the attractive forces between them are not strong enough to cause even temporary combinations. In the liquid state the energy of thermal agitation has decreased to such an extent that the collisions between molecules result in the formation of groups held together by secondary valence. Further collisions break up these groups so that their existence is only temporary and in actual time extremely brief. Liquids owe their fluidity to this constant shifting in the bonds between molecules. As the temperature is further lowered, the life of these molecular groups and the average number of molecules in them increase. Finally a point is reached at which the thermal energy of the individual molecules is not great enough to free them from the attraction of other molecules, and solidification takes place. The expansion of water which takes place on cooling from 4 to 0 deg. C. suggests the formation in the liquid of considerable molecular groups having the increased volume characteristic of crystalline ice. The metal bismuth also expands on solidification and we should therefore expect a slight expansion of the liquid immediately before solidification,

as in the case of water, or at least a decrease in the rate of fluid contraction.

The constriction of thermal motion can be accomplished by an increase in external pressure as well as by a decrease in temperature. If solidification takes place with a decrease in volume, as is the case with all the common metals except bismuth, the application of external pressure hastens solidification—that is, causes it to take place at a higher temperature. When solidification is accompanied by expansion, increase in pressure lowers the freezing point, but the actual changes in freezing point caused by changes in pressure are very slight.

We may review this discussion by the consideration of an example. Let us suppose some metallic tin is heated to a temperature of 2,500 deg. C. Under normal atmospheric pressure the tin will be in the gaseous state, since it boils at about 2,270 deg. C. To the best of our knowledge the gas is monatomic—that is, the molecules consist of single atoms. These atoms are in constant motion in straight lines, interrupted only by collisions. Each atom is surrounded by a field of force which attracts it to the other atoms with the same intensity as in the solid state. The kinetic energy, both of translation and rotation, overcomes the attractive forces, and no combination of atoms takes place. On cooling, this kinetic energy decreases until the attractive forces sufficiently overbalance it to cause the condensation of the gas to a liquid. Since the volume change is very much greater on passing from the gaseous to the liquid state than on passing from the liquid to the solid state, the effect of pressure on the boiling point is very much more marked than on the melting point. In liquid tin the atoms are held together by cohesion bonds of the secondary valence type, constantly breaking and re-forming, so that the positions of the atoms with reference to one another are not fixed. The liquid is therefore mobile, and can change its shape indefinitely without losing its continuity.

The atoms of tin are constantly tending to orient themselves into a regular pattern, a tendency which is

opposed by the energy of thermal motion. When this energy is sufficiently reduced, by cooling to 232 deg. C. the orienting or crystallizing tendency gains the ascendancy and solidification takes place. Solidification is identical with crystallization, or the arrangement of atoms into positions fixed with relation to each other. The atoms remain in a state of vibration about their equilibrium positions, but have probably lost their energy of rotation. On further cooling the amplitude of vibration decreases, causing a contraction of the metal. As the kinetic energy of the atoms decreases and they become closer together, it requires a greater external force to separate them—that is, the cohesion increases.

Crystals which form on solidification grow outward from nuclei until they meet each other along surfaces which are necessarily irregular. Some of the molten tin remains between the crystals in an unoriented or amorphous condition. On cooling to room temperature the motion of the atoms of the amorphous metal decreases to such an extent that the material, although possessing many of the structural features of a liquid, becomes rigid and is in effect a solid. However, the atoms retain their ability to change their position with relation to one another, and the substance is therefore capable of flow. Transition from a liquid to an amorphous solid is gradual and there is no sharp freezing point and no heat of solidification; an amorphous solid is doubtless an undercooled liquid.

COMPRESSION

T. W. Richards⁵ has pointed out that the attractive forces between atoms act in many ways like the application of external pressure. "There is strong evidence that where affinities are great the atomic centers come closer together, and that where the affinities are slight they are further apart." Richards considers the atom as including the entire "sphere of influence," or space

⁵"The Present Aspect of the Hypothesis of Compressible Atoms," Theodore W. Richards, *Journal of the American Chemical Society*, December, 1914.

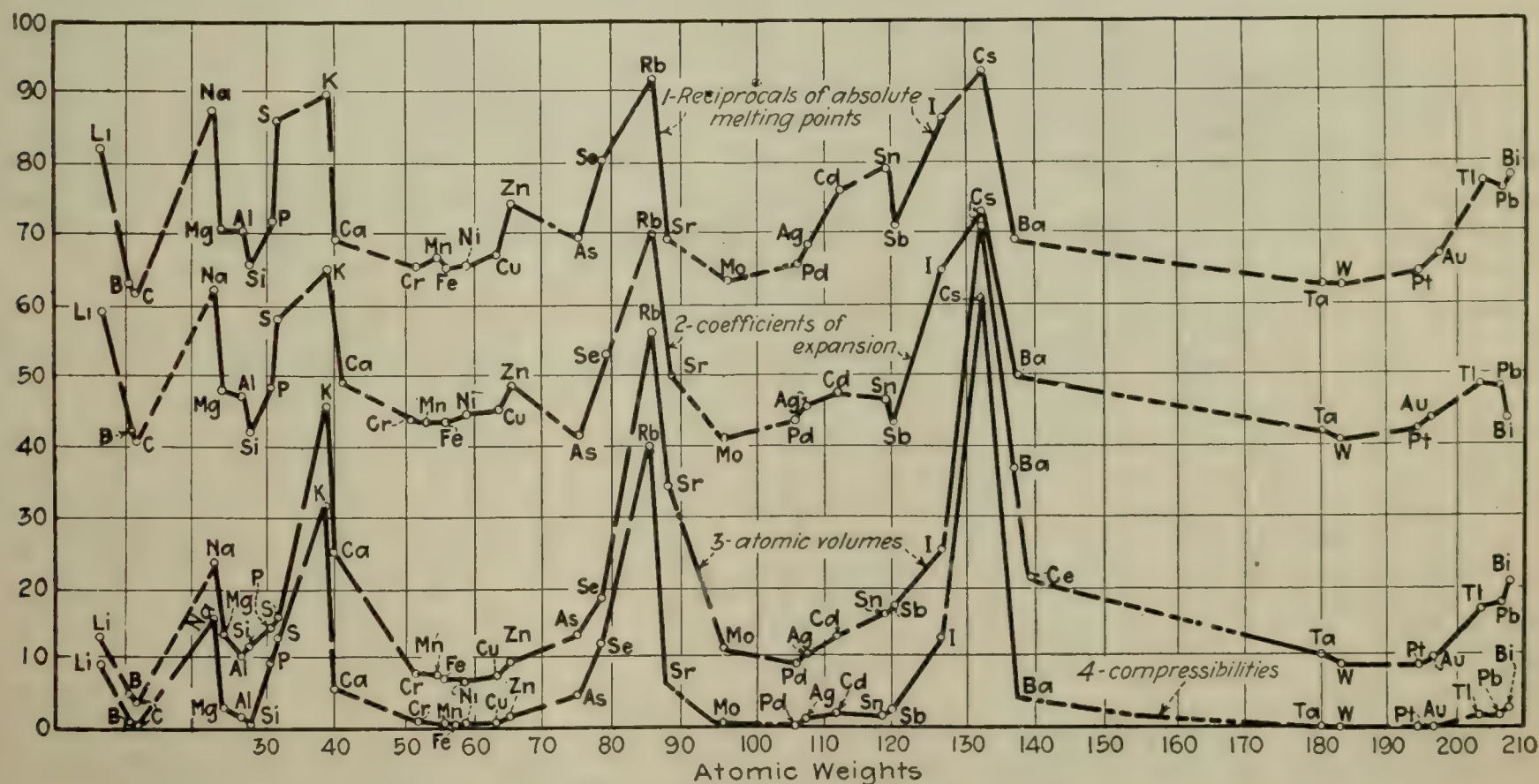


FIG. 2. RELATION BETWEEN MELTING POINTS, THERMAL EXPANSIONS, ATOMIC VOLUMES AND COMPRESSIBILITIES OF THE ELEMENTS (ACCORDING TO T. W. RICHARDS)

dominated by the atom. On this basis atoms must necessarily be regarded as compressible in order to account for the compressibility, expansibility, etc., of solids. The volume of an atom is then a definite quantity, depending on the pressure to which it is subjected.

This pressure may arise from external forces or from interatomic attraction. In the latter case it is spoken of as an internal pressure, and substances held together by strong affinities are said to be under high internal pressure. A striking example of compression by chemical affinity is found in the case of potassium chloride. The atomic volume of potassium is 45 (c.c. per gram-atom) and the molecular volume of KCl is 37 (c.c. per gram-molecule). In the compound the potassium atom and the chlorine atom together occupy less space than does the potassium atom alone in solid metallic potassium. This contraction is held to be due to a high internal pressure caused by the strong affinity of potassium for chlorine.

Small atomic volume is thus evidence of high internal pressure, which should be accompanied by great cohesion. The same forces that resist the separation of atoms by mechanical tension also resist their separation by thermal agitation, therefore small atomic volume should in general indicate low coefficient of thermal expansion, high boiling point and high heat of vaporization; such assumptions are verified in a most remarkable way in the diagram,⁶ Fig. 2, collecting the experimental evidence now available.

The volume of any substance is diminished by the application of hydrostatic pressure. If we suppose all solids to be inherently under internal pressure, then the actual effect of a given absolute increment of external pressure, such as 1,000 lb. per sq.in., must be greater the less the initial internal pressure. The fixed increment of pressure will be effective in proportion to its ratio to the total internal plus external pressure on the substance, and those elements whose internal pressures are low, as shown by high atomic volumes, should have high compressibilities.

INFLUENCE OF ATOMIC VOLUME ON THE CONSTANCY IN COMPRESSIBILITY

"In a system already under great pressure each small successive addition of pressure will be nearly the same percentage of the whole, and therefore each like addition would be expected to have very nearly the same effect upon the volume. On the other hand, if the substance is under small pressure, each successive equal addition of pressure will be a much smaller percentage than the preceding and would, therefore, have a greatly diminished effect upon the volume. Thus, if the compressibility decreases greatly with increasing pressure, one may infer that but little pressure was present in the first case, but if a body possesses a small compressibility which is nearly constant over a wide range of pressure, we should feel obliged to believe that a great internal pressure was already present in some form within the substance." Accordingly, substances which, like carbon, silicon, iron, etc., possess low atomic volume and low compressibility, should also show considerable constancy in compressibility with varying pressure.

These relations are actually found to hold with considerable regularity in the case of elementary sub-

stances, and, "Consistently, elements with great atomic volumes also show, in general, great volatility, great compressibility, great coefficient of expansion, and great change of compressibility with increasing pressure."

Cleveland, Ohio.

Chemical Warfare Exhibit in Washington

THE importance of chemistry in national defense and industrial independence is strikingly shown in an exhibit in the offices of the National Research Council in Washington, D. C. The exhibit was arranged by the Chemical Warfare Service and will be open to the public for a month or six weeks. After that time it is proposed to take it to Philadelphia and New York.

While most chemists and some of the United States Army officials realize that chemistry as applied to warfare is the most powerful of all modern weapons for national defense, the country at large—the average citizen—is apparently ignorant of this fact. To the average layman chemistry is a jumble of incomprehensible names and symbols, and chemical warfare is associated in his mind with hideous atrocities. Up to this time scarcely any effort has been made to educate the public not only as to the value of chemistry in national defense but also as to its importance in peace time. It is the purpose of this exhibit to assist in eliminating the false impressions that prevail and to show by novel graphic representations how national prosperity is dependent on the proper development of the chemical industries and how these industries in time of war provide the only adequate means of national defense.

The main feature of the exhibit is a topographic model (Fig. 1), 7 x 12 ft., of an idealized group of chemical industries whose development and maintenance are essential for adequate national defense. The outer portion of the model shows the plants and equipment required for the production of some of the more important crude materials which are required by the chemical industries. This includes models of sulphur wells; a sulphuric acid plant; a coal mine with the usual equipment for sorting and handling coal; a byproduct coke oven with stills and storage tanks for the various crude products obtained from coal tar; a hydro-electric power plant which supplies electric power to a plant for the production of nitric acid from atmospheric nitrogen and also to an electrolytic chlorine plant from which caustic soda and chlorine are produced by the electrolytic decomposition of salt; and salt wells which provide the salt for the chlorine plant.

This group of plants surrounds what may be called the heart of the chemical industry—that is, the plants which produce the intermediate and finished chemical products. The group of buildings representing the production of the intermediate chemicals is situated near the center of the model. Radiating from the intermediate chemical plant are four separate groups of factory buildings. One group represents an industry for the manufacture of dyes; another for explosives; another for pharmaceuticals and medicinals, and another for war gases. All of these four industries use the same chemical intermediates for the production of their finished products.

Back of this model are four charts (Figs. 2 to 5) showing some of the intermediates and finished products obtained from each of the four crude chemical materials—sulphur, salt, coal, and atmospheric air. On

⁶From an article by T. W. Richards on "The Compressibilities of the Elements and Their Relations to Other Properties," *Proc. National Acad. Sciences*, vol. 1, p. 411, July, 1915.



TOPOGRAPHIC MODEL SHOWING THE INTIMATE RELATION BETWEEN THE COAL TAR AND OTHER INDUSTRIES

Coal Mine Byproduct Coke Ovens Nitric-Acid Plant Hydro-Electric Power Plant Chlorine Plant
Sulphur Wells Sulphuric Acid Plant Explosives Intermediates Plant War Gases Dyes Salt Wells

these charts actual samples of the chemical substances are attached.

Other features of the exhibit are samples of the material used in chemical warfare, such as gas shells, gas masks, Stokes mortars, Livens projectors, complete collections of all the war gases used in the late war, samples of pharmaceuticals, medicinals, perfumes and dyes, with various dyed materials. All the products exhibited were made in the United States.

Another feature is a collection of models illustrating the arrangement of atoms in the molecules in various coal-tar products, thus showing the chemical similarity of dyes, war gases, explosives and pharmaceuticals. Examples of these models are given in Fig. 6, which illustrate the chemical structures of carbolic acid and picric acid respectively. This shows the similarity in the structures of these two chemicals and simplifies the explanation necessary to show the non-chemist how picric acid is produced from carbolic acid.

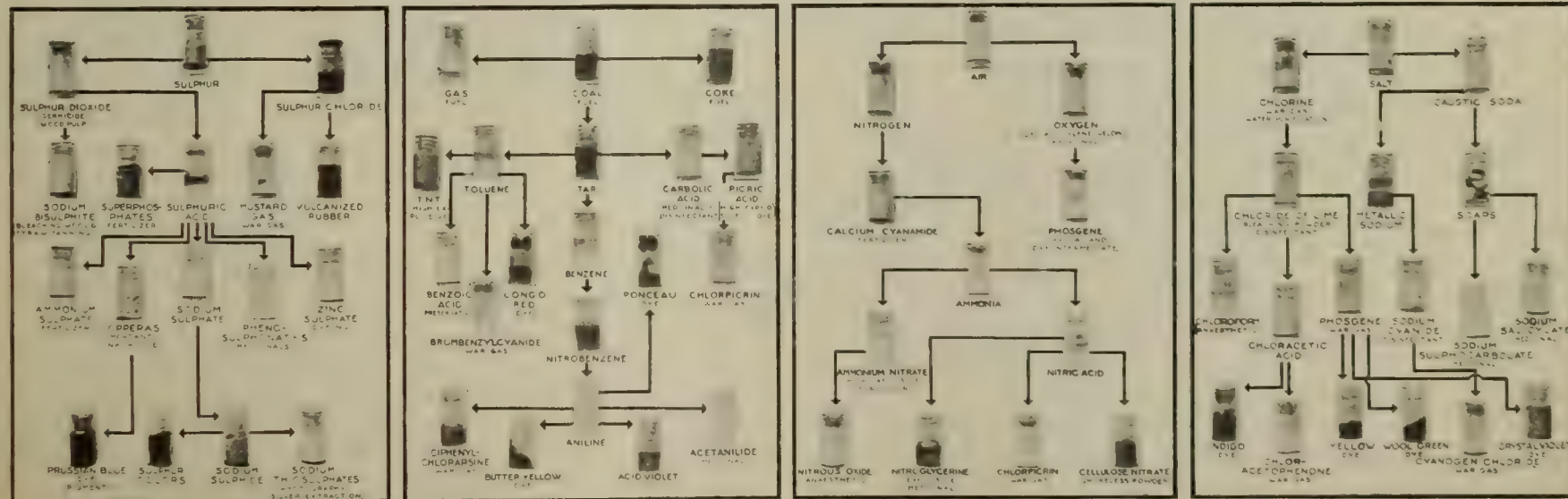
All these features are explained in detail in a booklet which is given to each visitor. The booklet also contains an article by Edwin E. Slosson on "What the Chemist Has Done and May Do in War and Peace." In it he says:

"The Great War forced America into a new industrial field, the manufacture of organic chemicals. When our soldiers met the enemy on the battlefields of France they had to fight fire with fire and poison gas with poison gas. At the same time the home folks found themselves without the dyes and drugs that they had hitherto obtained from Germany. It became necessary then to create

chemical industries of all sorts from optical glass to nitrates and this was done, but with haste and waste, for enterprises which should have been a gradual growth had to be extemporized in a year. But by the time the fighting was over the gigantic task was accomplished and the United States was for the first time 'free and independent' so far as most of the essential chemical products are concerned.

"Now that we have got this chemical industry the question is, What shall we do with it? Shall we again place the weapons needed for self-defense in the hands of possible enemies and shall we once more turn over to our commercial rivals the keys to our most important manufactures?

"The answer to this vital question can only be given by the American people and they will only be qualified to decide when they know the extent and importance of the chemical industry and how it may be kept at home. If now it had been a piece of land that we had acquired through the war, say the little island of Yap, we could have kept it by a few forts and ships. But science is more slippery. It does not stand still but keeps moving—and in the case of chemistry moving very rapidly. The only way to keep it is to keep ahead in it. The American dye maker now has at his disposal all the German patents, but the German chemists have not stopped using their brains and unless we use ours we shall soon be left behind. Of what value was the best patent on a flint-lock the day after the percussion cap was invented? As soon as the Germans found out how to make artificial indigo, the indigo crop of India



FIGS. 2 TO 5 CHART SHOWING WAR AND PEACE TIME USES OF PRODUCTS

From sulphur

From coal

From air

From salt

lost its value. The chemical industry is the offspring of science and dies if weaned from its mother.

"In the model are four groups of buildings looking very much alike because they are much alike, yet, as the labels state, the first may be turning out explosives, the second pharmaceuticals, the third war gases and the fourth dyes. This correlation of the chemical manufactures is a fortunate thing, for it means that while we are developing one of our essential home industries we are at the same time making the most effective provision for national defense. A warship is of no use except for war. But a chemical plant producing dyes may readily turn out explosives in an emergency and the making of medicines must go on in peace time and war time. Young men drilled in the art of presenting arms and forming fours may never have occasion to use this knowledge, but young men trained as chemists may make the most effective combatants as well as the most useful of citizens. The development of American chemical industry is a policy that commands the support of pacifist and militarist as well as of all the rest of us who come somewhere in between.

"The cost of a single battleship, about \$30,000,000, would endow an establishment for chemical research such as the world has never yet seen, and the expense of keeping the battleship in commission, about \$3,000,000 a year, allowing for depreciation, would pay for the education of all the chemists the country could need.

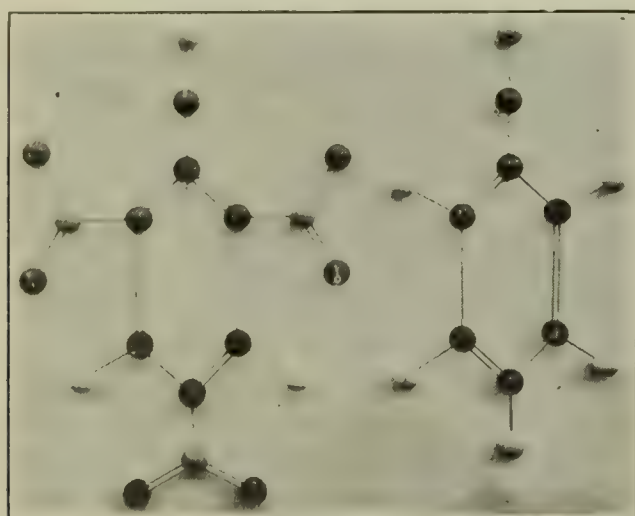


FIG. 6.

Models showing the arrangement of the atoms in the molecules of carbolic acid (right) and picric acid (left). The different atoms in the molecules are represented by different colored balls.

The modern battleship is made as invulnerable as possible but the men on it are not invulnerable. No armor can keep out air and a ship does not have to be sunk if the crew is suffocated. A sharpshooter wastes no more ammunition on a riderless horse. A single airplane with a couple of men may sail over a warship at an unassailable height and besprinkle its decks with a liquid so corrosive that three drops of it touching a man's skin at any part will kill him and so persistent that such little of it as may be caught in crevices will render the ship uninhabitable for days. A 14-in. shell pursues a single course and when it explodes that is the end of it. An ounce of diphenyl-chlor-arsine, an innocent looking white powder, will keep up its bombardment for weeks and its molecular projectiles will fly around corners and into the smallest cracks.

"Armed with such liquids and solids the airman of the next war will not need a machine gun or even bombs to attack the enemy underneath. He does not have to take accurate aim and calculate the allowance for wind,

height and velocity. All he need do is to attach a sprayer to the tail of his machine and rain down poison on the earth beneath as the farmer kills the bugs on his potato field."

It is hoped that this exhibit will enable the public to visualize the importance of chemistry to the nation, that it will show the necessity of building up an adequate Chemical Warfare Service, of developing chemical industries which will make the United States independent of foreign countries, of encouraging basic industrial chemical research and the training of a personnel capable of making this country the most powerful chemically both in war and in peace-time pursuits. The lesson sought to be taught is that any country that hopes to hold its own in peace or war must have an adequate chemical industry guided by scientific research and backed by patriotic public opinion.

United States Crude Oil Production in 1920

The following tables give a brief résumé of the crude oil situation in the United States for the past year:

INCOME AND OUTGO (Stated in Barrels)

	Domestic Production	Domestic Consumption	U. S. Imports	U. S. Exports
1920*	443,402,000	437,579,000	106,175,000	8,045,000
1919*	377,719,000	375,559,000	52,822,000	5,924,000
1918	355,927,716	380,242,153	37,735,641	4,900,691
1917	335,315,601	351,569,632	30,162,583	4,098,124

STOCKS OF CRUDE OIL

End of Year	Pipeline Stocks	Refinery Stocks	Field Stocks	Mexican Stocks in U. S.
1920*	133,690,000	21,373,945†	3,423,276†	7,442,000
1919*	127,867,000	13,143,285	§	2,919,000
1918	121,727,312	15,749,771	7,547,097	.....
1917	146,041,749	11,638,433	13,705,811	.....

* Preliminary figures. † As of Nov. 30, 1920. ‡ East of California. § Figures not available. Note.—Figures for 1920 and 1919 are subject to revision. Figures given are those of the U. S. Geological Survey and the Bureau of Foreign and Domestic Commerce, except in the case of refinery stocks, the source of these being the U. S. Bureau of Mines.

EXPORTS OF CRUDE OIL AND REFINED PRODUCTS FROM THE UNITED STATES, 1917-1920 (Stated in Gallons)

	1920	1919	1918	1917
Crude oil.....	337,886,081	248,821,453	205,829,030	172,121,195
Illuminating oil.....	861,891,942	979,155,147	491,109,815	658,156,487
Lubricating oil.....	410,874,209	274,795,166	257,317,253	280,437,663
Gasoline, naphtha, etc.	642,897,428	372,132,957	559,368,855	415,878,844
Fuel and gas oil.....	846,959,940	584,849,605	1,200,750,319	1,123,473,047
Residuum.....	*	32,999,699	244,474	1,051,113
	3,100,509,600	2,492,754,027	2,714,619,746	2,651,118,349

*Included with fuel and gas oil.

Sugar Imports in 1920

From the reports of the Department of Commerce Lamborn & Co. has compiled a tabular study of the sugar supply during 1919 and 1920. The following summary of the report as published recently in the *Journal of Commerce* shows how the high prices prevailing during 1920 increased the amount of sugar imported from unusual sources.

	Sugar Imports, Tons	
	1920	1919
Normal sources:		
Cuba	2,572,389	2,984,885
Porto Rico.....	368,798	325,175
Hawaii	490,906	506,692
Philippines	134,721	78,514
Total from normal sources.....	3,566,814	3,895,266
Other sources:		
Far East and Africa.....	380,512	0
South America.....	233,480	15,643
West Indies, exclusive of Cuba and Porto Rico.....	107,993	3,567
Europe	53,706	0
Central America.....	43,412	7,633
Canada	29,738	0
Mexico	27,759	0
Egypt	7,438	0
Newfoundland and Labrador.....	54	0
Total from unusual sources	884,092	*70,391

*Includes imports from countries which did not send any sugar to the United States during 1920.

Gas Furnaces for Melting Non-Ferrous Metals

BY M. A. COMBS

FOUNDERS, smelters and refiners realize the prime importance of the melting department. The character of the product, casting or ingot, and its cost are directly dependent on the fuel and furnace used. While this realization is general, it is also frequent that a thorough investigation into the various fuels and furnaces to meet the particular requirement has not been made. The great adaptability of gas in the particular furnaces to be used for the various classes of melting is so striking that an exposition will show this fuel to meet every demand most satisfactorily. Gas is often used as the fuel for pit furnaces formerly fired with solid fuel and for all types of open-flame or non-crucible furnaces. Particular advances have recently been made in melting brass aluminum and other alloys in a crucible furnace specially designed for gas fuel and in the gas-fired spherical type of non-crucible furnace. These two furnaces provide a medium for melting all kinds of non-ferrous metals, the choice depending on the scale of the work and character of the metals melted.

NON-CRUCIBLE FURNACE

Oil burning in an open-flame or non-crucible furnace where the flame comes in direct contact with the metal is attendant with excess air and an oxidizing atmosphere. Even with a frequently tilted furnace it does not take much of a metallurgist to know that an oxidizing atmosphere within such a furnace will not produce the best metal. A spherical furnace of this type is ideal, too, for smelters and large foundries. It is a sole question of burning enough fuel in this furnace with a non-oxidizing atmosphere to get the best product. Gas answers this purpose. Its freedom from sulphur is also an advantage over much of the fuel oil now used.

APPLICATION OF THE FUEL

The gas is fed to the furnace at low pressure mixed with just the right amount of air to burn it and no more. After determining the character of the flame and setting the adjustment at the proper relation of gas to air to give a neutral atmosphere within the furnace, the mixture may be controlled by one valve, proportioning the air as the gas is turned up or down. For best practice the burner nozzle is fired on a tangent to the lining of the furnace, well cemented into the furnace or fired to a hole. The pipe containing the mixture of gas and air should be run without reduction up to the nozzle with a minimum bend and rigidly fastened to the tilting furnace from a swing joint on the trunnion of the furnace.

Spherical type of gas-fired tilting furnace is made in various capacities from 500 to 8,000 lb. It is mounted on trunnions at such a height as to give plenty of room for pouring. It is tilted not only for charging and pouring but also during the heat at frequent intervals. The charging door is closed during the heating, the vent being through the pouring hole. The furnace of 1,000-lb. capacity is used with gas as a fuel in foundries for red brass and yellow brass and in smelting with wonderful results.

In making "G" metal a foundry in one of the large

New England shipyards required forty-two minutes per melt of 1,100 lb. of metal, and burned 310 cu.ft. of 600 B.t.u. gas per 100 lb. of metal.

A well-known die-casting company making yellow brass in a spherical furnace makes seven heats in six hours, melting 5,800 lb. with a gas consumption of 269 cu.ft. per 100 lb. Dross amounted to 3.74 per cent.

These figures show for the average of "G" metal and yellow brass a fuel cost of 35c. per 100 lb. of metal melted with gas at \$1.20 per 1,000 cu.ft.

The character of the metal is such as to meet the highest specifications, it is melted economically and with the best of operating conditions as to speed, cleanliness and comfort to the melters. The simplicity is extreme, and the possibilities of this furnace are wide indeed. Its use will decrease lost motion in foundry practice. It simplifies the production problem at the start and from the melting on speeds up and simplifies casting and ingoting.

Discussion of general foundry practice may not belong to the consideration of gas as the fuel; however, the fuel is the controlling element in the furnace and the melting unit profoundly affects the subsequent foundry operations. The potentialities of the large gas furnace to improve foundry practice, from the melting unit on, are evidently worth thinking about.

GAS VERSUS ELECTRICITY OR OIL

In comparing gas against electricity for melting furnaces the most striking advantage of gas after its economy is the flexibility of the furnace. Any alloy may be melted in a gas furnace without changes, excepting rarely a relining in the non-crucible type—no changes at all are necessary in the crucible type. This is true no matter whether a high lead, high zinc or any other difficult composition of copper or aluminum alloy is melted. There are some alloys which it is no easy matter to charge into an electric furnace, and some copper alloys which probably cannot be so melted.

Oil at present is equal to if not more expensive than gas in fuel cost alone. When the cost of oil was more favorable, the factors which even then gave gas an advantage were cost of storage, cost of preparation, crucible or lining life and metal shrinkage. These facts will be further brought out in comparative figures. However, there are certain advantages of the use of gas that do not appear in using any other fuel. Gas does not need to be stored, an economy of space and overhead, and it is not paid for until used, a further saving on investment. Due allowance should be given for these facts when considering the fuel question.

GAS CRUCIBLE FURNACE

The crucible pit furnace fired with coal or coke has long been the melting unit in non-ferrous foundries large and small. In many cases, particularly in the small foundry, it is still desirable to use a crucible furnace. However, pit furnaces with solid fuels are certainly not the speediest method of melting metal, even if they have done much good work in the past. Their continued existence is not justified merely as survivors of the days when metal founding was a black art. In economy of space alone a battery of gas-fired crucible furnaces takes only one-third the room needed for the solid-fuel furnace, a figure that does not include saving of space needed to store fuel. Two to three heats per furnace is the average of the pit fire as against eight heats per day with gas. For this class of melt-



FIG. 1. A BATTERY OF GAS CRUCIBLE FURNACES
FLUE-CONNECTED

ing one of the most important advantages to credit to gas is that it is not necessary to have the furnace started in the early morning hours in order to pour the first heat when the molders are ready for the metal. The first heat can be taken out of the gas furnace in about an hour, which means that the melters do not have to start work any earlier than the molders. When figuring in the attendant costs of other fuels, such as labor, time and shrinkage, and allowing for storage and preparation, the result shows that while the cost per B.t.u. in the case of gas is naturally higher, the cost per pound of metal melted, or the unit production cost, is lower.

DESIGN OF FURNACE AND APPLICATION OF FUEL

The properly designed crucible furnace for gas fuel is a cylindrical furnace with an interior diameter just large enough to admit the tongs, when removing the crucible. The crucible is set on a block at such height that the top of the crucible is not more than 2 in. below the furnace cover. The crucible block is graded toward a slag hole so that splash metal will not collect in bottom of furnace.

In firing a crucible furnace with gas, the fuel should be fed to the furnace mixed with the proper amount of air for perfect combustion, this mixture being controlled by one valve. A burner nozzle directing a fire tangent to the lining of the furnace at the bottom of the crucible gives the best distribution of heat and prevents localized heating of the pot. This method of firing is most effectually done by firing to a hole, the furnace being so designed that the amount of back pressure prevents sucking in secondary air around the nozzle. The advantage of firing to a hole against imbedding the nozzle in the refractory wall is that it prevents burned nozzles and the necessary care in cementing them in.

The ordinary type of furnace has a flat refractory cover with a central hole for charging metal into the pot and as a vent for the products of combustion. The fumes from the metal escape through this hole and it is necessary to have a hood to take the fumes out of the room. In melting red brass this is not so necessary, as the fumes are not as objectionable and harmful as those of yellow brass, or a copper:lead alloy.

From the last two alloys a gas furnace may be

COMPARATIVE FIGURES FOR CRUCIBLE MELTING

Fuel cost:		
75 lb. of coal per 100 lb. of metal at \$16 per ton.....		\$0.60
2½ gal. of oil per 100 lb. of metal at 16c. per gal.....		.40
500 cu.ft. of gas per 100 lb. of metal at \$1.20 per thousand.....		.60
Crucible costs. No. 80 crucible at \$8:		
Coal 15 heats.....		.266
Oil 20 heats.....		.21
Gas, 25 heats.....		.16
Shrinkage:		
Coal, 3½ per cent at 30c. per lb.....		1.05
Oil, 3 per cent at 30c. per lb.....		.90
Gas, 2½ per cent at 30c. per lb.....		.75
Labor:		
Coal, 2 hours at 70c. per hour.....		1.40
Oil, 1 hour at 70c. per hour.....		.70
Gas, 1 hour at 70c. per hour.....		.70

Summary of total costs per 100 lbs. of metal melted:

	Coal	Oil	Gas
Fuel.....	\$0.60	\$0.40	\$0.60
Crucible.....	.266	.21	.16
Shrink.....	1.05	.90	.75
Labor.....	1.40	.70	.70
	\$3.316	\$2.21	\$2.21

specially designed with a hood incorporated in the cover. This furnace cover is flue-connected, the fumes passing directly into the pit flue and out by an overhead flue. This type of cover also acts as a preheater in that the charge for the crucible may be placed in it and the products of combustion passing through it to the flue preheat the charge, effecting greater economy in fuel. A battery of six of these furnaces is shown in Fig. 1. They each hold a No. 80 crucible which has a capacity of 300 lb. of 50 per cent copper and 50 per cent lead.

OPERATING FIGURES—GAS CRUCIBLE FURNACE

Two furnaces, similar to the ones shown in the illustration, melting 50-50 copper and lead alloy in a foundry in the metropolitan district, show a fuel consumption of 400 cu.ft. of gas per 100 lb. of metal. This foundry also melts aluminum in the same furnaces.

A foundry in New England using four of these furnaces with No. 80 crucibles runs five heats of brass and eight heats of aluminum per furnace per day with a gas consumption of 6,700 cu.ft. per furnace per day. Thus 1,000 lb. of brass, or 1,000 lb. of aluminum, may be melted at a fuel cost of \$8.71 with gas at \$1.30 per 1,000 cu.ft. In this foundry one crucible has been used over fifty heats, a particularly long life for a crucible, even in a gas furnace. The shrinkage on the brass is only 2 per cent, a figure which is, however, not exceptional in gas crucible furnaces.

The accompanying table shows a day's run in a foundry in New York City melting 85-5-5 brass.

DAY'S RUN, NO. 40 CRUCIBLE FURNACE

No. Heat	Time Started	Time Finished	Time per Heat, Minutes	Lb. Metal Melted	Cu.Ft. Gas per Heat
1	8:40	9:30	50	105	500
2	9:40	10:21	41	105	375
3	10:30	11:10	40	105	320
4	11:19	11:49	40	105	280
5	12:00	12:30	30	105	300
6	12:40	1:12	32	105	280
7	1:24	1:56	32	105	250
8	2:05	2:33	28	105	300
Totals			293	840	2,605

Average time per melt $293 \div 8 = 35$ minutes.

Gas consumption, 310 cu.ft. per 100 lb. of metal melted.

Another foundry reports the following figures in brass melting: Metal melted, 848 lb.; gas consumption, 3,026 cu.ft.; metal loss (shrinkage), 2.25 per cent; fuel cost, 350 cu.ft. per 100 lb. gas at \$1 per 1,000 cu.ft., or 35c. per 100 lb.

Since the final cost per unit of production is less with gas than any other fuel, it is the most economical fuel.

Investigations of the Chemical Literature—III

Patent Searches—Facilities for Investigation Offered by the Patent Office—Official Publications Relating to Patents—Obtaining Copies of United States and Foreign Patents—Importance of Providing Better Facilities for Training in the Use of Chemical Literature*

BY FRANK E. BARROWS

Patents

PATENTS, from their very nature, require consideration from various aspects other than as a part of the chemical literature. Thus the patentability of inventions, the filing and prosecution of applications for patents, the construction, validity and scope of issued patents, questions of infringement of unexpired patents, patent litigation, property rights in patents, the rights and obligations of patentees, etc., are matters primarily involving patents as patents rather than as publications, and are matters requiring consideration from the standpoint of the relevant principles of the patent law applicable thereto, as well as from the standpoint of the chemical principles that are involved.

Patent searches or investigations may thus be of a special character. In considering questions of infringement, for example, the primary search extends only through the United States patents granted during the last seventeen years (the term of a United States patent), and requires consideration of the invention claimed rather than, or in addition to, the invention described, but inasmuch as the claims of a patent may require to be construed by the accompanying description and in the light of the Patent Office proceedings leading up to the grant of the patent, as well as in view of the prior state of the art disclosed by prior patents and publications, and in accordance with relevant principles of the patent law, a more extended search to include expired United States patents and other patents and publications may be important or even essential.

Investigations of the patentability of inventions, such as are made to determine the advisability of making application for patent, or by the Patent Office examiners in determining the patentability of inventions set forth in patent applications, as well as investigations of the scope and validity of issued patents, may likewise require an extended search of the prior patents and publications, to determine whether the invention is new and whether it is a patentable invention or discovery, within the meaning of the patent law.

Patent investigations thus include both investigations of patents as patents, and investigations or searches of patents as publications and as a part of the chemical literature.

THE PATENT LITERATURE

Considered as a part of the chemical literature, the patent literature furnishes one of the most important fields of search, inasmuch as it records the inventions and improvements, and hence the progress, made in almost all fields of chemical industry. Not infrequently inventors have patented their inventions without having published any descriptions of them elsewhere and with-

out any abstracts or digests of their inventions appearing in the periodical literature. The patent literature therefore contains much that is not available elsewhere.

UNITED STATES PATENTS

More than 1,300,000 United States patents have been granted, of which a very considerable number relate to chemistry and allied subjects. A proper classification of these patents is therefore indispensable for search purposes. The classified patents, however, are available only at the Patent Office at Washington, and for this reason comprehensive searches through the various classes of United States patents can be satisfactorily made only in Washington.

The classification of United States patents, so far as it is official, is set forth in the "Manual of Classification"; in the "Definitions of Revised Classes and Subclasses," and in the "Classification Bulletins" which are issued semi-annually by the Patent Office.

The "Manual of Classification" gives instructions for searching the classified United States patents, together with a list of classes and subclasses and an index of class and subclass titles. It is in constant use by those making searches at the Patent Office. Copies of this manual may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C. The price is 50c.

The work of classifying U. S. patents, of which there are about three hundred separate classes and thousands of subclasses, has been largely conducted by the classification division of the Patent Office. A history of this division and of its work and methods of classification is given in the "Report of the Investigation of the United States Patent Office," made by the President's Commission on Economy and Efficiency (published in 1912 as H.R. Document 1110, Sixty-third Congress, Third Session). A short description of the Scientific Library of the Patent Office and of the search room, as well as of the card index of Chemical Literature, is also given in this report (Appendix K).

The difficulties in making a satisfactory classification of patents for search purposes is complicated by the different kinds of patent searches required—whether novelty, validity or infringement—and this difficulty is well recognized by the Patent Office. There has been at times an unfortunate tendency in the classification of chemical and related patents to disregard the prevailing classification of the other chemical literature, and to use unusual terms and make unusual lines of distinction, which the average chemist does not readily recognize and which may even give trouble to the experienced patent searcher.

OFFICIAL CLASSES AVAILABLE AT PATENT OFFICE

As is to be expected, the chemical patents are classified in more or less definite and distinct classes, and

*For Parts I and II see CHEM & MET, ENG., vol. 24, Nos. 10 and 11, pp. 423 and 477, March 9 and 16, 1921.

are segregated, for purposes of examination, in a few examining divisions. The official classes of patents are accessible in the public search room of the Patent Office. Duplicate sets of classified patents are provided in the examining divisions. Many of the chemical classes of patents have never been officially reclassified, and the present official classification is often unsatisfactory for search purposes. Some of these classes have, however, been in part unofficially reclassified by the examiners who have examined them, so that a more satisfactory classification will be found in the examining divisions. It is thus quite common for different examiners to have special subclasses or digests of patents, both United States and foreign, as well as of other publications, along the lines which they have occasion to search. Some of these unofficial classes and digests are of very great value, but unfortunately they are not accessible except in the examining divisions, and with the permission of the examiners.

OTHER FACILITIES OFFERED BY PATENT OFFICE

In making searches at the Patent Office at Washington, not only does the searcher have available the classified United States patents, but he has access to the files of such patents containing the various Patent Office proceedings leading up to their grant, including the original application papers and amendments thereto, and the official communications of the examiners who examined the application, in which are referred to the prior patents and publications which the examiners found upon their search and considered relevant to the invention sought to be patented. By examining the files of United States patents which are of nearest subject matter to the investigation in question, it may be possible to obtain reference to prior patents or publications which are of particular interest and which would not be readily available otherwise.

A further value of the patented files is the indication therein of the classification of the respective patents and the indication in the various official actions of the classification of the prior patents which are referred to therein. Attention may thus be directed not only to prior patents of relevant subject matter, but even to other classes of the Patent Office which might otherwise have been overlooked but which may contain patents of interest. The number of classes and subclasses of patents is so great and the classification of patents is in many instances so complex that relevant classes or subclasses may well be overlooked unless special precautions are taken to insure their proper consideration.

Likewise available at the Patent Office are the records of interference proceedings in which issued patents have been involved—records which in some cases contain lists of prior patents and publications relating to the same subject matter as the patent, in others testimony of interest in connection with the patented invention.

COURT RECORDS OF PATENT CASES

Valuable information may likewise be obtained from many of the court records of patent cases and even from the court decisions in such cases, inasmuch as a consideration of the question of patentability, in view of prior patents and publications, is almost always raised in such cases. Extended searches are usually made in connection with such litigation and the pertinent results thereof made a part of the record of the case. The testimony forming a part of court records may likewise contain valuable information.

Attempts to make comprehensive investigations of United States patents elsewhere than at the Patent Office are generally unsatisfactory. However, abstracts of United States patents, as well as foreign patents, are published in *Chemical Abstracts*, classified in the same way as the other literature and similarly indexed, and a search through this field is a useful check upon any search made at the Patent Office itself. Nevertheless, experience has shown that a search through *Chemical Abstracts*, even during recent years, cannot be relied upon to disclose all patents of interest along any particular line, and, of course, the *Abstracts* go back only to 1907.

PARTIAL LISTS OF CHEMICAL PATENTS

There has been no comprehensive list published of United States patents relating to chemistry.

A valuable digest of the older United States patents relating to chemical industry has been published in Census Bulletin 210 (pub. 1902), but this list includes only patents granted prior to 1902, and hence only expired patents. Although the bulletin is now out of print, this list was also published as an appendix to Census Reports, Vol. X, Twelfth Census of the United States, Manufactures, Part IV, Special Reports on Selected Industries.

One of the few partial lists of United States patents that have been published appears in a German publication—viz., in vol. 3 of Winther's "Patente der organischen Chemie" (pub. 1910). This list includes patents relating to organic chemistry granted between 1895 and 1908, with the number, date, patentee and title of the patent, and the number of the corresponding German patent, if any.

Another of the partial lists of United States patents published is that of patents granted to Germans and Austrians, compiled by the Federal Trade Commission as *prima facie* enemy-owned patents. This list, or the part of it of more particular relation to chemistry, has been published by the *Oil, Paint and Drug Reporter* during the past year, and also appears in the "1918 Year Book" of that periodical.

A similar list of formerly enemy-owned patents, which have been taken over by the Alien Property Custodian and transferred to the Chemical Foundation, is contained in a "Temporary List" issued by the Chemical Foundation. This list includes about four thousand patents now in force, that is, granted during the past seventeen years.

All of these lists are at best but partial and incomplete, and unsatisfactory from the standpoint of making any comprehensive search.

BRITISH PATENTS

British patents have been granted since 1617, and as early as 1622 we find patents relating to chemical subjects—viz., the manufacture of soap and of white and red lead pigments. Prior to the year 1700, patents were also granted relating to various other chemical subjects, including alum, salt, pottery, the parting of silver from lead, saltpeter and various metallurgical processes.

The British patents are more generally accessible for purposes of search than the patents of any other country, for the reason that the British Patent Office has published classified abstracts or abridgments of all the patents which have been granted since the earliest days of the British patent system and up to within the last

digests or abridgments of British patents granted between 1622 and 1866 relating to "acids, alkalis, oxides and salts"; another volume containing digests or abridgments of British patents granted between 1617 and 1866 relating to "oils, fats, lubricants, candles and soaps," and so on.

Between the years 1855 and 1908 the classified British patents of each class have been published in nine successive volumes, each covering a period of a few years, so that, for example, the nine volumes of the class relating to "acids, alkalis, oxides and salts, inorganic," will contain abstracts or abridgments of the British patents of this class granted during this period. A similar series of nine volumes contains abstracts or abridgments relating to organic chemistry, and the same is true of metallurgy and other various classes into which the British patents are officially classified. The classified abridgments since 1908 are being published a few pages at a time.

In addition, fifty-year subject-matter indexes of the classified British patents have been published for each class, covering the period from 1861 to 1910.

GERMAN PATENTS

A complete set of German patents is available at the Patent Office in Washington, and in addition, a classified set of German patents for recent years, classified according to the German classification. A search of German patents can accordingly be much more readily conducted at Washington than elsewhere.

However, many of the German patents are abstracted in the German abstract and review periodicals, and in addition many compilations of German patents, relating to different subjects, have been published. Notable among these is the work by Friedlaender, relating to dyestuffs. This work, which has been issued in twelve parts and which covers the period from 1877 to 1916, gives a very complete and classified review of the German patent literature relating to organic dyestuffs.

A similar work is the three-volume compilation by Winther, "Patente der Organischen Chemie." This work is not so well known as Friedlaender's, but it is in some respects more accessible for search purposes. The first volume contains abstracts or digests of the German patents and applications between 1877 and 1905, relating to organic compounds other than dyestuffs. These are classified according to subject matter—for example, hydrocarbons, alcohols, ketones, alkaloids, photographic developers, etc.

Vol. 2 contains abstracts or digests of German patents relating to organic dyestuffs within the same period, 1877 to 1905, and these patents are classified according to classes—for example, sulphur dyes, indigo dyes, azo dyes, etc.

The third volume, published in 1910, is the index volume, and contains several different indexes, including a numerical list of German patents relating to organic chemistry, with the corresponding United States, English, French, Austrian and Russian patents, if any; also a list of United States patents (organic chemistry) between 1895 and 1908 with the number, date, patentee and title of the invention and the corresponding German patents, if any. Similar lists are given of the British, French, Austrian and Russian patents, with the corresponding German patents, if any. The volume also contains a list of patentees, with the patents of each patentee and of each company classified by subjects. The volume includes finally a subject-matter

index of the various organic compounds, intermediates, etc., with reference to the volume and page of the first two volumes of the work where they will be described.

A useful list of trade names of chemical compositions and products of various kinds is also included in this same volume (Winther, vol. 3), with indication of the chemical composition, manufacturer, and the patent or literature citation where a description of the substance will be found.

OTHER FOREIGN PATENTS

The patents of some of the other foreign countries, including France, Austria, Switzerland, Denmark, Norway and Sweden, are likewise available, in classified and bound form, at the Patent Office library, and for this reason are more readily searched there than elsewhere.

In addition to the foreign patents available at the Patent Office library, duplicate sets of patents of several foreign countries are accessible to the examiners in the examining divisions, classified the same as the United States patents, but may be there examined only with the examiner's permission.

The patents of some foreign countries are not available even at the Patent Office, particularly of those countries which do not publish their patents. Copies of such patents are usually obtainable only in manuscript form from the patent offices of these respective countries. Information regarding such patents may, however, be obtainable through the official Patent Office publications of each country. Thus, Canadian patents are not published, but certain of the patent claims are published in the *Patent Office Record*.

Frequently the same invention will be found patented in several different countries, and will be found abstracted or reviewed in the current literature. Again, the inventor may publish a full account of his work in addition to the particular part which he patents. Accordingly, when a patent is discovered which is of particular interest, it is sometimes profitable to see whether the same inventor has taken out patents in other countries, or has published other descriptions of his work at about the same time, from which still further information is obtainable.

If reference is found to foreign patents which were not published, or which are not available, it may nevertheless be possible to find a corresponding patent granted in another country, if there is any, or find further information about the particular patent or invention from the contemporaneous periodical literature.

OFFICIAL PUBLICATIONS RELATING TO PATENTS

United States. The official publication of the United States Patent Office is the *Official Gazette*, issued weekly. It contains an abstract of all patents granted each week, giving the title of the invention, the name of the inventor, the assignee if any, the date of filing and serial number of the application for patent, the classification of the patent (according to the Patent Office classification), one or more typical claims of the patent, and an illustrative figure of the drawings if the patent is accompanied by drawings. It also includes an index of patentees and of inventions, and a classified list of the patents, classified according to the Patent Office classification. The subscription is \$5 a year from the Superintendent of Documents, Government Printing Office, Washington.

Yearly indexes of United States patents and patentees

(including assignees) are also published under the title "Annual Report of the Commissioner of Patents." These annual indexes, during the last few years, also contain a classified list of the patents according to the Patent Office classification. These annual indexes are also obtainable from the Superintendent of Documents (price \$1).

Canada. The official publication of the Canadian Patent Office is the *Canadian Patent Office Record*. It is similar to the *Official Gazette* of the United States Patent Office. The annual subscription rate is \$4 from the Commissioner of Patents, Ottawa.

Great Britain. The official publication of the British Patent Office is the *Illustrated Official Journal*. It is published weekly and contains illustrated abstracts of all British patents, as well as indexes of applications filed and patents granted. This publication is obtainable from the Patent Office, London (subscription rate £3).

Germany. The official publication of the German Patent Office is the *Patentblatt*, published weekly, with a supplement *Auszüge aus den Patentschriften*, containing illustrated abstracts of German patents.

SUBSCRIPTIONS TO UNITED STATES PATENTS

By making a deposit with the Patent Office, it is possible to subscribe for one or more classes or sub-classes of United States patents and to obtain from week to week copies of the patents that are granted in such classes or sub-classes. In order to obtain patents relating to any particular subject, it is necessary to subscribe to such classes or sub-classes as contain patents relating thereto. It is not possible, for example, to subscribe for "all chemical patents," or all patents relating to the production of a particular chemical substance, but it is necessary to subscribe for specific classes or sub-classes according to the Patent Office classification. Subscriptions of this kind, therefore, may include many patents that are not of interest to the subscriber but which happen to be classified by the Patent Office in the same classes or sub-classes as patents in which he is interested. The minimum deposit required to enter a subscription is \$5. Inasmuch as the cost of patents is 10c. each, it is evident that the cost of the subscription, and the period of time which a given deposit will cover, will vary with the number of patents issued in the particular classes or sub-classes subscribed for. The deposit must, of course, be replenished from time to time to maintain the subscription in force.

OBTAINING COPIES OF UNITED STATES PATENTS

Copies of United States patents can be obtained from the Patent Office at Washington for 10c. each. For convenience in ordering patents and in remitting therefor, the Patent Office sells coupons, specially printed for the purpose, in books of one hundred coupons for \$10 and pads of twenty coupons for \$2. The use of these coupons requires merely the filling in on the coupon of the data of the patent and the address to which the patent is to be sent, and the forwarding of the coupon to the Patent Office. For ordering small numbers of patents from time to time the use of coupons is usually more satisfactory than the making of separate remittances with each order.

It not infrequently happens that United States patents cannot be obtained in printed form from the Patent Office, owing to the temporary exhaustion of the supply. Photographic copies of such patents can, however, be

obtained, either from the Patent Office or from some library that has copies of the patents and facilities for photographic reproduction.

OBTAINING COPIES OF FOREIGN PATENTS

While copies of foreign patents can be obtained by sending to the respective countries for them, this involves a considerable delay. A more expeditious way of obtaining copies of such patents is by ordering photostatic copies from the Patent Office at Washington, or from such libraries as contain them and have facilities for photographic reproduction. The patents of most foreign countries, in so far as such patents have been published, are available at the Patent Office at Washington, and photostatic copies of any such patents can be obtained. The cost of obtaining patents in this way depends upon the number of pages of the specification and the number of sheets of drawings. The charge by the Patent Office is 15c. a page for single pages and 25c. a page for double pages. An estimate of the cost of any particular patent or patents can be obtained from the Patent Office in advance of ordering them. By making a deposit with the Patent Office of \$25, with replenishment of the deposit as it becomes exhausted, such copies of foreign patents can be ordered and charged against the deposit account. Photostatic copies of United States patents (where the printed copies are exhausted) as well as of other publications in the Patent Office library can similarly be ordered and their cost charged against such a deposit.

The patents of some foreign countries are not published, and these patents are usually obtainable only in manuscript form, or in the form of photographic copies, from the Patent Office of the country in which they are granted. Canadian patents (which are not published) can thus be obtained from the Patent Office at Ottawa. Estimates of the cost of such patents will be furnished by the Canadian Patent Office upon request.

Where any large number of foreign patents are desired, and the delay of a few weeks in obtaining them is not of particular importance, they can usually be obtained at less expense by ordering them directly from the country of their origin.

OBTAINING COPIES OF PERIODICALS AND OTHER PUBLICATIONS

The obtaining of copies of articles appearing in periodicals and other publications has been very materially facilitated by the photographic processes of reproduction which have been installed in many of the leading libraries. These facilities are of special importance to investigators of the chemical literature, whose investigations frequently lead them to periodicals and other publications that are available only at certain libraries. They are also a great convenience in enabling the investigator to obtain copies of separate pages, or of articles from different periodicals, etc., in a form convenient for future reference and consideration. The cost of obtaining photographic copies varies somewhat with different libraries, but is usually around 15c. to 25c. a page.

Among the libraries which thus furnish photostatic or photographic reproductions of periodicals and other publications are the Patent Office library at Washington, the John Crerar Library of Chicago, the Carnegie Library of Pittsburgh, and the Engineering Societies, Chemists' Club and Public Libraries of New York City.

IMPORTANCE OF PROVIDING BETTER FACILITIES FOR INVESTIGATING AND USING THE CHEMICAL LITERATURE

The importance of providing better facilities for making use of the chemical literature is well set forth in the following extract from the "Report of the Committee on Publication of Compendia of Chemical Literature, etc.," appearing in the *Journal of Industrial and Engineering Chemistry* for May, 1919, pages 415-417:

The committee recommends cordial and effective co-operation in suitable ways by the American Chemical Society and other American scientific and technological bodies with the efforts of the chemists of Great Britain to organize the work of publication in English of compendia of chemical literature and to encourage the production of chemical literature in English.

In presenting the whole problem of the organization of compendia, monographs, etc., in English by the British as well as by ourselves, the committee would urge that the question be considered from the point of view of national (cultural) importance as well as from that of scientific utility. The almost exclusive use of German compendia and monographs in all countries has given the German scientists an influence in foreign countries (from China to Argentina, Spain and Russia, and all lands between these countries) entirely out of proportion to their real share in scientific productiveness—leading to the migration of foreigners to Germany for their advanced studies, with resultant serious influences, political, commercial and cultural, in these countries. We must recall, too, that in their compendia and monographs, German chemists have been wont to ignore to a certain large extent, or to underrate, the work done in other countries, especially perhaps that done in the United States.

The compilation of compendia of chemical literature requires extensive investigation of the literature by the compilers. The production of monographs of value likewise requires investigation of the literature by the producers. Such investigations necessarily involve the use of library facilities, and must be made by investigators trained and experienced in making such investigations. Accordingly, if the compilation of compendia and the production of chemical literature in English are to become at all general, and if proper use and investigations of the literature are to be made in connection therewith, and by chemists generally in the practice of their profession, it is important for future American chemists to be trained properly in the use of the chemical literature and in the facilities for its investigation.

TRAINING IN THE USE OF CHEMICAL LITERATURE

Adequate training in the use of the chemical literature is not as general as it should be, nor does its importance seem to be generally recognized. The proper use and investigation of the chemical literature necessarily involves the use of library facilities and familiarity therewith, yet until recently we find no text-book or manual dealing with the subject comparable to the many laboratory manuals which deal with the use of laboratory facilities.

A discussion of the extent to which training in the use of chemical literature is given in a number of American technical schools and universities is given in an excellent paper on "Chemical Literature and Its Use," by Miss Marion E. Sparks of the University of Illinois, appearing in *Science* for April 19, 1918, pages 377-381. In this paper Miss Sparks also describes the Journal-Library Course given to students in the chemical and chemical engineering courses at the University of Illinois. This paper is much less complete, however, than the lecture notes used in the course, which outline the entire subject in a comprehensive manner. These lec-

ture notes were published by Miss Sparks in pamphlet form in 1919. The first edition is already exhausted but a second edition will probably be published during the present year.

There is likewise need of a more general appreciation, among American chemists and among American colleges, technical schools and universities, of the importance of proper use of the chemical literature, and of more general training in its use. "Library" courses, as well as "laboratory" courses, should be included in every college and university course in chemistry and chemical engineering.

Legal Notes

BY WELLINGTON GUSTIN

Process for Making Arsenate of Lead Is Held Valid —Growth of the Industry

In a suit on the Luther and Volck patent, No. 892,603, for a process for making arsenate of lead, the Circuit Court of Appeals of the United States has affirmed the lower courts' decision holding the patent not void for lack of invention. The California Spray Chemical Co. charged infringement of the process by the Toledo Rex Spray Co.

The process is carried out by combining lead oxide (litharge) suspended in water and arsenic acid in solution; the reaction being assisted by the cyclic action of the catalyzing agent—either acetic acid or nitric acid. The specification gives the formula or combining weights of lead oxide and arsenic acid, respectively, as varying from 1.938 to 2.9 parts of the lead oxide to one part of arsenic acid, according as ortho-arsenate or pyro-arsenate is desired. As shown by the specification, the weaker acid solution produces the ortho-arsenate, "with traces of pyro-arsenate of lead, lead salts of the catalyzer, and the catalyzer." The stronger acid solution (practically two parts of lead oxide and one part of arsenic acid) produces pyro-arsenate, "with traces of ortho-arsenate of lead, lead salts of the catalyzer, and the catalyzer." A varying of these proportions produces a corresponding variation in the acidity of the product. The preferable proportion of the catalyzing agent is given as "1 to 3 lb. of the catalyzer to 100 lb. of the lead oxide."

DEFENSE OF LACK OF INVENTION AND INSUFFICIENT DISCLOSURE

The defenses were that the patent was invalid and there was no infringement. It was contended that in view of the prior art there was lack of invention, especially if the patent was construed broadly enough to include defendant's process, and that the patent did not sufficiently disclose its process.

Regarding invention it was said that standard chemical authorities had taught that arsenate of lead could be obtained by the action of arsenic acid or nitrate of lead, by direct precipitation. Previous to the patent in suit the commercial method of making arsenate of lead was by combining either acetate of lead or nitrate of lead with arsenate of soda; the products of the respective reactions consisting of arsenate of lead, together with acetate or nitrate of soda, according as acetate or nitrate of lead was used. In neither the

general teaching nor the double decomposition process was there any catalytic or cyclic action involved.

However, back in 1866, Bell and Fell had been granted a patent, No. 59,901, for an improvement in the manufacture of white lead, by which sulphate of lead was produced by the direct action of nitric acid upon lead oxide (forming nitrate of lead), to which product was added sulphuric acid and water, resulting in a lead sulphate. In this process the nitric acid acted as a catalyst or agent in liberating, from time to time, portions of the oxide of lead and converting the same into lead nitrate, which, by the action of the sulphuric acid, are immediately converted into lead sulphate, the constant repetition of this process until the whole mass of lead oxide is converted into lead sulphate constituting the so-called cyclic action. The patent also states that acetic acid may be used in place of nitric acid.

QUESTION OF INVENTION CONSIDERED

Therefore, the court said the presence or absence of invention in the patent in suit depended on whether at the time of Luther and Volck's application in 1907 it was within the expected skill of the chemist, knowing first that lead nitrate would react with arsenic acid to produce lead arsenate, and second that the Bell and Fell process converted lead oxide into sulphate of lead by the use of nitric acid as a catalyzer, to know further that arsenate of lead could be produced instead of sulphate by substituting arsenic acid for Bell and Fell's sulphuric acid. On these facts it would seem the presence of invention in the Luther and Volck patent was doubtful, says the court.

Arsenate of lead in combination with other substances has long been used in the paint and dye arts, but uncombined its sole use seems to have been as an insecticide. The insecticide art, however, involves not only chemistry but entomology, the live problem being to obtain a product such as will cover the foliage and fruit, and so result in killing the insect without killing or injuring either fruit or foliage. Climatic conditions and the degree of sensitiveness of both fruit and foliage are necessarily involved. The invention of the patent in suit came from a campaign for the extermination of the codling moth in California, conducted by the University of California.

A factory was established at Watsonville, Cal., for the manufacture upon a large scale of arsenate of lead in accordance with the formula of the patent. The process is shown to have substantial advantages over the process of the prior art, its new and especially distinguishing feature being the ability to control more positively and more readily the character of the arsenate (whether ortho or pyro), including the percentage of acidity. Evidence showed the process more readily and effectively produces superiority of product as respects smoothness, distribution and adhesiveness. The double decomposition process has been largely superseded by the process of the patent.

Beginning in March, 1916, licenses under the patent were issued to the two largest chemical corporations, perhaps the largest drug manufacturer, the largest dry color manufacturer, one of the largest paint manufacturers and one of the largest insecticide manufacturers in the United States—all except one operating upon substantial royalties, the remaining company paying an outright consideration of \$30,000, besides royalties.

It was said that while it may seem that it would naturally have occurred to one acquainted with the

Bell and Fell disclosure to try the substitution of arsenic acid for sulphuric acid in making arsenate of lead, the fact remains that in the forty years which elapsed no one tried that experiment. In the light of that fact and the further fact that mere analogy is not, in chemistry, usually so certain an index as in mechanics, the court could not say that it was within the expected skill of the chemist to know that Bell and Fell's process of making sulphate of lead was equally available for producing arsenate of lead by the mere substitution of arsenic acid for sulphuric acid. Further, the court said that the favorable public reception and commercial success of the process in suit removed whatever doubt might otherwise exist as to invention.

DISCLOSURE SUFFICIENT, DECLARES THE COURT

On the question of lack of sufficient disclosure in the patent to enable one skilled in the art to practice it, the court held that it was sufficient to enable one skilled in chemistry to practice the process; though conditions of temperature, quality of the ingredients used and perhaps other elements require care and to some extent experimentation to produce the best results (*Minerals Separation, Ltd., vs. Hyde*, 37 Sup. Ct., 82).

As the patent was construed it was found that defendant's process infringed it. It employed 2.2 parts of lead oxide to one part of arsenic acid, being thus between the minimum and maximum of the patent, and it employed 2.81 per cent of nitric acid as a catalyzer, which is between the minimum of 1 and the maximum of 3 per cent specified in the patent. The court said it was not important that defendant makes only a pyro-arsenate, or that plaintiff uses the word "ortho" as a trade mark, making its ortho-arsenate product more prominent than its pyro-arsenate. Use of the formula of the patent was enough to charge defendant.

Where Customs and Usages Were Part of Contract —Deliveries Explained by Showing Custom

Customs and usages implied in a contract came up in a Georgia case in which the Producers' Co. sued the Empire Cotton Oil Co. alleging breach of two written contracts for the sale of peanut products. Under terms of one of the contracts the products were to be delivered in March, 1918; under the other, delivery was to be made in April, 1918. The plaintiff alleged that both contracts were breached by the Empire company in failing to deliver on demand in July, 1918, and sued for damages accordingly.

It was alleged that there was a custom of usage of the trade among dealers in peanut products to the effect that when, under a contract of sale, such products were to be shipped during a named month in the year, and delivery was not demanded by the purchaser during that month, and there was likewise no tender of delivery by the seller, the time of delivery was automatically extended from month to month until either the purchaser made demand upon the seller for delivery or the seller tendered delivery to the purchaser.

The Court of Appeals reversed judgment in favor of the plaintiff. It said while the terms of a written contract cannot be varied by a contemporaneous oral agreement, yet it is permissible to show the existence of a custom of the trade or business, not at variance with such terms, concerning which the contract was made, which is of such universal practice as to justify the conclusion that the custom became a part of the contract.

Effects of Metallic Structure Upon Properties

The Disposition, Amount and Nature of the Various Constituents of a Metallic Alloy Have a Great Effect Upon the Mechanical Properties of the Substance and Its Resistance to Corrosion, Especially in Strong Electrolytes

By HENRY S. RAWDON
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THE ultimate aim of any metallographic examination is to show in what manner and to what extent the characteristics of the material, particularly the mechanical properties, are dependent upon the particular features characterizing the structure of the metal under observation. To discuss this phase of the subject, even in a manner only approximately complete, is manifestly impossible in small limits. Only a few of the most obvious effects of structure upon the properties will be mentioned.

MECHANICAL PROPERTIES AS AFFECTED BY STRUCTURE

It must be borne in mind in a discussion of this subject that the mechanical properties of any material, as expressed numerically, are more or less dependent upon the method of determination used—for example, size and shape of test specimen, rate at which the stress is applied, etc. The structural features of the material are closely related to the mechanical properties, this relationship of course being much more apparent in the case of the grosser or macroscopic features than for the very minute characteristics, as will be evident in the following examples which are discussed. The previous treatment, mechanical as well as thermal, also affects the mechanical properties, although in this case it may be contended that the structural effects caused by the previous treatments are largely, if not entirely, responsible for the changes noted.

HARD AND SOFT CONSTITUENTS

Many of the alloys most useful from the industrial standpoint consist of two or more constituents which vary quite widely in their characteristics. One of the constituents is often relatively very soft and ductile, while a second is hard and brittle. Such a condition occurs in steels, in aluminum casting alloys, and in

bronzes, particularly those for bearing purposes. The softer constituent gives the required ductility, while stiffness and strength are contributed by the harder one which is disseminated throughout the soft matrix. The relative proportions of the two determine the properties of alloys of the same general series which differ among themselves in their percentage composition.

Fig. 1 shows a specimen of cast zinc-bronze (approximately 88 per cent copper, 10 tin and 2 zinc) which was stressed in tension until fracture occurred. The soft ductile copper-rich matrix easily adapts itself to the applied loading, the hard brittle tin-rich constituent is shattered and broken, as shown, when stressed sufficiently. Similar cases may be noted in other alloys such as an aluminum casting alloy containing Cu 1.8 per cent, Mg 1.7 per cent and Mn 1.2 per cent. The hard constituent separating from such an alloy, consisting of a compound of aluminum and copper (CuAl_2), is sufficient in amount to form a continuous network throughout the alloy. The course or path of the fracture of a test specimen is determined by this network; thus the results of a tension test of such a material depend primarily upon the amount and the properties of this constituent.

SOFT DUCTILE CONSTITUENTS

Copper and lead do not alloy with each other in the sense that most metals do; neither solid solutions nor definite compounds of the two are formed. An "alloy" of these metals consists only of a mechanical mixture of the two metals, the intimacy of the mix depending largely upon the care used in preparation and the skill of the operator. The "alloy" may be considered, for convenience, as a copper sponge, the interstices of which are filled with globules of lead.

Although both copper and lead, when reasonably pure, are highly ductile, the mixture of the two behaves in a rather anomalous manner when tested. The behavior of the material when stressed in tension is somewhat as might be expected. It is somewhat ductile, but is decidedly inferior to metallic copper in its properties. Thus a tension test of an alloy consisting essentially of 40 per cent lead and 60 per cent copper gave the following results: Ultimate strength in tension, 10,650 lb. per sq.in.; elongation in 2 in., 8.5 per cent, and reduction of area, 7.5 per cent. The continuity of the copper matrix is so broken up and weakened by the inclosed globules of lead—which of course are of very low tensile strength—that the resulting tensile properties are correspondingly lowered. The properties measured are essentially those of the copper sponge and the properties of any particular specimen are inferior to those of a specimen containing the same amount of copper in the form of a solid, but smaller, rod.



FIG. 1. CAST ZINC-BRONZE PULLED AT RIGHT ANGLES TO CRACKS IN BRITTLE CONSTITUENT. $\times 250$
Etched with concentrated NH_4OH

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FIG. 2. Cu 60, Pb 40
BROKEN IN COM-
PRESSION. × 1

The appearance of the fractured specimen of the "alloy" when tested in compression is shown in Fig. 2. Although each of the two constituents is decidedly ductile under compression, the mixture of the two behaves in a manner characteristic of a brittle material. Instead of flattening to any appreciable extent the specimen shears in a manner such as is expected, for example, in cast iron. The inclosed globules of the lead undoubtedly contribute largely to the failure of the specimen in the manner shown by their action as a "lubricant." The ultimate strength in compression of lead is very much lower than that of copper; thus the lead yields under the applied loading and "flows" long before the copper is stressed to a degree which would cause appreciable deformation.

ORIENTATION OF TEST SPECIMEN

It is known that the mechanical working which is necessary for forming a metal after casting affects the structure to a very marked extent. The worked material has a more or less "fibrous" structure depending largely upon variations in composition across a section of the ingot used and particularly upon the various inclusions within the metal. After the working of the metal these are arranged in rather definite lines the course of which is determined by the shaping of the particular piece. It is evident that the mechanical properties, when measured across a laminated or fibrous material, will be quite different from those of the same material the test specimen of which was cut parallel to the course of the fibers. In the latter case—which covers by far the greater majority of the test specimens used in industrial testing—the mechanical properties are not seriously affected. It is only when it is specified, as is done for example in gun forgings, that the test specimen shall be cut transversely to the direction of working that the effect is marked. Fig. 3 shows the appearance of a specimen of gun steel (carbon 0.48, manganese 0.76, nickel 2.85, sulphur 0.02, phosphorus 0.02), broken in tension, the following results being obtained: Yield point (by divider method), 79,000 lb. per sq.in.; ultimate strength, 83,000 lb. per sq.in.; reduction of area, 3.5 per cent; elongation in 2 in., 3.5 per cent. The

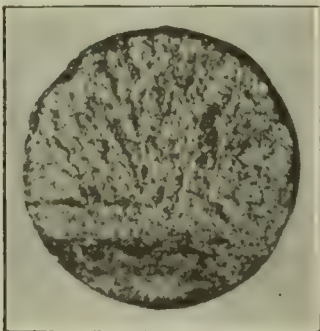


FIG. 3. FRACTURE OF
GUN FORGING. × 2

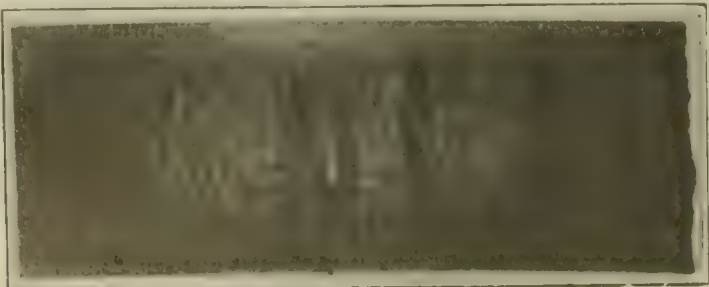


FIG. 4. LONGITUDINAL MEDIAL SECTION OF
TEST PIECE, FIG. 3
Etched with copper ammonium chloride. × 2.

very marked banded structure of the material which macroscopic examination (Fig. 4) showed was caused by threads of inclusions is unquestionably the reason for the very low ductility shown by the material. From the microstructure of this material (Fig. 5) one has reason to expect that considerable ductility would be shown. In Table I are summarized the results obtained by testing duplicate transverse and longitudinal specimens

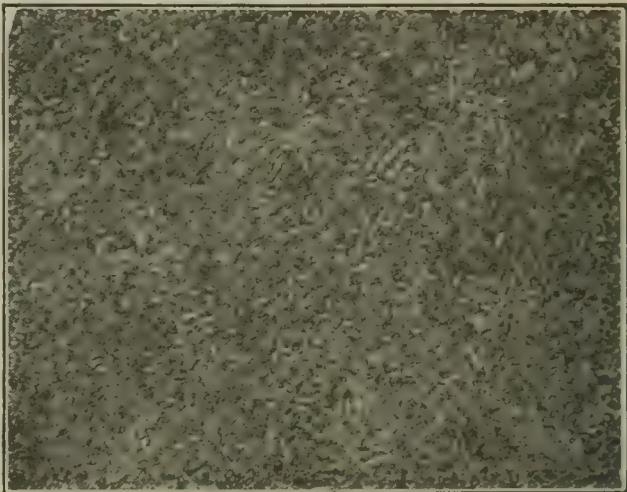


FIG. 5. MICROSTRUCTURE OF FIG. 3.
Etched with 2 per cent alcoholic HNO₃. × 500

TABLE I. TENSILE PROPERTIES OF FLAKY STEEL AS REVEALED
BY TRANSVERSE AND BY LONGITUDINAL TEST SPECIMENS

Specimen No.	P-Limit, Lb. per Sq. In.	Yield Point, Lb. per Sq. In.	Ultimate Strength, Lb. per Sq. In.	Reduction of Area, Per Cent	Elongation in 2 In., Per Cent	Modulus of Elasticity, Lb. per Sq. In.
T	53,500	56,100	59,200	1.5	1.5	29,000,000
Tl	65,000	67,000	92,950	5.0	3.5	29,000,000
L	62,500	65,000	106,500	52.0	26.5	29,500,000
Ll	62,500	65,000	106,850	50.5	26.0	29,500,000

of the same material in tension. The metal chosen was a type of defective steel encountered particularly in gun forgings, which has been designated as "flaky steel" of a composition very similar to that given above. Agreement among metallurgists as to the origin of these defects, "flakes," has not yet been reached. Defective material of the type used when tested in the ordinary manner shows apparently very superior properties, particularly in ductility. However, when a specimen cut transversely from the material is tested,

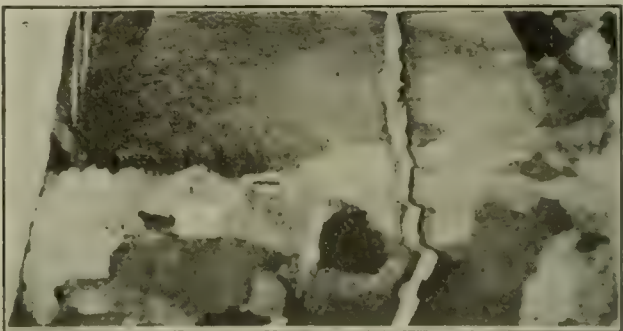


FIG. 6. MICROSTRUCTURE OF CAST ZINC-BRONZE AT FRACTURE. × 3
Etched with alcoholic ferric chloride.

it behaves very differently and breaks with practically no ductility. The elastic properties are not seriously affected, however, even when the internal defects are sufficient to reduce the ultimate strength of the material to approximately only 50 per cent of the normal value. When such material is subjected to some of the dynamic methods of testing, impact, fatigue, etc., the difference in the results obtained for the transverse specimen is usually even more marked than the results given above for the tension test.

It has been suggested that the grain size of a metal has a pronounced effect upon many of the properties of a material. Coarsely grained metals are quite universally regarded with disfavor, although there appears to be no evidence at hand to demonstrate the unsuitability of such material for many purposes. The brittleness, usually attributed to large grain size, is not very well revealed by a tension test, at least as ordinarily carried out. Fig. 6 shows a section of a coarsely grained tension specimen of cast bronze, (88:10:2) broken in tension. Fracture is intracrystalline. The structure indicates that the mechanical properties were determined to a very large degree by the fact that the entire cross-sectional area at the point at which the fracture occurred comprised only a few large grains. There was nothing, however, to indicate this until the specimen was sectioned and its structure examined.

A shock or impact test reveals the effect of coarse grain in a much more striking manner. Fig. 7 shows the appearance of a specimen of low-carbon steel, after testing in a Fremont impact testing machine which showed exceptionally superior qualities. The microstructure of Fig. 8 suggests that the superior shock-

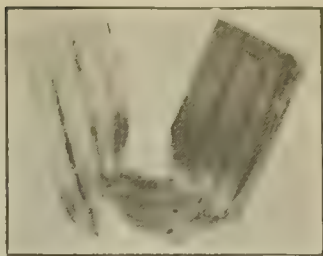


FIG. 7. FREMONT IMPACT ON TOUGH LOW-CARBON STEEL. $\times 1.5$

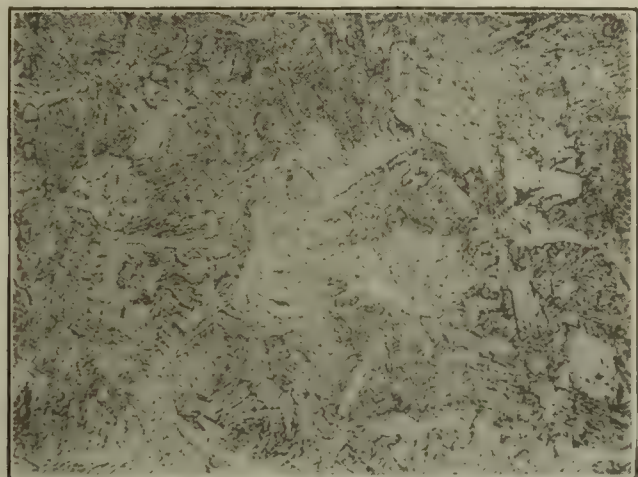


FIG. 8. MICROSTRUCTURE OF FIG. 7. $\times 100$
Etched with 2% HNO_3 in alcohol

resisting properties were undoubtedly produced by quenching the steel from a high temperature, probably above that of the A_3 transformation. Another piece of the same steel, which had evidently been overheated in annealing and which showed a coarsely polyhedral structure, broke off easily and squarely. The entire lack of ductility of the coarsely grained specimen as compared with the superior shock-resisting qualities of the same steel when properly treated affords striking evidence of the influence of grain size upon mechanical properties.

PHYSICAL STATE OF MICROSCOPIC CONSTITUENTS

The relative size, arrangement and method of distribution of the various constituents which make up the structure of an alloy bear a close relationship to the various properties of the alloy. This is best noted in a binary alloy—for example eutectoid carbon steel—different specimens of which have been subjected to various thermal treatments with the express purpose of producing the variations in the microstructural features suggested above. Precautions of course must be taken that no phase changes in the alloy occur and that it is

in stable equilibrium throughout, the differences produced in the structure being physical ones only.

Considerable investigational work has been done to show how the mechanical properties of carbon steels, particularly those of eutectoid composition, vary with the physical state of the pearlite, the steel being in the softened state throughout and the pearlite ranging from the lamellar type through various stages to the completely "divorced" or spheroidized condition. The work of Hanemann¹ and of Howe² illustrates this.

The influence of the physical state of the pearlite in steel upon the properties is well shown by a study of the magnetic characteristics of the same steel after various treatments.³ The various specimens of the steel (carbon 0.85 per cent, manganese 0.28) were cooled from the same temperature (800 deg. C.) at rates so chosen that the structure of the different specimens varied from a fine sorbitic condition to a "divorced" or spheroidized pearlite. Without discussing here the significance of the various properties revealed by the magnetic tests, it may be noted that the properties of the steel are affected to a marked degree by the changes which have been brought about in the physical state of the pearlite. Corresponding differences in the mechanical properties would also be found upon testing, although perhaps of not so great a magnitude as in the magnetic properties, since the magnetic tests are much more sensitive than the ordinary mechanical ones and often reveal changes which are detectable by almost no other means.

CHEMICAL PROPERTIES AS AFFECTED BY STRUCTURE

The chemical property of metals and alloys which is probably most important industrially is that designated by the rather loose term of "solubility." Upon this property depends the etching of metallographic speci-

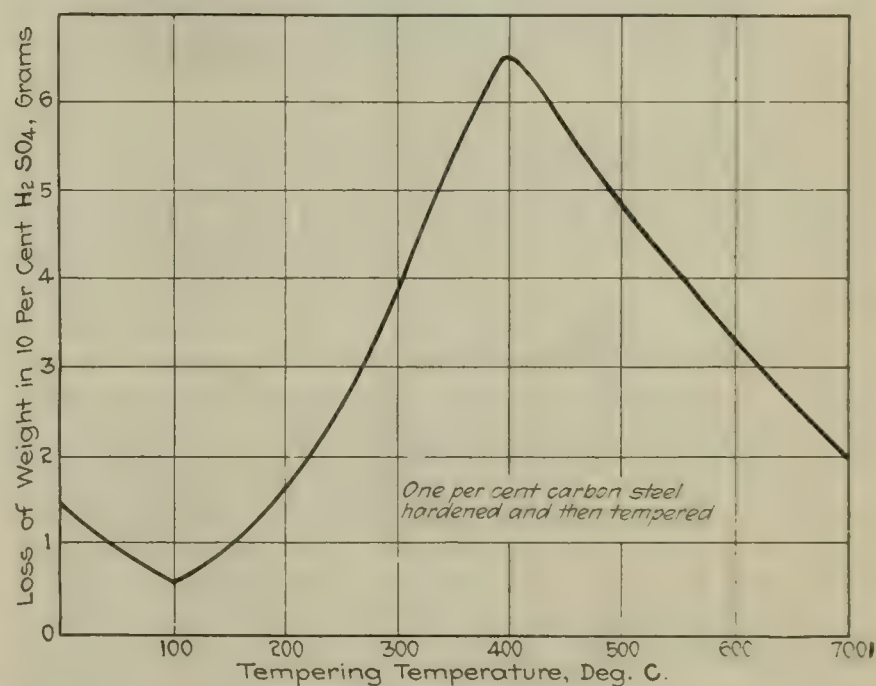


FIG. 9

Variation in the solubility of 1% carbon steel in dilute sulphuric acid, after hardening and tempering to different temperatures. (Hanemann.)

mens, the coloring of metallic surfaces, the corrodibility of materials under service conditions, and often, by the selective corrosion of certain constituents, the complete deterioration of the entire alloy in service. This property of an alloy is often influenced to a marked degree by the structure.

¹H. Hanemann and F. Morawe, "Über den körnigen Perlit und seiner Bedeutung für die Wärme Behandlung des Stahls." *Stahl und Eisen*, vol. 33, part 2, p. 1359 (1913).

²H. M. Howe and A. G. Levy, "Notes on Pearlite," *J. Iron & Steel Inst.* vol. 94, p. 210 (1916).

³C. Nusbaum and W. L. Cheney. Bureau of Standards Sci. Paper 408 (1921).

SOLUBILITY OF TEMPERED STEELS

It is quite well recognized that the solubility of steel varies considerably according to the heat-treatment which it has received. Fig. 9 illustrates this variation of solubility according to treatment,⁴ which may be well shown in the following manner: Harden a rod of high-carbon steel (approximately 1 per cent carbon) by quenching in water from a temperature of 765 deg. C. and then differentially temper it by heating one end to approximately 850 deg. C. while the other is kept cool with water. Thus the rod is tempered at different points along its length at all temperatures between the two extremes. When immersed in dilute sulphuric acid (20 per cent solution) for a day the acid will eat into the rod at different rates, forming a neck close to the reheated end.

Considerable attention has been given to this property of tempered steels by foreign metallurgists, and it has been shown, as is illustrated by Fig. 9, that the rate of solubility can be used as an indication of the tempering a specimen of steel has received. Maximum solubility corresponds to a tempering at 400 deg. C. A special

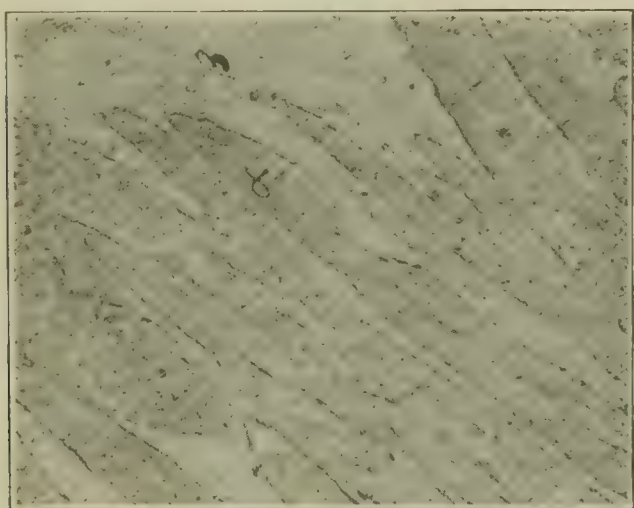


FIG. 10

Microstructure of Muntz metal showing the two constituents α and β . $\times 500$. Etched with ammonium hydroxide and hydrogen peroxide.

name, Osmondite, has been given to steel in this particular condition on account of its characteristic properties.

Thus it is evident that the rate of solution is profoundly affected by the structure of the steel. In the form of the solid solution the material is the least soluble; as the degree of tempering is increased and the carbide held in solid solution is progressively precipitated, the rate progressively increases. The maximum solubility occurs in the troostitic steel after the simple solid solution has been changed by tempering into a state of agglomeration resembling that of an emulsion. The material in this condition is not resolvable under the microscope into its constituent parts. As the tempering is continued, progressively higher temperatures being used, the ultramicroscopic particles increase in size until finally the ordinary microscopic examination reveals them. This increase in the size of particles of the constituents is accompanied by a decreased solubility, although the fully annealed specimen is somewhat more soluble than is the material in its initial or fully hardened state.

CORROSION

This term when strictly used refers to the tendency of metals to revert to the stable form in which they

⁴H. Hanemann, "Einführung in die Metallographie und Wärmebehandlung," p. 87.

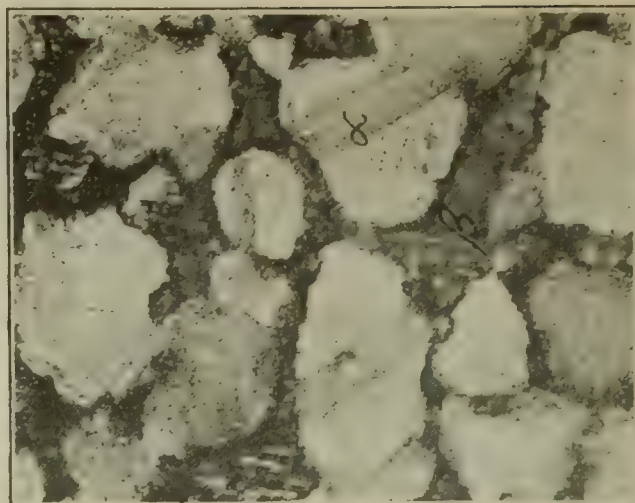


FIG. 11

Microstructure of a corroded sheet of Muntz metal after 7 years exposure in sea water. $\times 500$. Etched with ammonium hydroxide and oxidized in the air.

occur in nature—that is, the oxide. The subject is so broad and the contributing causes so many and so varied that considerable differences of opinion are held as to the mechanism by which the process of corrosion is brought about. Only a brief mention will be made here of how structural features aid in the process.

In general the corrosive attack of a metal is more pronounced in the direction of the "fibers" than across them. This is most marked in case of accelerated corrosion by exposure to sea air, sea water or similar conditions and is found in all types of readily corrodible alloys if in the wrought state. This may be attributed largely to the mechanical effect of inclusion streaks by affording lodgment for moisture so that the attack at such points is accelerated and access to the interior more readily gained along the line of the inclusion. Similar instances have been noted in wrought aluminum alloys in which it appears that the difference in the electrochemical properties of streaks of the metal in various

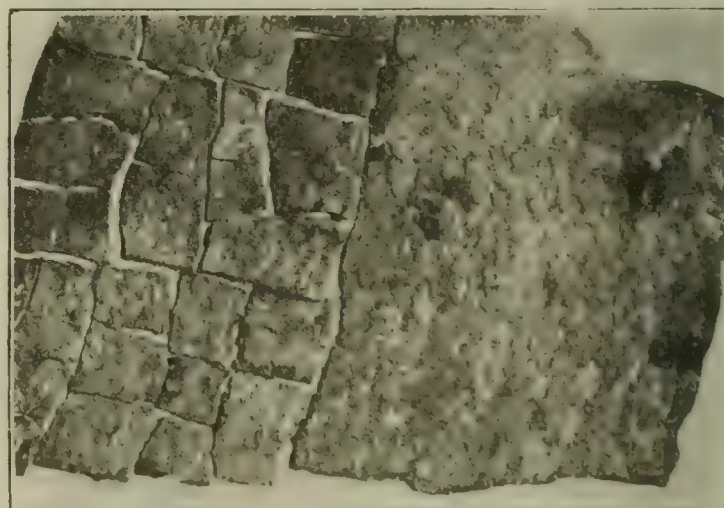


FIG. 12. FRAGILE CONDITION OF SHEET OF FIG. 11

stages of cold-working is responsible in a large degree for the fibrous appearance of the corroded ends of wrought rods.

Brass of the type termed Muntz metal, approximately 60 per cent copper and 40 per cent zinc, exemplifies well the specific effect of a metallographic constituent upon corrosion. Such a brass has a duplex structure, as is shown in Fig. 10, the α constituent being much richer in copper than the β . The zinc-rich constituent is quite readily attacked by sea water, the difference in the electrochemical potential of the two being a contributing factor. The zinc from the β is leached out and a spongy mass of "copper" remains filling the spaces previously

occupied by the β . (Fig. 11.) Thus the alloy is converted into a weak brittle mass consisting of a "sponge" of the more or less attacked α constituent and the pulverulent material resulting the disintegration of the β . Material of this kind in the form of sheets often becomes so brittle that it can be readily broken into small fragments in the fingers. (Fig. 12.)

A soft ductile metal like lead may under some conditions of accelerated corrosion become so brittle that it can be crumbled to powder in the fingers. This is most apt to occur if the lead is somewhat impure. Each grain, however, may retain its initial ductility and other characteristic properties of lead. The corrosive attack of the metal in one case studied^{*} was essentially intercrystalline in character, due in all probability largely to the impurity contained by the metal (1.09 per cent tin), although it was shown that lead of exceptionably high purity (99.99 per cent) is subject to intercrystalline brittleness under certain conditions. In lead cable sheaths the tin and other impurities present exist as constituents of a eutectic surrounding the crystals of lead; thus the corrosive attack will be localized to a large extent and the metal as a whole will show "intercrystalline brittleness."

The Manufacture of Arsenic Trioxide*

BY GEORGE VIE

THE manufacture of arsenic trioxide comprises two distinct stages—namely, production of the crude trioxide and its refining. Each of these stages comprises several different operations.

The production of the crude trioxide necessitates drying of the ore, roasting, purification of the arsenic trioxide vapors obtained in the roasting and their condensation.

The refining of the trioxide necessitates washing, drying, distillation and condensation of the refined product.

TREATMENT OF THE ARSENIC ORES

The arsenical pyrite used in the manufacture of the arsenic trioxide is first crushed by jaw crushers and then ground in a rotary ball mill. The ground product is then washed and freed from foreign matter, and as this product contains about 25 per cent moisture it is necessary to dry it before it is sent to the roasting furnaces. Formerly the drying was done at the top of the roasting furnaces by the waste heat, but this method had the disadvantage of cooling the furnace to an appreciable degree and thus reduced the roasting efficiency. At present the drying is done in mechanical driers (Fig. 1), which consist of an oven *A* into which the wet product coming from the washery in cars *B* is fed and conveyed by a screw conveyor *C* rotating at a given speed so as to keep the product in a loose state and convey the dried material to the outlet *D* leading to a bucket elevator. The oven is heated by a furnace *F*. By the use of this drying arrangement no dust fills the building and the steam is carried away through hoods and chimneys.

ROASTING OF ARSENICAL PYRITES

The arsenical pyrites properly ground and dried are conveyed by a bucket elevator to the charging hopper of the roasting furnaces. The roasting operation is sim-

ilar to that used in roasting copper and iron pyrites. Hand-rabbled furnaces of the Maletra type are now entirely replaced by mechanically rabbled furnaces, thus reducing the manual labor cost and the dangers of poisoning. The furnace used is of the vertical type, made of sheet iron lined internally with refractory material and externally with insulating material. The

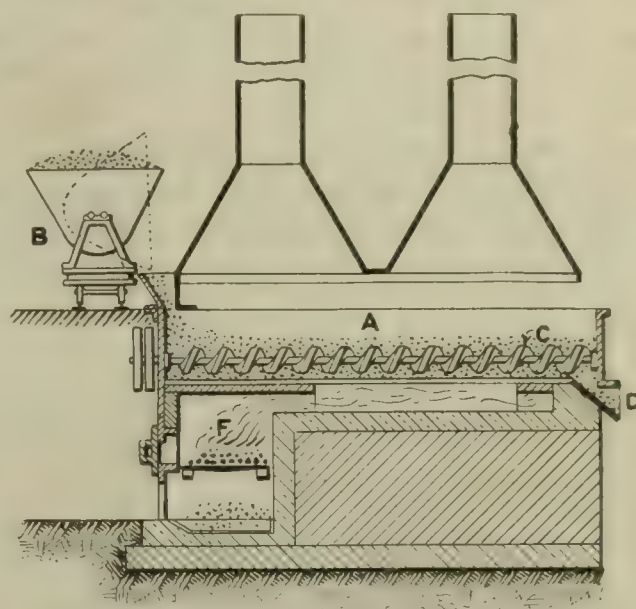
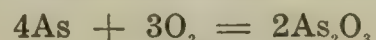


FIG. 1. MECHANICAL DRIER

dimensions of the furnace are from 6 to 10 m. high and from 3 to 5 m. in diameter. A centrally located vertical shaft provided with rabbles rotates at a given speed. The dried pyrite enters the furnace at the top. A series of annular slabs of 10 cm. thickness with plane upper surfaces and curved bottom surface are placed in the interior of the furnace. Each slab is provided with openings for the charging of the pyrite and for the upward circulation of the arsenic trioxide vapors. The lower part of the furnace is fitted to receive the roasted pyrites, which now contain only a negligible proportion of arsenic. The shaft and rabbles are hollow and cooled by a cold air current supplied by a ventilator. This air current provides also the needed oxygen for the oxidation of the ore and facilitates the escape of the arsenic trioxide as soon as formed.

The oxidation takes place according to the equation



Peep holes in the furnace walls located at the levels of the rabbles permit the easy inspection of the operation of the furnace and of the rabbling mechanism.

PURIFICATION OF THE ARSENIC TRIOXIDE VAPORS

During the roasting process the material is continuously being ground by the rotation movement of the rabbles, so that although the rotation is usually only 5 r.p.m., sufficient finely pulverized pyrite is carried along by the vapors to discolor the final product. It is therefore necessary to separate these solid particles before the vapors reach the condensing chambers. This is done by the use of a dust separator placed at the furnace vapor outlet. This separator consists of an insulated chamber containing two fine-mesh rotating cylindrical screens through which the vapors have to pass. A large part of the dust is retained by the first screen and the vapor passing through the second screen is practically free of solid particles. The cylinders rotate at a speed of 2 r.p.m. The screens are kept clean by two cylindrical drums provided with metallic brushes which rotate in a direction opposite to that of

*From *L'Industrie Chimique*, December, 1920, pp. 426-429.

^{*}H. S. Rawdon, "Intercrystalline Brittleness of Lead," Bureau of Standards Sci. Paper 377 (1920).

the screens. The brushing is very efficient and the screens are always clean and offer very little resistance to the passage of the vapors.

CONDENSATION OF THE ARSENIC TRIOXIDE VAPORS

The purified vapors are drawn by a suction fan into a series of sheet lead chambers, Fig. 2. A very slight vacuum is maintained in the roasting furnace. To overcome the resistance offered to the vapors by the purifier and pipe lines the fan has to produce a vacuum of from 60 to 80 mm. of water.

The condensing chambers are separated into equal parts by vertical baffle plates, thus increasing the condensing surfaces. These baffle plates are of sheet lead,

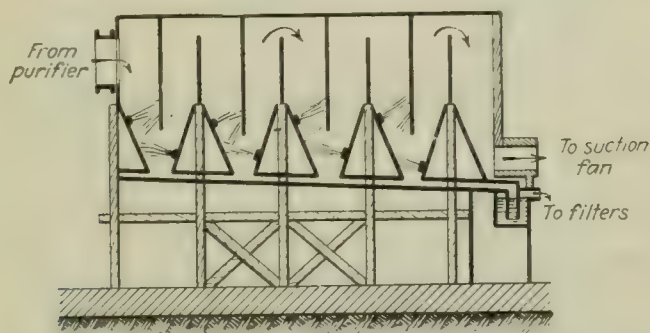


FIG. 2. CONDENSING CHAMBERS

the same as the chamber walls. The use of sheet lead is necessary because SO_2 from the roasting furnace is carried over into the chamber and would soon destroy any other metal lining and baffles.

About a third of the height of the chamber is in the form of a truncated cone. Rapid condensation is facilitated by the use of sprays of cold water. The bottoms of the chambers are connected to a manifold conduit leading the condensed milky product into a vat provided with agitator to mix the product before it is sent to the filtering room.

The chamber nearest to the fan is not provided with water sprays, so that only dry gas passes the fan. The thoroughness of the condensing operation can be judged by the color of the gases leaving the fan. If they are whitish, it indicates that the condensation is not complete and that heavier water spraying is required.

FILTRATION

The condensed milky product is filtered in a specially constructed filter. This filter consists of a shallow tank, 4 m. long, provided with a false bottom spaced 20 cm. above the fixed bottom. The perforated false bottom is covered with filter cloth. The filtration is facilitated by continuous stirring with a revolving helicoidal propeller, the helices of which reach within a few centimeters of the filter cloth. This propeller will serve also to convey the partly dried product to the final drying compartments.

When the tank is filled with the milky condensate pumps of 13 cu.m. per hour capacity evacuate the space between the two bottoms and the greater part of the water is soon filtered out.

There are a series of such tanks, and each tank has its own vacuum pump. When the contents of a tank have been partly freed of the water the cake is somewhat dried by the circulation of a strong current of air. The cracks forming in the drying cake are kept well closed so as to avoid short circuiting of the air current. Experience has proved that by adding dry As_2O_3 to the partly dried mass the degree of dryness

which can be realized by this air-current drying is greatly increased, and it also prevents the helicoidal propeller from getting jammed by the sticky product.

DRYING

The preliminary air-dried product, which still contains from 20 to 25 per cent of moisture, is completely dried in a reverberatory furnace, or better still, in a horizontal rotary drier. This latter consists of a horizontal sheet-iron cylinder having about 10 sq.m. drying surface and rotates at a speed of 10 r.p.m.

The feeding to the drier is made by the helicoidal propeller and the sticking of the material to the sides of the cylinder is prevented by the use of a smooth porcelain lining. The drying temperature is below 180 deg. C., thus avoiding any distillation of arsenic trioxide and its subsequent loss. The resulting steam escapes to the atmosphere through a chimney placed above the outlet from the drier. The dried product is led to bucket elevators and conveyed to the refining department.

REFINING OF THE CRUDE ARSENIC TRIOXIDE

The refining of the crude arsenic trioxide involves the following operations: Distillation, condensation, filtration and drying.

The distillation of the dried crude arsenic trioxide can be carried out in different ways. Some plants still use fireclay retorts similar to those used for the manufacture of coal gas, but the charging of the retorts requires very difficult and long manipulation. The latest improvements for industrial arsenic trioxide distillation consists in the use of a furnace 3 to 4 m. in diameter and about 50 cm. deep made of pig iron. The cover is provided with openings for the inlet of the crude material brought to the hopper by bucket elevators and for the outlet of the vapors. An axial shaft provided with rabbling arms rotating with a speed of 5 r.p.m. serves to stir the material uniformly and avoid the sticking to the bottom. It has been found that 245 deg. C. is the most convenient distillation temperature. This type of furnace offers the advantages of fuel economy besides those of mechanical charging, rabbling and uniform distillation. Industrial average data have shown that about 70 kg. of coal is required per 100 kg. of refined arsenic trioxide.

The final condensation takes place in lead-lined wooden chambers in the form of inverted rectangular pyramids. Each chamber is divided into two compartments so as to increase the condensing area. About 3 kg. of trioxide is condensed per sq.m. of condensing area. The outlet from the condensing chambers leads to a coke-filled tower, in which the last traces of the trioxide are condensed by a continuous spray of water.

A porcelain screw conveyor operating in a trough connected to the bottoms of the condensing chambers removes the refined material to the packing department.

The finished product, As_2O_3 , is finely powdered, perfectly white and quite chemically pure, analyzing 99 per cent As_2O_3 .

Importation of Dyes and Dyestuffs Into Egypt

The amounts and values of dyes and dyestuffs (exclusive of natural and synthetic indigo) imported into Egypt for the first eight months of 1919 and 1920, respectively, were 104,700 and 189,400 lb., valued at \$98,000 and \$146,000. Values are converted into dollars at the normal rate of exchange (20.23 piasters = \$1).

Recovery of Potash Alum and Sulphur at Tonopah

Description of the Process and Plant Operated by the Western Chemicals, Inc., in the Recovery of Potash Alum and an Agricultural Grade of Sulphur by Extraction and Flotation

By LINDSAY DUNCAN
Consulting Engineer, San Francisco

ABOUT thirty-five miles west of Tonopah, Nev., and six miles south of the Tonopah & Goldfield R.R. there is a deposit containing potash alum and free sulphur. The deposit was first described by J. E. Spurr, although it had been previously prospected and located as a sulphur mine. The alum and sulphur occur together in thin stringers running throughout a mass of decomposed rhyolitic tuffs. More than 100,000 tons has already been blocked out, and the estimated probable tonnage is more than 1,000,000. The deposit is owned by the Western Chemicals, Inc., of Tonopah, Nev., and a plant has recently been put in operation for the recovery of the alum and sulphur.

A typical analysis of the run-of-mine ore is given in Table I. With the exception of a very small amount of calcium sulphate, the alum is the only soluble sub-

TABLE I. ANALYSIS OF RUN-OF-MINE ORE

	Per Cent
$K_2Al_2(SO_4)_4 \cdot 24H_2O$	20.0
S (free).....	15.0
SiO_2	58.8
Al_2O_3	2.6
$CaSO_4$	2.1
$CaCO_3$	1.2
Fe_2O_3	0.3
	100.0

stance in the ore. Potash alum is very much more soluble in hot than in cold water, while the solubility of the calcium sulphate does not vary with the temperature. It is therefore possible to recover the alum free from calcium sulphate by merely dissolving the ore in hot water and crystallizing the alum by cooling the solution, leaving the calcium salt in solution.

MATERIAL USED IN THE PLANT DESIGN AND PROCESS OF TREATMENT

In designing the plant considerable difficulty was caused by the fact that the hot saturated alum solutions would attack most of the materials commonly used in construction. Aluminum, copper, iron, tin and nickel in

various compositions were tried and found unsuitable and as finally constructed wood, rubber, chemical and antimonial lead were the only substances allowed to come in contact with the alum solutions after leaving the ball mill, and the mill is lined with silex blocks set in water glass and sand and Danish flint pebbles are used for grinding.

The method of treatment consists in first dry-crushing the ore to $\frac{3}{4}$ in. by a jaw crusher and then grinding to 80 to 100 mesh in a 5 x 14-ft. pebble mill, the grinding being done in warm solution from the first cone.

The pulp from the pebble mill is delivered to the dissolving section of the plant by an air lift. The dissolving section consists of five 10 x 8-ft. propeller-type agitation tanks, five 5 ft. 6 in. Allen cones and five air lifts. The process is essentially that of continuous counter-current leaching in which the pulp is dewatered at each of the five stages. The agitator tanks are made of redwood, the propellers of antimonial lead and the propeller shafts are lead covered. All pipes leading to or from the tanks are of lead. The Allen cones are constructed of redwood and all metal parts are of antimonial lead. The air lifts are formed of redwood pipe; the tail pipe is a machine-banded stovepipe with a solid redwood plug in the bottom; the discharge pipe, which is exposed to the action of the solution on both sides, is solid bored. The air pipe is of lead where submerged.

FLOW SHEET OF THE PLANT OPERATION

Referring to the flow sheet (Fig. 4), the pulp leaving the ball mill flows to No. 1 air lift and is discharged to No. 1 agitator. It then flows to No. 1 Allen cone, where it is dewatered; the spigot product drops to No. 2 air lift, which in turn discharges to No. 2 agitator, the cycle of operations being repeated in each succeeding unit. The spigot product of the fifth cone, which contains less than 1 per cent of soluble alum, is delivered to the flotation unit.

The pulp remains in each agitator about three hours,



FIG. 1. POTASH ALUM-SULPHUR DEPOSIT

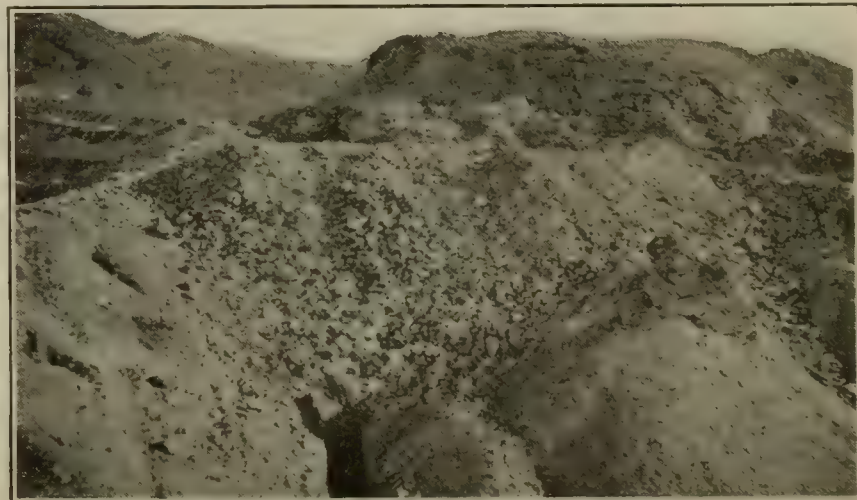


FIG. 2. FACE CUT INTO ORE

and as about four hours is required to dissolve completely the alum from the pulp, under operating conditions, it is evident that the solution of the alum is complete before the pulp leaves the second agitator. The function of the last three agitators and cones is simply that of washing the pulp and replacing the alum-laden solution with fresh water. Fresh hot make-up water is admitted to the fifth agitator and together with the agitated pulp goes to the fifth cone. The overflow solution from the fifth cone flows to the fourth air lift; a portion is, however, returned to the fifth air lift to maintain the proper dilution of the pulp. The solution is advanced in this manner progressively from the fifth to the first agitator, increasing in alum content. The third, fourth and fifth agitators accomplish the washing and the solution takes place in the first two. The overflow solution from the first Allen cone is divided into two portions, part going to the crystallizing vats, the remainder to the pebble mill, from which it returns to the first air lift with the freshly ground ore.

Live steam is used to heat the solutions and is admitted to the vortex of the agitators, where it is drawn down into and distributed throughout the agitated liquid by the propeller. Thermostatic valves control the temperature of the solution in the agitators at 85 deg. C. Lead-covered bulbs governing the steam valves are inserted through the sides of the agitator tanks.

The portion of the solution overflowing from No. 1 Allen cone, which is not used in the pebble mill, is forced by a 1-in. lead-lined centrifugal pump through Sperry filter presses. The presses have wooden plates, and woolen filter cloths are used. Each filter has a filtering area of 100 sq.ft. and a cake capacity of 5 cu.ft. The two filters are set in parallel and are valved with lead-lined stopcocks so that either press can be cut out for cleaning without interfering with the operation of the other. The filters remove colloidal material that may be present in the overflow from the first Allen cone, and the filter cake is delivered to the flotation cell feed box.

The filtrate flows to one or more of the four 29 x 6-ft. crystallizing tanks. After the alum has crystallized



FIG. 3. PLANT OF WESTERN CHEMICALS, INC.

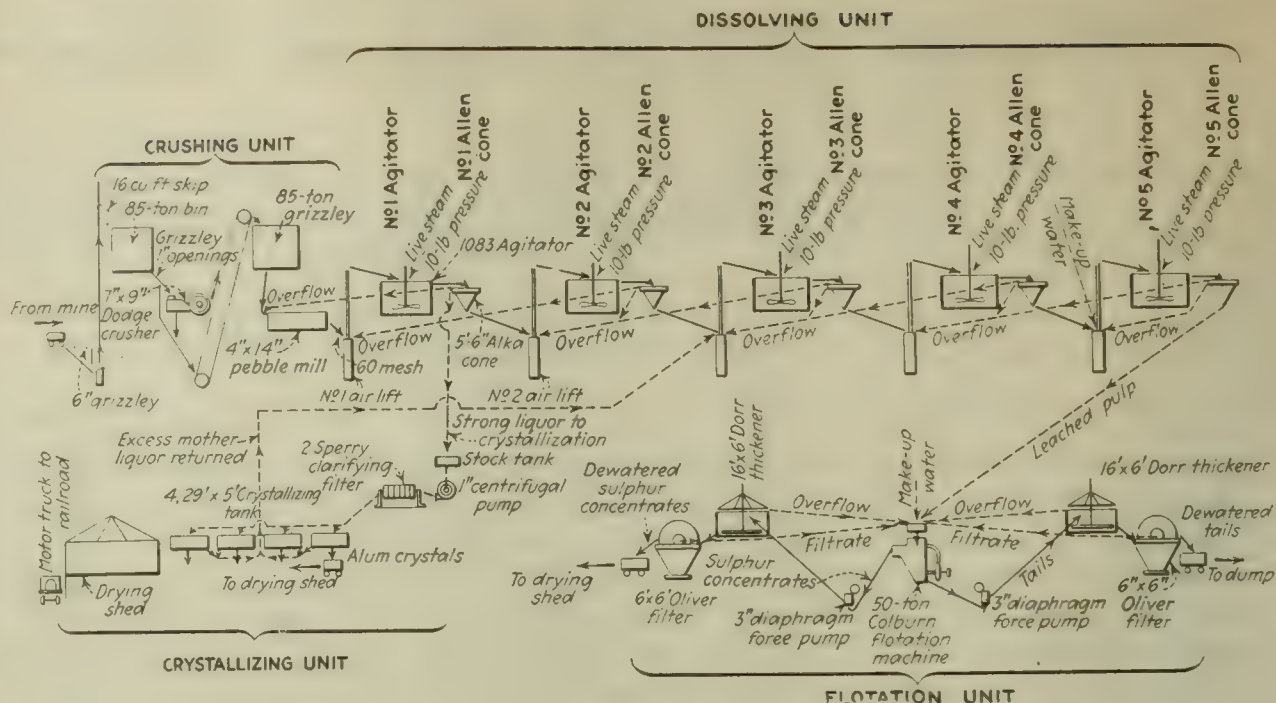


FIG. 4. FLOW SHEET OF PROCESS

from the solution in a tank the mother-liquor is returned to No. 3 agitator and the tank is again filled with pregnant solution. When a tank is finally filled with alum crystals the motor-liquor is completely drained off. The crystals are removed through an acid-proof wooden gate valve in the bottom of the tank, fall into cars and are trammed to the drying shed.

SULPHUR RECOVERY

The underflow from No. 5 Allen cone, which has been practically denuded of alum and contains approximately 30 per cent of moisture, is delivered by launder to a feed box for the flotation cell, where it is mixed with the return water from the flotation cell. Hot make-up water is added at this point, as it has been found that a better recovery of the sulphur and a higher grade of concentrate is obtained by the use of hot water in the flotation cell. From the feed box the pulp flows directly to a six-compartment Colburn flotation cell which has a capacity of about 2½ tons of feed per hour. The sulphur concentrates are pumped to a 6 x 6-ft. Oliver filter and the filter cake is trammed to the drying shed. The filtrate flows back to the feed box. The tailing product is pumped to a 16-ft. Dorr thickener, the underflow from the thickener is filtered by a 6 x 6-ft. Oliver filter and the overflow returns to the feed box. The filter cake is trammed to a dump and the filtrate flows to the feed box. These steps are necessary to conserve water, which is very difficult to obtain in a Nevada desert. The sulphur recovery is from 85 to 90 per cent and the grade of the concentrate from 80 to 85 per cent. The impurity is almost entirely silica. The product is particularly desirable for dusting vines.

CAPACITY OF THE PLANT

The capacity of the entire plant is governed by the mechanical loss of alum which it is economical to allow. A loss of 5 per cent has been decided upon and under these conditions the plant will produce about ten tons of c.p. alum and ten tons of 85 per cent sulphur concentrates per day.

The plant was designed and constructed by Duncan & Lindley, Mills Bldg., San Francisco. The chemistry of the process was reported upon by Dr. Merle Randall and the geology of the deposit by Dr. A. C. Lawson, both of the University of California.

Silver Peak, Nev.

Cost of Fixed Nitrogen in Norway

BY T. C. HAGEMANN*

THE object of the present article is not to make an accurate calculation of the cost of construction and working expenses of a plant for the manufacture of nitrates by the electrical oxidation of air, but, taking into consideration the market price of the products, to show that this process is profitable in Norway. If one intended to do so, it would be absolutely necessary to know the location of the plant in contemplation and the exact cost of materials, machines and apparatus, besides local prices of power, raw materials and wages.

STEPS IN THE PROCESS

Let us first outline the steps in an arc-process plant.

The air to be treated is let into a chamber, where it passes through an electrical arc, which by some artificial means is given an increased area in order to heat the air so intensely that a part of the nitrogen burns—that is, combines with the oxygen and forms NO .

The nitrous gas, which at the outlet of the furnace has a temperature of about 1,000 deg. C., passes first through a steam boiler, where it gives up the greater part of its heat to the water in the boiler, thus producing steam of a convenient pressure and temperature. The further cooling of the gas (from about 200 deg. C. to about 40 deg. C.) occurs in coolers fitted with tubes of aluminum, this part of the heat being lost with the cooling water.

During the following stay of about one minute in the oxidation chamber the nitrous oxide has time to combine with one more molecule of oxygen and forms NO_2 .

The gas is now fit for absorption and accordingly passes through a series of towers of granite—generally four—filled with broken quartz. On the top of the fourth tower water enters as a spray and runs out at the bottom in form of weak nitric acid. A portion of this acid is forced back to the top of the same tower, while the rest is forced to the top of the third tower, and so on. At the bottom of the first tower it meets the fresh gases from the oxidation chamber, and a weak nitric acid containing about 30 per cent HNO_3 by volume is produced.

CONVERSION TO CALCIUM NITRATE OR SODIUM NITRITE

This acid is not suitable for transportation, and must first be concentrated to the strength of 96 to 98 per cent HNO_3 , in which form it can be transported without any difficulty in containers made of 98 per cent aluminum; or it can be neutralized with ammonia to form ammonium nitrate or with calcium hydrate to form calcium nitrate ("Norwegian saltpeter").

During the war there was a great demand for ammonium nitrate, but now, in peace time, preference is given to the more pacific material calcium nitrate.

In this case, we allow the acid to pass through open towers, filled with limestone, and afterward we destroy the small amount of remaining acid in the solution with slaked lime. We then remove a part of the water content in evaporators fitted with copper steam coils, until the solution contains 13 per cent N, utilizing steam from the boilers in which we have cooled our gases. We now pass the solution into flat pans or in a more improved apparatus, allow it to solidify on rotating water-cooled drums. The crude lumps from the pans,

or from the surface of the drums, are broken up and then packed into barrels, ready for marketing. By the process described above, we can utilize about 80 per cent of the nitrous oxide content of the gases.

In order to recover an additional 15 per cent, the gas from the fourth "acid tower" is led into a tower, which may be made of iron, filled with broken quartz, and through which is pumped soda lye, until the solution at the bottom of the tower contains practically pure sodium nitrite.

Owing to the fact that the market for this very valuable product, NaNO_2 , is rather limited, we convert it to the less valuable product sodium nitrate by means of nitric acid. The solution is then evaporated, crystallized in flat pans or, more rationally, in finishers, fitted with salt boxes, centrifuged, dried with hot air and packed into sacks ready for market.

ESTIMATED YIELD

Concerning the quantity of the finished products, we are in any case safe, if we figure on a yield of 540 kg. HNO_3 (calculated at 100 per cent per kw.-yr., or 62½ g. per kw.-hr.). For a medium-sized factory, say of 40,000 kw., the amount, after having subtracted the power for working the auxiliary machinery, will be about 20,000 tons HNO_3 , equivalent to 4,500 tons N, in the form of 29,000 tons Norwegian saltpeter with 13 per cent N, and 4,400 tons sodium nitrate with 16.5 per cent N.

Of raw materials there will be required 15,000 tons limestone, 500 tons lime and 2,500 tons soda.

For the economical calculation I prefer to figure in Norwegian kroner, being most familiar with that coinage. (1 kr. normal exchange or parity = \$0.268, at present market = \$0.18.)

The market price of the nitrogen in the above-mentioned products is about 3,000 kr. per ton. Total selling price for 4,500 tons is 13,500,000 kr.

Approximate running expenses are:

	Kroner
Power, 40,000 kw. @ 100 kr.....	4,000,000
Administration and wages.....	1,500,000
Raw and other materials.....	1,100,000
Packing	1,000,000
Sundries	400,000

Total 8,000,000

Balance: 13,500,000 kr. — 8,000,000 kr. = 5,500,000 kr.

The investment is estimated to be about 20,000,000 kr., and taking 7½ per cent, or 1,500,000 kr., for amortization, the profit will be about 4,000,000 kr.

As will be seen from the above, the cost of power represents half of the total running expenses, and indeed, this item, together with the relative yield of the future, is of vital importance when considering the cost and returns of any one individual factory.

DEMAND FOR THE PRODUCT

During my stay in the United States two years ago I was told that the Norwegian saltpeter was not salable in large amounts, because it is not applicable to the manufacture of the mixed fertilizer demanded by American farmers. Afterward I saw the same statement made in the technical journals. The fact is, however, that this product, calcium nitrate, is exported from Norway in increasing amounts, and if the claim of the producers that this fertilizer, especially on lime-poor soil, is more valuable than other fertilizers, is proved to be correct, it seems likely that the American farmers will find it to their interest to use it.

*Consulting Engineer for the Nitrate Industry, Christiania, Norway.

Recent Chemical & Metallurgical Patents

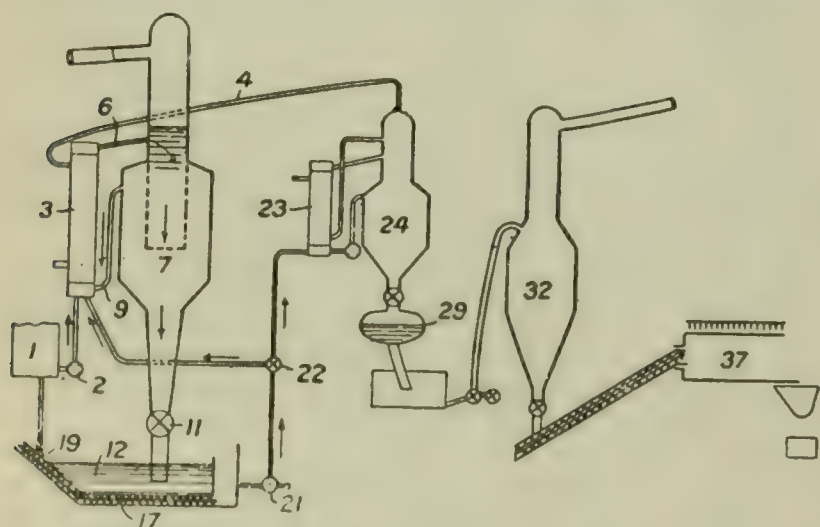
British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Phenol-Aldehyde Condensation Products.—Condensation products are obtained by reaction of phenol or its homologues with formaldehyde in the presence of dilute sulphuric acid in the proportions of 500 volumes of phenol or its homologues, 450 to 550 volumes of 40 per cent formaldehyde, and 2 to 6 per cent by volume relatively to the phenol of dilute sulphuric acid made by mixing 20 volumes of acid of 1.84 sp.gr. with 80 volumes of water the reaction being effected at a temperature of 60 to 80 deg. C. After reaction and removal of water, the product is neutralized—e.g., by milk of lime—and the remaining water is removed by heating *in vacuo*. The product may be finally hardened by heating under pressure. (Br. Pat. 153,494; A. T. BIRKLEY, and F. E. BIRKLEY, Liversedge, Yorkshire. Jan. 19, 1921.)

Devulcanizing Rubber.—Vulcanized rubber is devulcanized by simultaneous treatment with a benzene hydrocarbon, such as 10 per cent of xylol or one of its homologues and a carbocyclic amido compound, such as 2½ per cent of aniline or one of its homologues in the presence of a substance capable of absorbing or combining with sulphur, such as a hydrate of an alkali metal. The treatment is conducted in a digester in which the temperature corresponds with a steam pressure of from 60 to 150 lb. per sq.in. (Br. Pat. 153,646; J. YOUNG and W. W. BENNER, Akron, Ohio. Jan. 19, 1921.)

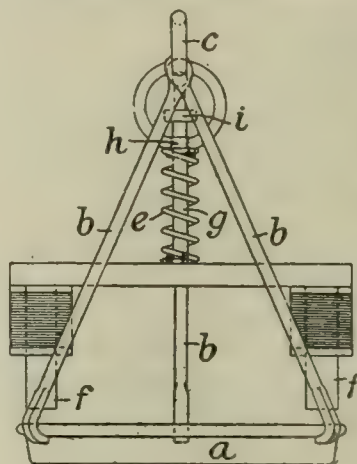
Sodium Nitrate.—Sodium nitrate is obtained from its solutions by first separating a considerable proportion of the sulphates and chlorides present by concentration under an absolute pressure of 11 lb. per sq.in. until the temperature of 90 to 95 deg. C. is reached, and afterward concentrating the liquor at atmospheric or other pressure until the content of chloride (calculated as the sodium salt) is 75 to 80 g. per liter. The concentrated liquor is then cooled for the production of sodium nitrate crystals. The first stage of the concentration is effected in a vacuum evaporator,



consisting of a heater 3 and a separator 7 connected by circulating pipes 6, 9. The crystals of chlorides and sulphates that separate are discharged through a valve 11 into a settling tank 12 from which they are removed by conveyors, 17, 19. The crystals may be washed by liquor from the store tank 1. A pump 2 feeds liquor from the store tank 1 to the heater 3, and a pump 21 returns liquor from the settling tank 12 to the heater. The second stage of the concentration is effected in an intermittently-working evaporator consisting of a heater 23 and a separator 24 operating under a pressure such that the steam generated may be led by a pipe 4 to the heater 3 and used as a heating agent therein. The evaporator 23, 24 is filled by adjust-

ing a valve 22 so as to permit a portion of the liquor from the pump 21 to enter the heater 23. When the liquor has reached the prescribed concentration, the contents of the evaporator 23, 24 are discharged through a filter 29 and are pumped into a chamber 32 maintained under an absolute pressure of 12 to 13 lb. per sq.in., and are cooled to 70 to 75 deg. C. by evaporation under the reduced pressure. The liquor is then transferred to a rotary cooler 37, in which the sodium nitrate separates. (Br. Pat. 153,649; J. L. GRINGIONI, Valparaiso. Jan. 19, 1921.)

Heat-Treatment of Steel.—Steel, after being heated to above the critical temperature, is cooled in proximity to an electro-magnet so that when the critical temperature is reached and the steel regains its magnetic properties, the attraction of the electromagnet may be arranged to give an indication that this temperature has been reached and, if desired, to effect a stoppage of the cooling. In the figure a railway wheel tire *a* is shown suspended in a cooling bath by dogs *b* from a ring *c*; an electro-magnet *f* is suspended above the tire by a spring *e* of such a strength that when the tire is cooled to the critical temperature and becomes magnetic, the magnet *f* moves downward against the spring until the collar *i* on the rod *g* comes



into contact with the stop *h*. This movement gives a visual indication or may be arranged to operate a switch to start a crane which lifts the tire from the cooling bath. In a modification the tire is placed on a revolving table and is cooled by a spray. In this case, when the tire becomes magnetic the core of a solenoid is attracted against a spring. The movement of the core may be used as a visual indicator or may operate a device for shutting off the cooling spray. (Br. Pat. 153,756; C. P. SANBERG and J. C. W. HUMPHREY, both of London. Jan. 19, 1921.)

Phenol-Aldehyde Condensation Products.—A thin aqueous liquid condensation product is obtained by reaction of about 1,000 parts of carbolic acid, 1,000 parts of 40 per cent formaldehyde and 50 parts of sodium sulphite, at ordinary temperature for three to four days. The product can be applied directly for impregnating fibrous, etc., materials, which are subsequently dried, and hardened by heating under pressure—for example in the manufacture of friction blocks or pads or stair treads. Water-soluble dyes may be dissolved in the liquid to dye textile materials. (Br. Pat. 153,796; F. SCUDDER and R. PETTIGREW, Manchester. Jan. 19, 1921.)

Solidified Oil Composition.—Tung oil or Chinese wood oil is solidified by the action of haloid salts, particularly chlorides, uniformly disseminated through the oil. To secure this dissemination, the chlorides are first ground up with an indifferent oil, such as resin oil or linseed oil, or dissolved in an anhydrous organic solvent, and the liquid produced mixed with the tung oil. Suitable combinations of salts and solvents are anhydrous ferric chloride in anhydrous acetone, anhydrous aluminum chloride in anhydrous acetone, anhydrous stannic chloride in acetone, anhydrous zinc chloride in amyl acetate or alcohol, and antimony or bismuth chloride in acetone; the use of ferric bromide is also mentioned, and mixtures of various salts may be employed. Fuming chlorides, such as antimony chloride or stannic chloride may be dissolved in benzine or the like and mixed with an indifferent oil and the mixture added to the tung oil, or they may be changed into hydrated chlorides and dissolved in anhydrous solvent and used directly. Filling and coloring matters, fibrous or otherwise, may also be added; a number of suitable and unsuitable substances are mentioned. Rosin gums, ester gums, or other gums easily soluble in oil may be added to the tung oil, as may tung oil fatty acids. Either raw or blown tung oil may be employed, but oil that has been partly polymerized by heat is unsuitable. (Br. Pat. 153,942; B. SCOBEL, New York. Jan. 19, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Preliminary Program, Rochester Meeting, A.C.S.

While the full program for the spring meeting of the American Chemical Society, which will be held in Rochester, N. Y., April 26 to 29, has not been completed as this is written, some features of the program are known at this time. Senator Wadsworth of New York and Representative Longworth of Ohio have promised definitely to address the meeting and have been assigned places on the program of the opening day. On that day also E. C. Franklin will deliver his address on "Ammono Carbonic Acids."

GENERAL ARRANGEMENTS

Tuesday afternoon will be devoted to a general meeting which will be held in the large auditorium of Convention Hall. Alpha Chi Sigma will hold a banquet Tuesday evening at 6:30. Members desiring to attend this banquet should write to I. N. Hultman, Eastman Kodak Co., at their earliest convenience so that reservations can be made. Wednesday and Thursday will be devoted entirely to the presentation and discussion of papers. No excursions or other functions have been planned for these two days, so that there will be absolutely no interference with this part of the program, which is the most important side of the meeting. All divisions and sections can begin their meetings Wednesday morning simultaneously. The place of this meeting is Mechanics Institute and the rooms will be provided with modern projection apparatus and with communicating telephones so that members in other sections can be posted as to what is being done in various other sections. This scheme increases the time devoted to presentation and discussion of papers in all cases by at least one-half day and in many cases by a whole day. Wednesday evening will be given over to general addresses at Convention Hall. Thursday evening has been set aside for a good-fellowship meeting at the Bausch & Lomb Optical Co. Friday and Saturday will be devoted to excursions to the various industrial plants and laboratories in the city.

It is planned to charge a registration fee of \$1. This is in line with the action taken by the council at the fall meeting in Chicago. The money resulting from this registration will be used to defray necessary expenses incurred for arrangements of the meeting.

TENTATIVE DIVISIONAL PROGRAMS

The Division of Industrial and Engineering Chemistry will discuss drying under the guidance of Charles O. Lavett, the chairman of the drying symposium committee.

Division of Physical and Inorganic Chemistry will have a symposium on contact catalysis, over which W. D. Bancroft will preside. Among those who will present papers on that subject are A. F. Benton, R. M. Burns, R. F. Chambers, J. C. Frazer, C. H. Milligan, H. A. Neville, R. N. Pease, F. H. Pollard, E. Emmet Reid, F. L. Simons and H. S. Taylor.

The Division of Rubber Chemistry will discuss among other things a tentative draft of specifications for the analysis of rubber goods.

In view of the critical situation in the dye industry the meeting of the Division of Dye Chemistry is expected to be of unusual interest. The Division of Fertilizer Chemistry is the only division which will not have a group meeting at the Rochester convention.

LOCAL COMMITTEES IN CHARGE OF THE MEETING

The local committees and their chairmen who will be in charge of the meeting are as follows: Executive Committee, Frank W. Lovejoy, honorary chairman; J. Ernest Woodland, chairman; finance, Herbert Eisenhardt; enter-

tainment, Charles F. Hutchinson; registration and information, Harry A. Carpenter; program, Erle M. Billings; transportation, Charles Markus; hotels, Harry L. Gray; excursions, William Earle; arrangements, Donald B. Howe; college and fraternity dinners, and exhibits, Ivan N. Hultman; publicity, Benjamin V. Bush.

The council of the society will meet April 25 at Rochester.

Tariff Prospects

Since tariff legislation affects directly only 14 per cent of the population, while the internal revenue laws apply to practically 100 per cent, there is great political inducement for Congress to take up the revision of taxation ahead of the revision of the tariff. There is a substantial proportion of the membership in each house of Congress, however, that will demand immediate action on the tariff. They point to the chemical industries as affording the most clear-cut cases of the need for immediate protection from the increasing volume of imports.

It is not disputed generally that it would be very difficult at this time to write a permanent tariff measure. It is recognized that information is incomplete with regard to costs of production abroad. There is great uncertainty as to the trend of production costs even in the United States. Foreign exchange adds another element of uncertainty. There is very general support, however, for the proposed re-enactment of a revised Payne-Aldrich bill or of a measure in which the schedules would be more or less arbitrarily arrived at. Either plan, it is argued, would serve as stop-gap measures to apply only until the regular bill can be worked out later in the year.

In the event of the adoption of the Payne-Aldrich schedule to serve until the regular bill can be put into effect, it is pointed out that considerable revision must be had of the rates of duty fixed in that act on chemicals. Since that law was enacted in 1909 a real chemical industry has been developed in the United States. As a result it is contended that many articles now on the free list should bear a duty, while changed conditions require higher schedules on many items.

The duties prescribed by the Payne-Aldrich act on some of the more important chemicals are as follows: Ammonia, liquid anhydrous, 5c. per lb.; essential oils, 25 per cent; coal tar, dyes or colors, 30 per cent; preparations of coal tar, not colors or dyes, 20 per cent; benzene, toluene and naphthalene, free; glycerine, refined, 3c. per lb.; chromium colors, 4½c. per lb.; litharge, 2½c. per lb.; white lead, 3c. per lb.; zinc oxide (dry), 1c. per lb.; zinc chloride, 1c. per lb.; carbon, 20 per cent.

Plans for Mme. Curie's Visit

As a mark of respect to Mme. Curie the formal opening of the Cryogenic Laboratory of the Bureau of Mines will be postponed until the visit of the noted French scientist. Plans are being perfected for other features of Mme. Curie's entertainment, which will include a general reception, at which time all scientists residing in Washington will be given an opportunity to meet the distinguished visitor. The arrangements are in charge of Dr. Vernon Kellogg of the National Research Council.

Buenos Aires Exposition Delayed

The American National Exposition, Inc., which was planning an exposition of United States manufacturers for March 1, 1921, at Buenos Aires, has postponed the enterprise indefinitely due to business conditions in Argentina. The exposition will not be permanently abandoned, and a proposed new date is November and December of this year.

Butyl Alcohol and Acetone From Starch

At the March meeting of the Indiana Section of the American Chemical Society held at Indianapolis M. E. Nasmith, superintendent of the Commercial Solvents Corporation of Terre Haute, Ind., described in considerable detail the process of making acetone and butyl alcohol from starch.

DEVELOPMENT OF THE PROCESS

The fermentation of the hydrolyzed starch is done by an anaërobic spore-forming bacterium, *B. Granulobacter pectinovorum*. This microbe was supplied by Fernbach of the Pasteur Institute to some Englishmen who were interested in producing acetone and higher alcohols for the synthesis of isoprene. At the outbreak of the Great War Weitzman, who had been associated with Fernbach, offered the use of this fermentation process to the British government for the production of acetone needed in cordite manufacture.

When Colonel Gooderham tendered the use of his distillery in Toronto to them the British sent over a chemist and bacteriologist. The difficulties inherent in the adjustment of such a process to a large scale were gradually overcome, but it seemed desirable to have a works nearer the source of raw material, so a distillery was selected in the corn belt at Terre Haute.

When the United States entered the war an adjacent distillery in the same city was adapted to this process, getting well started just before the signing of the armistice. The two governments were in partnership in these two plants. The English sold great quantities of acetone, so there was little demand for that substance after the signing of the armistice, but there has been a real need for higher alcohols for solvent purposes.

This demand encouraged the formation of a syndicate to take over the first plant, which was operated from April, 1920, to the end of that year. At present it is not producing solvents, but many improvements to the process are being worked out.

PREPARING CORN FOR FERMENTATION

Almost any starchy substance may serve as raw material, but there must be sufficient nitrogenous material to give the organism a suitable ration. Of course, corn is the principal substance used and is not hurt even if it has been frostbitten. If the corn is too damp, it must be dried before being stored. The corn is broken in corrugated rollers called "breaks" so that the hulls and bran may be separated from the starch. The germs of the corn are left to supply the organism with necessary nitrogen. The corn meal is gradually fed into ten parts of boiling water with constant stirring. Then the pressure is increased to 70 lb. in 20 min. To overcome the tendency toward foaming of the pasty material when the pressure is released the large pipe leading upward from the cooker is provided with an expansion or blow-off tank to prevent any loss. The cooking brings the starch into a finely divided, more or less hydrolized condition which is suitable for fermentation. It also sterilizes the starch very thoroughly. The cooked material is then pumped through 5-in. pipes to the 50,000-gal. fermentation tanks. The greatest care must be exercised in sterilizing everything with which the material comes in contact—a very nice problem with such large units. Also very great care and nice adjustment have to be exercised in controlling the temperature of the mash as it reaches the tanks, since the range of activity of the organism is limited. A slight lowering of temperature will chill the bacteria so that it may take 24 hr. to recover, and again a slight elevation may kill them.

FERMENTATION

The technique of handling and developing the cultures of this bacteria has to be of a very high order. The test-tube cultures are inoculated into 1,200-c.c. Erlenmeyer flasks and after 24 hr. the emulsion breaks, leaving the beer below, in which there is often a slimy streak or "shroud." The Erlenmeyers are taken to the seed room and the culture is introduced into sterile mash in sterilized 5-gal. copper kettles provided with hand stirrers. From

these in due time the inoculated mash is run into the empty sterile fermentation tanks and the mash is next added. The tanks are provided with water seals so that the gases evolved, 60 per cent carbon monoxide to 40 per cent hydrogen by volume, can escape. More or less of the volatile solvents is apt to be lost during this evolution of gas. During 24 hr. 26 tons of carbon monoxide and 1,800 lb. of hydrogen are evolved from a tank, but no attempt is made at present to recover them.

During the fermentation the acidity increases to a maximum, after which it steadily falls off to a constant value. The formation of the solvents begins at this maximum point. It seems probable that there is reduction by the nascent hydrogen of some of the acids formed. If wild ferments have got in, the acidity keeps on rising till the special bacteria are all killed, so that practically no solvents are produced and the batch is wasted.

DISTILLATION

The solvents are removed from the mash by the usual method with suitable heat interchangers. The spent mash contains 3 to 3.5 per cent of solids, which when dried contain 40 to 45 per cent protein, making it valuable for fertilizer or cattle feed. It is an interesting fact that the mash coming out from this still has about double the acidity of the ingoing mash. The water solution of the solvents is pumped into a 20,000-gal. discontinuous still provided with a 30-section rectifying column.

After the removal of the acetone ethyl alcohol is obtained in the next fractions. Then comes the constant composition vapor of waterbutyl alcohol containing 68 per cent of the alcohol. On cooling, this separates into two layers, the upper one containing 88 per cent alcohol to 12 per cent water and the lower one 8 per cent alcohol to 92 per cent water. On separation, the lower layer is run back into distillate from the mash column still, while the upper layer is redistilled in a smaller still. The distillate is always richer in water than the residue, so that finally pure butyl alcohol is left in the still.

From 1 bu. of corn 9.5 to 10 lb. of solvent is obtained. The solvent is a mixture of 60 per cent acetone, 30 per cent ethyl alcohol and about 10 per cent butyl alcohol. There are also traces of amyl alcohols. Butyl alcohol makes a fine solvent for many materials like fine paints and varnishes and rubber. It also is made into esters. The capacity of the plant is 7 tons of solvents a day.

Surplus Brass Sold

Sale of 30,000,000 lb. of brass cartridge cases has been announced by the Director of Sales. The purchasers are: Chase Co., Inc., Waterbury, Conn.; Scovill Mfg. Co., Waterbury, and the Bridgeport Brass Co., Bridgeport, Conn. The price is to be determined by the market price at the time sales are made by these purchasers. The government is to receive 41½ per cent of the average market price for the copper content, plus 19½ per cent of the average market price for prime Western zinc for the month in which deliveries are made. Under this agreement the government will receive a greater return than would have been the case had it accepted the highest bid offered for the outright purchase of the material.

In addition the government has 6,000,000 lb. of cartridge cases still on its hands. This will be held available for sale at any time to brass mills and other consumers under the same general terms.

Oil and Gas Claims in Alberta

It is reported from Edmonton, Alta., that nineteen oil and gas claims, covering 6,000 acres of ground, have been filed with the Dominion government at Fort Smith since the beginning of the year. Practically the entire area in the vicinity of Pine Point, Great Slave Lake, has been staked. The ground has been staked under the old laws, allowing the filing of 320-acre claims, by parties who started for the district before the laws were suspended. The government agent was unable to say what effect the new laws, recently passed but which were made retroactive to the first of the year, will have on these claims.

Need for Fertilizer Grows Rapidly

As a result of the controversy in Congress over the development of Muscle Shoals a great deal of statistical material was gathered in regard to the fertilizer requirements of the country. Among the striking facts brought out was the great increase in the use of fertilizers in sections of the country other than the South. In South Dakota the consumption of fertilizer in 1918 increased 1,150 per cent as compared with the consumption in 1911. During the same period Minnesota's consumption increased 250 per cent. In Oklahoma the increase was 212 per cent, in Wisconsin 200 per cent, in Iowa 150 per cent, in Missouri 122 per cent, in Delaware 216 per cent, in Connecticut 200 per cent, in Oregon 100 per cent.

Wood Pulp Mill at Juneau, Alaska

Wood pulp is now being manufactured in Alaska near Juneau, in the Tongass National Forest. The first mill to be established in this territory has a capacity of twenty tons of pulp a day, but the available hydro-electric power is ample to increase the output to 250 tons. Spruce and hemlock will be ground for newsprint purposes and later the plant will be enlarged so as to manufacture paper.

In response to inquiries from prospective manufacturer's Forest Service officials have announced that an area of the Tongass National Forest containing 2,000,000,000 ft. of pulp-making timber would be placed on the market soon.

American Oil Chemists' Society

For a number of years the leading chemists in the cottonseed oil industry have been fraternally associated in the Society of Cotton Products Analysts. This organization primarily concerned itself with perfecting methods of analysis used in the cottonseed crushing and refining industry. It did for the edible oil trade what the Association of Official Agricultural Chemists does for the food industry; the Society for Testing Materials for the paint trade; and the Leather Chemists' Association for the leather and tanning industry. Certain specific qualifications as to membership limited it in numbers to those highly specialized but insured a large amount of important investigational work. The great war drew this country into a large international trade in several of the vegetable oils which became keen competitors of cotton oil. This caused a commensurate widening of the society's interest, with the result that at the annual meeting of the Society in May, 1920, it was reorganized under the name of the American Oil Chemists' Society.

Its aim can be no better expressed than in the words of Article II of its constitution:

Section 1. The object and purpose of the society shall be, first, to unite for fraternal and business purposes all chemists interested in the promotion of the chemistry of fats, oils, waxes and allied industries.

Section 2. To cultivate the ties of friendship that should exist between those who have adopted a similar profession and who enjoy common interests.

Section 3. To encourage the writing of original papers on subjects pertaining to chemical work, to foster and encourage chemical research, to promote a spirit of co-operation and interchange of ideas and to strive for the adoption of uniform methods of analysis to be used by all the members of the society.

Section 4. To exert our influence and efforts toward securing the enactment of state laws safeguarding and protecting the practice and dignity of the chemical profession.

Section 5. To place the profession on the high plane its dignity deserves, and to secure for those engaged in it adequate recognition of their services, in keeping with the years of study required to master it, and the high character of those to whom only its responsibilities should be entrusted.

All persons engaged in chemical work relating to fats, oils, waxes and allied interests are eligible for active membership provided they have had at least five years' chemical training. Its meetings are held once a year, usually in May and in conjunction with the Interstate Cottonseed Crushers'

Association. It regularly publishes its transactions and maintains the chemists' section in the *Cotton Oil Press*, a journal devoted exclusively to the interests of the edible vegetable oil industry.

Its membership, however, is not limited to chemists and technologists engaged exclusively in the edible oil trade, but includes also those interested in its so-called industrial or technical aspects. Although the entire vegetable oil industry is founded upon more or less similar practice in obtaining the oil, the unified character of the industry ceases at that point and then splits up into several rather well-defined branches, namely those of edible oil, paint, soap, vulcanization, sulphonation, etc. The oil industry is too elastic to permit any oil to be pocketed; therefore, no oil chemist should confine his interest exclusively to his given line. Since most of the oils dealt with are industrially more or less interchangeable, their chemical control and technological development can be properly fostered only by sympathetic and intimate contacts between science and industry, such as are furnished by the American Oil Chemists' Society.

Chemical Imports and Exports

Imports of chemicals, drugs, dyes and medicines continued to increase during January, according to figures which just have become available at the Bureau of Foreign and Domestic Commerce. The increase applies only to chemicals on the free list. In January, 1921, the value of chemicals imported on which no duty was charged was \$8,994,118. The value of the dutiable chemicals imported was \$3,237,732.

Exports of chemicals during January of 1921 were valued at \$9,420,043. This is a decrease from \$11,367,979, which was the value of exports in January of 1920.

The imports of colors and dyes slumped decidedly in January of 1921, as compared with the corresponding month of 1920. In January, 1921, the imports amounted to 270,833 lb. In January of 1920 the aggregate of the imports was 539,144 lb. On coal-tar products as a whole, however, there was an increase in January of 1921. In that month the value of all coal-tar products was \$1,495,375. This compares with \$1,229,116, the total value of coal-tar products imported in January of 1920.

The recession in imports of gums continued during January. The total imports during January of 1921 was 7,518,576 lb. In January of 1920 the imports were 12,328,990 lb. Imports of other chemicals and drugs which do not move in such large quantities are shown by the following:

	January	
	1920	1921
Ammonia, muriate of, lb.	599,979	41,727
Arsenic, lb.	569,562	740,976
Indigo:		
Natural, lb.	13,413	6,063
Synthetic, lb.	18,001	.....
Glycerine, lb.	658,630	111,701
Iodine, lb.	100	37,203
Magnesite, tons	3,613	4,366

Acids were exported during January, 1921, in somewhat less volume than in the corresponding month of 1920. In January, 1921, the exports of carbolic, nitric, picric, sulphuric and other acids were valued at \$315,562. This compares with \$490,353, the value of the exports in January, 1920. The value of dyes and dyestuffs exported in January, 1921, amounted to \$1,335,531. In January, 1920, the figure was \$1,449,153. Extracts for tanning exported in January, 1921, were valued at \$116,445, which is a decided decrease from \$500,276, the value of the exports in January of 1920. The value of the exports of the various salts of soda in January, 1921, was \$755,471. The exports in January, 1920, were valued at nearly double that sum, or \$1,361,316. Exports of chemicals which moved in less volume are shown as follows:

	January	
	1920	1921
Alcohol, wood, gal.	126,673	49,685
Calcium carbide, lb.	736,959	2,131,432
Sulphur, tons	51,019	30,222

British Columbia Industrial Notes

A loan of \$25,000, under the provincial industrial act, has been granted by the government to the Douglas Fir Turpentine Co., to assist in the development of the resinous product industry. The company's plant is situated on False Bay, Vancouver, and the company is collecting resins by a special process from Douglas fir trees, which abound in this vicinity. Turpentine, flotation oils, balsam, burgundy pitch and venice turpentine are manufactured from the material collected. It is claimed that by the method of tapping adopted the trees are not injured, but, on the other hand, the growth is stimulated—a statement that has been corroborated by the provincial forestry experts.

The Forestry Branch of the Department of Lands has published the following outputs of pulp and paper in British Columbia for last year:

	1919	1920
	Tons	Tons
Sulphite pulp	80,047	92,229
Sulphate pulp	3,473	16,380
Ground wood	99,769	108,665
Newsprint	123,607	136,832
Wrapping paper	7,202	9,792

The Consolidated Mining & Smelting Co. has shipped a large consignment of refined copper on the Empress of Russia, which sailed recently for the Orient from Vancouver.

New Arsenic Plant at Toulon, Nev.

The new arsenic plant which recently was erected at Toulon, Nev., is intended to supply from domestic sources the arsenic used in insecticides by the citrus fruit industry of the Southwest. It is stated that the bulk of the arsenic used for that purpose now is being imported from Japan.

The new plant will draw its supplies of arsenic from two extensive deposits located at Battle Mountain and Beowawe, nearby points in Nevada.

A very determined effort is being made by those interested in the development of these Nevada deposits to get an import duty on arsenic. The Committee on Ways and Means has been told that the Japanese have resorted to various methods to prevent the amount of arsenic imports from becoming known. During 1920 the official figures show imports of only 8,160,000 lb. Since large quantities of arsenic are said to have come in under other designations, it is claimed that the real imports are much higher. It also is asserted that the product from the Nevada plant will not enter into competition with other domestically produced arsenic in the territories now supplied by domestic producers, particularly those in Montana and Washington.

National Research Council Establishes Research Information Service

The National Research Council has recently established a research information service which will be a clearing house for information about the mathematical, physiological and biological sciences and their applications in industry, commerce and education. A technical staff assures an intelligent interpretation of requests and skillful search for the information desired.

Ultimately it is planned to have a specialist on the staff to represent each major division of science and technology, as well as specialists on the relation of science to industrial, commercial and educational problems.

No charge is made for replies to inquiries which do not necessitate a special search. Requests for data which can be secured only by expending considerable time are acknowledged with an estimate of the necessary cost of assembling what is desired.

Further information may be secured from the Research Information Service of the National Research Council, Washington, D. C.

Aluminum Production in 1920

The value of primary aluminum produced in the United States in 1920, according to reports received by the U. S. Geological Survey, was \$41,375,000, as compared with \$38,558,000 in 1919. The market prices throughout the year have been nearly constant, ranging from 32c. to 33c. per lb.

Book Reviews

LEHRBUCH DER EISEN UND STAHLGIESSEREI (Text Book on Iron and Steel Founding). By *Prof. B. Osann*. Leipzig: Wilhelm Engelman, 1920. Price, 42 marks in paper cover, 52 marks in cloth both plus export tax, at present 175 per cent.

Every book written by Prof. Osann is characterized by thoroughness and technical value. This new (fourth) edition is an amplification of the original work, 170 added pages bringing the information contained up to date. The thoroughness displayed by the author accounts for the retention of much obsolete matter, from which, however, one who wishes can learn what not to do. The effect of American foundry literature is plainly manifest throughout the book, and indeed this is generously acknowledged by the author.

After a general classification of iron products, a few pages are given to the technology of combustion and refractory linings. The history of cast iron is given in very condensed form, which is rather astonishing in a German book. Pig iron, "direct" metal from the blast furnace for castings, come next and then a short comparison of melting methods. The crucible melting process and its derivatives follow, and then we have twenty pages on the air furnace. Much of value is given in this connection, particularly the calculation of furnace dimensions—of which little has been published heretofore. Since the steel casting is involved, the open-hearth and converter processes are explained.

Ninety pages are devoted to cupola practice to bring the subject as up to date in Germany as we know it here. The greater familiarity of the author with the blast furnace is plainly evident, as he misses some of the important requirements of cupola charging, and dismisses the oil-fired cupola with two lines.

The chemistry and physics of cast iron are gone into quite thoroughly. Unfortunately, the information is quite scattered, but none the less faithfully recorded somewhere in the book. The action of the elements in iron castings, a list of recommended compositions for castings, the varieties of pig and scrap used in mixture-making, ferro-alloy additions, and the effect of remelting are taken up in succession.

Next come the methods of testing cast iron and castings for strength, contraction, shrinkage, hardness, casting strains, chill, etc. The art of molding follows, with fifty pages of material on molding machines, after which the several methods of molding are gone into thoroughly, with many examples. Permanent molds, foundry rigging, flasks, etc., are described, and special chapters on pipe making, car wheels, and other standard branches of the art follow. Pouring methods with the recent advances in centrifugal pouring, mold drying methods, core-making, molding sand preparation—in which Europe is somewhat ahead of us—are given. The disposition of foundry refuse is also taken up specially.

The steel casting comes next, with twenty-seven pages; and "malleable" follows with twenty more. Cleaning methods from hand brushing to the sand blast are gone into. The "burning on" of defective work, traveling and other cranes follow, and the book is completed by chapters on the foundry lay-out, foundry costs, and finally a chapter on the metallography of cast iron.

Perhaps the most serious criticism of this otherwise admirable book can be directed against the sequence of the material contained. One has to consult the not too copious index to find a lot of things which seem to be thrown in at random. None the less most of the information required for an operating foundry is there. The book deserves to be added to the working library of every foundryman and engineer able to handle the German language, as it is unquestionably the standard foundry book for Continental Europe.

RICHARD MOLDENKE.

Personal

Dr. C. L. ALSBERG has resigned as chief of the Bureau of Chemistry, Department of Agriculture, to accept the directorship of the food research institute of Leland Stanford University, which is founded by the Carnegie Corporation grant. Dr. Alsberg's resignation will take effect in the early summer, as soon as his successor can be obtained.

C. K. CALVERT has resigned as chemist and bacteriologist with the Indianapolis Water Co. His place has been taken by Norman D. Doane of Meadville, Pa.

CHRISTIAN CHRISTENSEN of Washington, D. C., has opened a laboratory and office in the Transportation Building, Indianapolis, Ind., for consulting work in engineering problems of a chemical nature.

Dr. W. R. CLEMENTS, head physician at the Repauno plant of E. I. du Pont de Nemours & Co., gave an interesting address recently before the members of the Delaware Safety Council, Wilmington, on the subject of "General Industrial Health."

H. A. DEFRIES has resigned his position as vice-president of Hamilton & Hansell, Inc., New York City, and has opened offices at 15 Park Row, New York City, as a consulting engineer and metallurgist, specializing in electric-furnace construction and electrometallurgy.

A. M. FAIRLIE of Atlanta, Ga., was in New York City recently on business.

HAROLD A. HARTT, who recently was graduated from Cornell University, is now research chemist in the moving picture department of the research laboratory of the Eastman Kodak Co., Rochester, N. Y.

ELMER F. JOURDAIN, of the U. S. Industrial Alcohol Co., addressed the Chicago Chemists Club, March 1, on the restrictions covering the use of alcohol in laboratories.

Dr. A. E. KOENIG resigned as assistant professor of chemistry at the University of Wisconsin to become associate professor of chemistry at the State School of Chemistry at the State School of Mines, Butte, Mont.

S. C. LOO, technical adviser to the Leather and Wool Commission and the Board of Communication, Peking, China, is touring the United States gathering information on apparatus for chemical plants. His address in the United States is care of the Chinese Legation, Washington, D. C.

JESSE P. LYMAN, Boston, Mass., has been elected president of the American Glue Co., to succeed King Upton, who died recently at his home at Marblehead. Mr. Lyman was president of the company from 1905 to 1918, resigning to be relieved of the duties of the office. He has been treasurer since 1907.

F. B. ORTMAN, who has been for some time associated with the staff of the Northwestern Terra Cotta Co., Chicago, Ill., has resigned to become vice-president and general manager of the Tropico Potteries, Inc., Los Angeles, Cal.

ARTHUR E. RICE has been elected president of the Pennsylvania Salt Co., Philadelphia, Pa., succeeding Joseph Moore, Jr., who died recently. Mr. Rice has recently been vice-president of the company, and treasurer previous to that. Edward Armstrong, for many years superintendent of the company's plant at Pittsburgh, has been elected vice-president, succeeding Mr. Rice.

Major ALFRED L. ROCKWOOD and Captain ADRIAN ST. JOHN, of the Chemical Warfare Service, have been ordered to Fort Leavenworth for duty as student officers at the School of the Line for the year 1921-1922.

Dr. C. B. THWING, president of the Thwing Instrument Co., is taking a much-needed rest in Florida for a month as the guest of his brother, F. H. Thwing, at Orlando.

F. B. TOUGH, petroleum technologist of the Bureau of Mines, has been made supervisor of oil and gas operations, with headquarters in the Custom House Building, Denver, Col.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, March 21, 1921.

The chemical market during the past week showed a more or less potential buying power. This, together with reduced stocks, imparted greater confidence in the trade outlook. There seemed to be more confidence, however, than actual performance, but all the indications pointed to a slow and steady rehabilitation in the industry.

It is generally admitted that the foreign situation of today is exceedingly problematical and might well cause anxiety among buyers who have taken advantage of the low prices named. Yet the actual new buying for the period under review could not be termed active and the inquiries received seemed to have a feeling out character to ascertain the status of the market here. Several prominent interests close to the pulse of domestic trading stated that during the latter part of the week more inquiries were received than during the entire month of February. Developments are being keenly awaited and sellers are expecting some shift of operations from foreign to domestic chemicals. Another feature of foreign chemicals has materialized in sales of English *soda ash*. Some small-lot business has been placed in this chemical at \$1.90 per 100 lb. N. Y., and it is understood that orders can be taken at this figure for prompt shipment from England. Imported *prussiate of soda* has weakened the market considerably for that chemical. The return of large quantities of American *caustic potash* from foreign ports has kept prices uncertain, while various grades of *chlorate of potash* have been on the market at prices well below the views of domestic producers.

DEMAND FROM INDUSTRIAL PLANTS IRREGULAR

Textile mills have bought moderately, although the general disposition of all Eastern mills is to purchase conservatively. Soapmakers seem to be showing more interest and prominent dealers among rubber manufacturers stated that they have noted a perceptible improvement in the call for miscellaneous chemicals. Tanneries are not interested in any marked degree. The demand from paint and glass manufacturers is quite irregular and without any tint of real snap. The closing down of some large chemical producing plants on account of the low prevailing prices is indicative at least that the reaction of values has gone its limit and that crude materials have got to decrease if any further downward revisions are to be expected in finished products.

On account of the recent slump in alcohol prices first hands have reduced *formaldehyde* to 15½¢@16¢. per lb. *Acetic acid* is somewhat lower. *Oxalic acid* closed higher under an improved inquiry. *Sulphuric acid* consumers seemed to be more attentive of late and producers have noticed this improvement with revisions in prices. *Caustic soda*, *bichromate of soda* and *soda ash* displayed a slightly easier tendency, although buyers have experienced some difficulty in getting any round lots. A fair amount of *bleach* business was placed at 2½¢. per lb. f.o.b. works for prompt and forward shipments to papermakers. Export business continued slow, although conditions appear to be crystallizing in a more favorable light for improvement. The strong recovery in exchange rates during the past week was a satisfactory development.

GENERAL CHEMICALS

Leading producers of *copper sulphate* report a slightly easier market for standard brands, 99 per cent, large crystals. Carlots are obtainable at 5½¢. per lb., while the small crystals, 98½-99 per cent, can be purchased at 5¼¢. per lb. A fairly active inquiry has reached the market from several European centers along the Mediterranean coast and also from France. It seems that German competition is keen enough to restrict any real business, as the price named by Germany c.i.f. those ports is about the cost of

production in America. The demand from domestic consumers has remained quiet. Buyers are hesitating because they believe that the market will go lower. Textile mills are buying sparingly and the movement to dyestuffs plants is far below that of last year. Makers of insecticides are also hesitating, awaiting any new revision in prices. Isolated lots of *prussiate of soda* sold as low as 13c. per lb. during the week, but most sellers were not eager to shade 13½c. An irregular call from the consuming trade has been experienced and transactions as a rule were confined to small tonnage lots. Solid *caustic soda* was quoted at \$3.60@\$3.75 per 100 lb., the inside figure being a domestic price and the outside an export figure. It is understood that quite a number of sales were made at out-of-town points by dealers for nearby shipments at the inside quotation. Outside brands can be purchased below these prices. Resale lots of standard brands are quite difficult to be found and the market showed a firmer tendency. Producers' prices remained unchanged at 3½c. per lb., basis 60 per cent, f.o.b. works for prompt and future shipments.

There are sellers of small lots of *bichromate of potash* at 13@13½c. per lb. Reports were current that scattered lots have occasionally been sold a shade under the inside price. The demand is quiet and there is no special feature to trading. Large consumers are receiving their supplies through regular contract channels. Resale lots of *soda ash* in single bags were offered by dealers at \$1.95@\$2.05 per 100 lb. Limited quantities of barrels were quoted at 2½c. per lb. Imported ash is obtainable at \$1.90 per 100 lb. Sales were not heavy during the week, but the tendency of prices continued steady. Anxiety over receiving shipments from abroad has strengthened the inquiry for *oxalic acid* in the local market and prices at the close of the week were considerably higher, with sellers naming 17½@20c. per lb. Some prominent dealers were naming prices all the way up to 25c. per lb. for prime domestic material. Resale *formaldehyde* is on the market at 16@16½c. per lb., but producers have lowered their price to a level which now offers keen competition. The minimum price now heard in first-hand quarters for large lots is 15½c. and 16c. per lb. and upward for small quantities. Trading in *bichromate of soda* during the past week has not shown much improvement. Limited quantities of resale material have been taken by buyers at prices ranging from 7½@8½c. per lb. Sellers in most quarters have not been inclined to shade 8c., but these holders have met with strong competition and the market has shown an irregular tendency. Futures have been practically neglected and the market was in a nominal condition.

COAL-TAR PRODUCTS

Improvement, while not general, has certainly made its appearance in various quarters of the coal-tar products market, which of course is traceable to and accounted for by the more extensive operations in the allied trades. Retail prices on many commodities have reached a level that is attracting the ultimate consumer, and large quantities of the accumulated stocks are being taken off the market. This seems to be particularly the case along the line of shoes, clothing and fabrics. The textile mills have increased their operations and many plants report their output substantially enlarged. An indication of the feeling as to the ultimate trend of this market is illustrated to some extent by the fact that only recently there have been some new concerns entering the manufacturing end of intermediates and dyestuffs. These factors have a good grip on the prevailing conditions and report some regular business of an encouraging nature. Sellers, including producers and dealers, are now handling what business comes their way and are going as far as they can without having to take any loss to meet buyers' views. The crude market is holding steady and considering the curtailed production and the lack of any outlook for a decrease in costs, firmness is looked for in this end of the industry. Intermediates have deviated very little during the week. Any firm orders were met with considerable shading in all quarters.

Producers report a fairly steady demand for supplies of *para-amidophenol*. Sellers seem to be in a good position on available material and quote the market at \$1.90@\$2 per

lb. for the base and \$2.10@\$2.20 for the HCl material. Trading in the market for *diethylaniline* continued along quiet lines with the demand routine for small lots. Supplies are available in fair volume on a basis of \$1.20@\$1.30 per lb. Consumers showed an added interest in *para-phenylenediamine* during the week and prices have held steady at \$1.90@\$2 per lb. During the year 1918, 215,148 lb., valued at \$3.68 per lb., was produced, while in 1919, 234,332 lb., valued at \$2.43 per lb., was manufactured. Trading in *orthonitrophenol* was reported in some quarters as fairly steady, but the lots were of a small nature. Sales are heard on a basis of 75c. per lb., but shading is possible on a firm bid. There was nothing in the way of buying to attract attention in the *nitro-benzene* market, as only a small routine business was reported in some quarters. Prices remained unchanged at 12@14c. per lb.

While the market remained easy on *aniline oil* supplies, there seems to be little pressure to sell and prices in first-hand quarters are fairly steady at 22@27c. per lb. There is a moderate amount of business reported in some directions and shading of the above prices is thought possible in some second-hand quarters on a firm order. Reports of producers of *benzene* show a fairly active market with domestic consumers quite interested and taking regular supplies, while the foreign demand is growing. Producers are steady in their views and quote on a basis of 30@36c. per gal. for the pure material and 28@32c. per gal. for the 90 per cent grade. The demand for *toluene* has remained dull and little has occurred to stimulate trading. Producers have stocks in fair volume, but production at plants has been somewhat curtailed in view of the light demand. Prices are held steady at 30@36c. per gal.

WAXES

Trading in crude *beeswax* was along routine lines, but prices were mainly on a fairly even basis throughout the week. African crude was offered at 17@20c. per lb. Brazilian was held at 25@27c. per lb. Refined wax was moving slowly at 27@32c. per lb. Leading importers report the market for *carnauba wax* unchanged, with trading comparatively quiet. Flora was available at 68@70c. per lb. and No. 2 North Country at 30@32c. per lb. The demand for *Japan wax* was limited, but with no apparent selling pressure in evidence, due to the fact that stocks on hand are small, prices were maintained at 19@20c. per lb.

With the market for crude oil moving down and export trade showing no improvement the market for *paraffine wax* closed weak with prices irregular. Scale wax, 122-124 melting point, was offered at 2½c. per lb. Fully refined, 130-132 melting point, was quoted on the basis of 5¼@6c. per lb.

The Iron and Steel Market

PITTSBURGH, March 18, 1921.

Production of steel has been still lower in the past week, the Steel Corporation's production this week being hardly over 45 per cent of capacity, against about 60 per cent last week, while independent mill operations seem to be considerably below the 25 per cent rate the independents were being credited with a fortnight ago.

For weeks past the volume of buying, including both fresh purchases and specifications against contracts, has been far below the production. The rate of buying appears to have turned upward in the past week or ten days, though only very slightly. Production on the whole continues to decline rather sharply, but the two lines are still far apart.

The case is simply that the independents have been unable to maintain their rate of production even by price cutting, while the disturbance in market values has caused Steel Corporation customers to call for a greater reduction in shipments to them than would otherwise have been the case. The Steel Corporation's shipments promise to continue declining unless consumption increases very materially, since many of the corporation's customers have stocks, accumulated recently when the shipments were in excess of consumption.

Improvement in demand is noticed particularly in the case of standard steel pipe and black and galvanized sheets. The increase in volume is slight and is noticeable only be-

cause the volume formerly was so small. There is no reason to suppose that there is reflected anything like the beginning of a general buying movement. Rather there is a reaction from a buying rate that was too low for permanence, for consumption cannot possibly cease entirely. To a slight extent there is probably reflected the advance in the season, but the full influence of the advent of spring is not yet seen.

PRICES

Bars are still quotable at 2c. and shapes and plates at 2.10c., there being no quotable change in two or three weeks, but perhaps there is a difference in that single carloads can now be bought at the prices just named. Concessions for larger tonnages with attractive specifications are possible, as formerly. The record low on plates seems to be 1.90c., made on a particularly desirable order.

Sheets are definitely lower than a week ago, single carloads being obtainable at 3.85c. for black and 5c. for galvanized, prices that ten days ago were possible only on fair sized lots, say 500 tons.

Hoops are obtainable more freely at 2.80c., against 3.05c. in the Industrial Board schedule. Cold-rolled strips can be done at 5.65c., the usual asking price being 6c., while the nominal price is 5.25c.

Steel prices are really of no particular moment at this time. There is no price issue between buyer and seller, and no reduction possible that would bring out any considerable volume of buying. Many buyers prefer to see prices maintained, as they have stocks of steel or of their manufactured goods and are more interested in disposing of these stocks than in making fresh purchases. The situation is of course one that will liquidate itself in time, and then price will be a very interesting subject to all buyers.

The Steel Corporation continues to maintain the Industrial Board prices it adhered to in 1920 when all independents advanced to higher levels. There is no prospect of the corporation taking any action in the very near future. Indications are that the corporation will probably change its system of mill and furnace operation in the course of a month or so by eliminating the 12-hour workday, but whether the change will be made in such manner as to decrease the wage cost of producing steel is merely matter for conjecture, hence it is not necessarily to be assumed that the corporation will reduce its prices at that time. Some of the corporation's customers have expressed their full approval of the corporation's policy of maintaining prices at this time and there is no evidence that buyers in general are eager for a reduction. It is a situation that must be allowed to work itself out.

Steel-producing capacity is so large, and the prospects for reducing production costs so uncertain, that if producers became careless in the matter of quoting prices the market might descend to a level that would mean loss for an indefinite period, as it would be extremely difficult to get prices up again without a demand representing approximately the full capacity, and such demand is not to be seen even in dim prospect. There has never been a demand for steel equal to the present capacity. Production during the first nine months of 1920, when demand seemed very heavy, was only 80 per cent of capacity, there being restriction by rail transportation and other conditions.

PIG IRON AND COKE

Merchant production of pig iron is extremely light, yet not all the iron produced is being shipped. Foundries appear in many cases to have fairly large stocks. It is only occasionally that there is any inquiry in the open market. The market is largely nominal at \$27 for bessemer, \$25 for basic and \$26 for foundry, f.o.b. valley furnaces. On a round tonnage lower prices could probably be done. Price is not entirely a matter of cost, since there are stocks that producers would be glad to work off, while some furnaces would probably be willing to accept orders for pig iron still to be made at less than present cost, in hope of being able to reduce cost during operation. Several Connellsville coke producers have reduced wages, and this may account for offerings of spot furnace coke at \$4.25, against \$4.50 recently the minimum.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	\$0 13 - \$0 13	\$0 55 - \$0 60
Acetone.....lb.	14 - 15	13 - 14
Acid, acetic, 28 per cent.....100 lbs.	2.50 - 2.75	3.00 - 3.25
Acetic, 56 per cent.....100 lbs.	4.00 - 4.25	4.50 - 5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	9.00 - 9.50	10.00 - 10.50
Boric, crystals.....lb.	14½ - 15	15½ - 16
Boric, powder.....lb.	15½ - 16½	17 - 18
Citric.....lb.	-	46 - 48
Hydrochloric.....100 lb.	1.75 - 2.00	2.10 - 2.25
Hydrofluoric, 52 per cent.....lb.	15 - 16	16½ - 18
Lactic, 44 per cent tech.....lb.	10 - 11	11½ - 12
Lactic, 22 per cent tech.....lb.	04½ - 05½	06 - 07
Molybdic, C. P.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.	06½ - 07	07½ - 08½
Nitric, 40 deg.....lb.	07½ - 08	08½ - 09½
Nitric, 42 deg.....lb.	17 - 18	19 - 20
Oxalic, crystals.....lb.	15 - 15½	16 - 16½
Phosphoric, Ortho, 50 per cent solution.....lb.	30 - 32	35 - 40
Picric.....lb.	-	2.30 - 2.40
Pyrrolidic, resublimed.....lb.	-	15.00 - 16.00
Sulphuric, 60 deg., tank cars.....ton	19.00 - 20.00	23.00 - 23.50
Sulphuric, 60 deg., drums.....ton	22.00 - 22.50	-
Sulphuric, 66 deg., tank cars.....ton	-	-
Sulphuric, 66 deg., drums.....ton	23.00 - 24.00	-
Sulphuric, 66 deg., carboys.....ton	-	-
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	32.00 - 35.00	40.00 -
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	1.15 - 1.25	1.48 - 1.50
Tannic, U. S. P.....lb.	45 - 47	34 - 38
Tannic (tech.).....lb.	-	1.30 - 1.40
Tartaric, crystals.....lb.	-	4.75 - 5.00
Tungstic, per lb. of WO.....lb.	-	-
Alcohol, Ethyl.....gal.	-	44 - 50
Alcohol, Methyl (see methanol).....gal.	-	51 - 54
Alcohol, denatured, 188 proof.....gal.	-	04½ - 05
Alcohol, denatured, 190 proof.....gal.	-	05½ - 06
Alum, ammonia lump.....lb.	04½ - 04½	14 - 14½
Alum, potash lump.....lb.	05½ - 06	02½ - 03
Alum, chrome lump.....lb.	13 - 13½	03½ - 03½
Aluminum sulphate, commercial.....lb.	02½ - 02½	07½ - 08
Aluminum sulphate, iron free.....lb.	03 - 03½	33 - 35
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	07 - 07½	11½ - 12
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	30 - 32	-
Ammonium carbonate, powder.....lb.	10 - 11	-
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	07½ - 08	08½ - 08½
Ammonium chloride, granular (gray salamoniac).....lb.	08½ - 08½	09 - 09½
Ammonium nitrate.....lb.	08 - 08½	10 - 10
Ammonium sulphate.....100 lb.	2.90 - 3.00	3.10 - 3.20
Amylacetate.....gal.	-	4.00 - 4.25
Amylacetate tech.....gal.	-	3.25 - 3.50
Arsenic oxide, (white arsenic) powdered lb.....lb.	09 - 09½	10 - 10½
Arsenic, sulphide, powdered (red arsenic) lb.....lb.	14 - 14½	15 - 15½
Barium chloride.....ton	65.00 - 70.00	75.00 - 80.00
Barium dioxide (peroxide).....lb.	19 - 20	21 - 22
Barium nitrate.....lb.	10 - 10½	10½ - 11
Barium sulphate (precip.) (blanc fixe).....lb.	04½ - 05	05½ - 06
Bleaching powder (see calc. hypochlorite).....	-	-
Blue vitriol (see copper sulphate).....	-	-
Borax (see sodium borate).....	-	-
Brimstone (see sulphur, roll).....	-	-
Bromine.....lb.	40 - 41	42 - 45
Calcium acetate.....100 lbs.	1.60 - 2.00	-
Calcium carbide.....lb.	04 - 04½	04½ - 05
Calcium chloride, fused, lump.....ton	27.00 - 29.00	30.00 - 32.00
Calcium chloride, granulated.....lb.	01½ - 01½	02 - 02½
Calcium hypochlorite (bleach'g powder) lb.....lb.	02½ - 02½	03 - 03½
Calcium peroxide.....lb.	-	1.25 - 1.50
Calcium phosphate, tribasic.....lb.	-	15 - 16
Camphor.....lb.	-	72 - 75
Carbon bisulphide.....lb.	08 - 08½	09 - 09½
Carbon tetrachloride, drums.....lb.	10 - 10½	11 - 12
Carbonyl chloride (phosgene).....lb.	-	75 - 1.00
Caustic potash (see potassium hydroxide).....	-	-
Caustic soda (see sodium hydroxide).....	-	-
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	08 - 09	09½ - 10
Chloroform.....lb.	-	38 - 40
Cobalt oxide.....lb.	-	3.00 - 3.10
Copper as (see iron sulphate).....	-	-
Copper carbonate, green precipitate.....lb.	22 - 23	24 - 25
Copper cyanide.....lb.	-	60 - 62
Copper sulphate, crystals.....lb.	05½ - 05½	06 - 06½
Cream of tartar (see potassium bitartrate).....	-	-
Epsom salt (see magnesium sulphate).....	-	-
Ethyl Acetate Com. 85%.....gal.	-	1.00 - 1.00
Ethyl Acetate pure (acetic ether 98% to 100%).....	-	-
Formaldehyde, 40 per cent.....lb.	15 - 16	16 - 16½
Fusel oil, ref.....gal.	-	4.00 - 4.50
Fusel oil, crude.....gal.	-	2.50 - 2.75
Glauber's salt (see sodium sulphate).....	-	-
Glycerine, C. P. drums extra.....lb.	-	19 - 20
Iodine, resublimed.....lb.	-	3.75 - 3.85
Iron oxide, red.....lb.	-	10 - 20
Iron sulphate (copperas).....100 lb.	1.15 - 1.25	1.50 - 1.75
Lead acetate.....lb.	-	14½ - 16
Lead arsenate.....lb.	11 - 12	12½ - 13
Lead nitrate.....lb.	-	15 - 20
Litharge.....lb.	08½ - 09	09½ - 10
Lithium carbonate.....lb.	-	1.25 -
Magnesium carbonate, technical.....lb.	10½ - 11	11½ - 12
Magnesium sulphate, U. S. P.....100 lb.	2.25 - 2.75	-
Magnesium sulphate, commercial.....100 lb.	-	1.70 - 2.00
Methanol, 95%.....gal.	-	88 - 92
Methanol, Colombian spirits.....gal.	-	1.20 - 1.25
Nickel salt, double.....lb.	-	12 - 12½
Nickel salt, single.....lb.	-	13 - 13½
Phosgene (see carbonyl chloride).....	-	-
Phosphorus, red.....lb.	45 - 46	47 - 50
Phosphorus, yellow.....lb.	-	35 - 37
Potassium bichromate.....lb.	12 - 13	13½ - 14

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	\$.35 — .40	\$0.30 — \$0.35
Potassium bromide, granular	lb.	.35 — .40	.20 — .40
Potassium carbonate, U. S. P.	lb.	.08 — .08½	.09 — .10
Potassium carbonate, crude	lb.	.08 — .10	.11 — .15
Potassium chlorate, crystals	lb.	.10 — .11	.40 — .45
Potassium cyanide	lb.	.10 — .11	.12 — .13
Potassium hydroxide (caustic potash)	lb.	.10 — .11	.12 — .13
Potassium muriate	ton	60.00 — 70.00	
Potassium iodide	lb.	.09½ — .09½	2.75 — 3.00
Potassium nitrate	lb.	.45 — .46	.10 — .12½
Potassium permanganate	lb.	.50 — .52	.48 — .50
Potassium prussiate, red	lb.	.25 — .26	.53 — .55
Potassium prussiate, yellow	lb.		.27 — .28
Potassium sulphate (powdered)	per uni.		2.25
Rochelle salts (see sodium potas. tartrate)			
Salammoniac (see ammonium chloride)			
Sal soda (see sodium carbonate)			
Salt cake	ton		30.00 — 33.00
Silver cyanide	oz.		1.30 — 1.35
Silver nitrate	oz.		.38 — .40
Soda ash, light	100 lb.	1.95 — 2.10	2.15 — 2.40
Soda ash, dense	100 lb.	2.20 — 2.30	2.40 — 2.60
Sodium acetate	lb.	.05½ — .05½	.06 — .06½
Sodium bicarbonate	100 lb.	2.60 — 2.75	3.00 — 3.25
Sodium bichromate	lb.	.08 — .08½	.08½ — .08½
Sodium bisulphate (nitre cake)	ton	7.00 — 7.50	8.00 — 11.00
Sodium bisulphate powdered, U.S.P.	lb.	.05½ — .05½	.06 — .06½
Sodium borate (borax)	lb.	.07 — .08	.08½ — .08½
Sodium carbonate (sal soda)	100 lb.	1.90 — 2.00	2.25 — 2.50
Sodium chlorate	lb.	.10 — .10½	.10½ — .11
Sodium cyanide, 96-98 per cent	lb.	.20 — .22	.23 — .30
Sodium fluoride	lb.	.13 — .13½	.14 — .14½
Sodium hydroxide (caustic soda)	100 lb.	3.60 — 3.70	3.80 — 4.00
Sodium hyposulphite	lb.		.03½ — .04
Sodium nitrate	100 lb.	2.75 —	2.85 —
Sodium nitrite	lb.	.06 — .06½	.06½ — .07
Sodium peroxide, powdered	lb.	.30 — .31	.32 — .34
Sodium phosphate, dibasic	lb.	.04½ — .04½	.05 — .05½
Sodium potassium tartrate (Rochelle salts)	lb.	.14 — .14½	.14½ — .14½
Sodium prussiate, yellow	lb.	1.25 — 1.35	1.40 — 1.50
Sodium silicate, solution (40 deg.)	lb.	.03 — .03½	.03½ — .03½
Sodium silicate, solution (60 deg.)	lb.	1.75 — 2.00	2.25 — 2.50
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	.05 — .05½	.05½ — .06
Sodium sulphide, crystal, 60-62 per cent (conc.)	lb.	.04 — .04½	.04½ — .05
Sodium sulphite, crystals	lb.	.16 — .16½	.16½ — .17
Strontium nitrate, powdered	lb.	.07 — .07½	.07½ — .08
Sulphur chl ride, red	lb.	16.00 — 20.00	.08 — .09
Sulphur, crude	ton	.08 — .08½	2.25 — 3.10
Sulphur dioxide, liquid, cylinders	lb.		2.00 — 2.75
Sulphur (sublimed), flour	100 lb.		
Sulphur, roll (brimstone)	100 lb.		
Tin bichloride, 50 per cent	lb.	.18 — .19	.40 — .42
Tin oxide	lb.	.16 — .18	.19 — .20
Zinc carbonate, precipitate	lb.	.11 — .11½	.11½ — .12
Zinc chloride, gran.	lb.	.45 — .49	.50 — .60
Zinc cyanide	lb.	.12 — .13	.13½ — .14
Zinc dust	lb.	.09 — .09½	.09½ — .10
Zinc oxide, XX	lb.	.03½ — .03½	.04 — .05
Zinc sulphate	lb.		

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	\$1.10 — \$1.15
Alpha-naphthol, refined	lb.	1.45 — 1.50
Alpha-naphthylamine	lb.	.38 — .40
Aniline oil, drums extra	lb.	.22 — .26
Aniline salts	lb.	.28 — .32
Anthracene, 80% in drums (100 lb.)	lb.	.75 — 1.00
Benzaldehyde U.S.P.	lb.	1.00 — 1.50
Benzidine, base	lb.	.95 — 1.05
Benzidine sulphate	lb.	.80 — .90
Benzoic acid, U.S.P.	lb.	.65 — .70
Benzoate of soda, U.S.P.	lb.	.65 — .70
Benzene, pure, water-white, in drums (100 gal.)	gal.	.30 — .35
Benzene, 90%, in drums (100 gal.)	gal.	.28 — .32
Benzyl chloride, 95-97%, refined	lb.	.30 — .35
Benzyl chloride, tech.	lb.	.25 — .30
Beta-naphthol benzoate	lb.	3.50 — 4.00
Beta-naphthol, sublimed	lb.	.70 — .75
Beta-naphthol, tech.	lb.	.35 — .45
Beta-naphthylamine, sublimed	lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)	lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums	gal.	.90 — .95
Cresylic acid, 75-97%, dark, in drums	gal.	.85 — .90
Cresylic acid, 50%, first quality, drums	gal.	.55 — .60
Dichlorobenzene	lb.	.06 — .09
Diethylaniline	lb.	1.20 — 1.30
Dimethylaniline	lb.	.55 — .65
Dinitrobenzene	lb.	.30 — .32
Dinitrochlorobenzene	lb.	.25 — .30
Dinitronaphthalene	lb.	.33 — .35
Dinitrophenol	lb.	.40 — .45
Dinitrotoluene	lb.	.27 — .30
Dip oil, 25%, tar acids, car lots, in drums	gal.	.38 — .40
Diphenylamine	lb.	.60 — .70
H-acid	lb.	1.30 — 1.50
Meta-phenylenediamine	lb.	1.25 — 1.30
Monochlorobenzene	lb.	.14 — .16
Monoethylaniline	lb.	1.75 — 2.00
Naphthalene crushed, in bbls. (250 lb.)	lb.	.08 — .08½
Naphthalene, flake	lb.	.08 — .08½
Naphthalene, balls	lb.	.09½ — .10½
Naphthionic acid, crude	lb.	.70 — .75
Nitrobenzene	lb.	.12 — .15
Nitro-naphthalene	lb.	.30 — .35
Nitro-toluene	lb.	.18 — .25
Ortho-amidophenol	lb.	3.20 — 3.75
Ortho-dichlor-benzene	lb.	.15 — .20
Ortho-nitro-phenol	lb.	.75 — .80
Ortho-nitro-toluene	lb.	.20 — .24
Ortho-toluidine	lb.	.25 — .30
Para-amidophenol, base	lb.	1.90 — 2.00
Para-amidophenol, HCl	lb.	2.10 — 2.20

Para-dichlorobenzene	lb.	.15 — .20
Paranitroaniline	lb.	.85 — .90
Para-nitrotoluene	lb.	.90 — 1.05
Para-phenylenediamine	lb.	1.90 — 2.00
Para-toluidine	lb.	1.30 — 1.60
Phthalic anhydride	lb.	.55 — .60
Phenol, U. S. P., drums (dest.), (240 lb.)	lb.	.12 — .14
Pyridine	gal.	2.00 — 3.50
Resorcinol, technical	lb.	1.85 — 2.00
Resorcinol, pure	lb.	2.30 — 2.50
Salicylic acid, tech., in bbls. (110 lb.)	lb.	.22 — .23
Salicylic acid, U. S. P.	lb.	.25 — .27
Salol	lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.28 — .32
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.16 — .18
Sulphanilic acid, crude	lb.	.30 — .35
Tolidine	lb.	1.35 — 1.45
Toluidine, mixed	lb.	.40 — .45
Toluene, in tank cars	gal.	.28 — .32
Toluene, in drums	gal.	.30 — .35
Xylidines, drums, 100 gal.	lb.	.40 — .45
Xylene, pure, in drums	gal.	.42 — .45
Xylene, pure, in tank cars	gal.	.45 — .45
Xylene, commercial, in drums, 100 gal.	gal.	.33 — .35
Xylene, commercial, in tank cars	gal.	.30 — .35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	\$0.24 — \$0.26
Beeswax, refined, light	lb.	.27 — .28
Beeswax, white pure	lb.	.40 — .45
Carnauba, Fl ra.	lb.	.68 — .70
Carnauba, No. 2, North Country	lb.	.30 — .32
Carnauba, No. 3, North Country	lb.	.18 — .19
Japan	lb.	.19½ — .20
Montan, crude	lb.	.07 — .08
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.03½ — .03½
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.03 — .03½
Paraffine waxes, refined, 118-120 m.p.	lb.	.04 — .04½
Paraffine waxes, refined, 125 m.p.	lb.	.05 — .05½
Paraffine waxes, refined, 128-130 m.p.	lb.	.05 — .06
Paraffine waxes, refined, 133-135 m.p.	lb.	.06½ — .06½
Paraffine waxes, refined, 135-137 m.p.	lb.	.07 — .07½
Stearic acid, single pressed	lb.	.11 — .11
Stearic acid, double pressed	lb.	.11½ — .11½
Stearic acid, triple pressed	lb.	.12 — .12½

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940	gal.	\$1.70
Pine oil, pure, dest. dist.	gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75
Pine tar, ref., thin, sp.gr., 1.080-1.960	gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970	gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990	gal.	.37
Pinewood creosote, ref.	gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl.	280 lb.	\$6.25 —
Rosin E-1	280 lb.	6.25 —
Rosin K-N	280 lb.	6.25 —
Rosin W. G.-W. W.	280 lb.	6.50 —
Wood rosin, bbl.	280 lb.	6.75 —
Spirits of turpentine	gal.	.59 —
Wood turpentine steam dist	gal.	.53 —
Wood turpentine, dest. dist.	gal.	.52 —
Pine tar pitch, bbl.	200 lb.	— 7.00
Tar, kiln burned, bbl. (500 lb.)	bbl.	— 14.50
Retort tar, bbl.	500 lb.	15.00 — 14.75
Rosin oil, first run	gal.	.45 —
Rosin oil, second run	gal.	.48 —
Rosin oil, third run	gal.	.60 —

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	\$0.41
70-72 deg., steel bbls. (85 lb.)	gal.	.39
68-70 deg., steel bbls. (85 lb.)	gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30

Crude Rubber

Para-Upriver fine	lb.	\$0.17 — \$0.18
Upriver coarse	lb.	.13 — .14
Upriver caucho ball	lb.	.14 — .14½
Plantation—First latex crepe	lb.	.19½ —
Ribbed smoked sheets	lb.	.17½ —
Brown crepe, thin, clean	lb.	.18 —
Amber crepe No. 1	lb.	.20 —

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	\$0.08½ — \$0.09
Castor oil, AA, in bbls.	lb.	.10 — .10½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.07½ — .08
Cocoonut oil, Ceylon grade, in bbls.	lb.	.09½ — .09½
Cocoonut oil, Cochinchina grade, in bbls.	lb.	.09½ — .10
Corn oil, crude, in bbls.	lb.	.08 — .08½
Cottonseed oil, crude (f. o. b. mill)	lb.	.04 —
Cottonseed oil, summer yellow	lb.	.06½ — .06½
Cottonseed oil, winter yellow	lb.	.07 — .07½
Linseed oil, raw, car lots (domestic)	gal.	.65 — .68
Linseed oil, raw, tank cars (domestic)	gal.	.58 —
Linseed oil, in 5-bbl lots (domestic)	gal.	.67 —

Olive oil, commercial.....	gal.	\$2.00	—	\$2.50
Palm, Lagos.....	lb.	.07½	—	.07½
Palm, Niger.....	lb.	.06½	—	.06½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.05½	—	.06
Peanut oil, refined, in bbls.....	lb.	.11	—	.11½
Rapeseed oil, refined in bbls.....	gal.	1.05	—	1.10
Rapeseed oil, blown, in bbls.....	gal.	1.15	—	1.20
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07	—	.07½
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.04	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.45	—	\$0.47
Yellow bleached menhaden.....	gal.	.47	—	.....
White bleached menhaden.....	gal.	.49	—	.....
Blown menhaden.....	gal.	.84	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	17.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	.....
Blanc fixe, dry.....	lb.	.05	—	.05½
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.16
Chalk, domestic, extra light.....	lb.	.05	—	.05½
Chalk, domestic, light.....	lb.	.04½	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04½	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Fla.....	net ton	25.00	—	.....
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	30.00	—	35.00
Graphite, Ceylon lump, first quality.....	lb.	.08	—	.09
Graphite, Ceylon chip.....	lb.	.07	—	.08
Graphite, higher lubricating grades.....	lb.	.11	—	.40
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.57	—	.....
Shellac, orange superfine.....	lb.	.62	—	.....
Shellac, A. C. garnet.....	lb.	.45	—	.....
Shellac, T. N.....	lb.	.47	—	.....
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	14.00	—	15.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	40.00	—	50.00
Talc, California talcum powder grade.....	ton	20.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	.....	.....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	80-100	.....	.....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	45-50	.....	.....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	.....	55	.....
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	.....	.....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	.....	.....
Magnesite brick, 9-in. straight.....	net ton	100	.....	.....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105	.....	.....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	120	.....	.....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65-70	.....	.....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56-61	.....	.....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	50-60	.....	.....

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.15	—	.....
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.15	—	.16
Ferromanganese, 76-80% Mn, domestic.....	gross ton	90.00	—	95.00
Ferromanganese, 76-80% Mn, English.....	gross ton	90.00	—	95.00
Spiegeleisen, 18-22% Mn.....	gross ton	38.00	—	40.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.00	—	2.50
Ferrosilicon, 10-15%.....	gross ton	50.00	—	55.00
Ferrosilicon, 30%.....	gross ton	85.00	—	90.00
Ferrosilicon, 75%.....	gross ton	145.00	—	150.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.50	—	.55
Ferroumium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	.....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00	—	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.45	—	.50
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.45	—	.50
Coke, foundry, f.o.b. ovens.....	net ton	5.00	—	6.00
Coke, furnace, f.o.b. ovens.....	net ton	4.50	—	5.00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00	—	16.00
Fluorspar, lump, f.o.b. Hea'hden, New Mexico.....	net ton	17.50	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	—	25.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01
Manganese ore 50% Mn, c.i.f. Atlantic seaport.....	unit	.35	—	.40
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.16	—	.....
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.16½	—	.....
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	—	3.25
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	.....
Zircon, washed, iron free.....	lb.	.03	—	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.00
Aluminum, 98 to 99 per cent.....	28.3 @ 28.5
Antimony, wholesale lots, Chinese and Japanese.....	5½ @ 5½
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	.35
Monel metal ingots.....	.38
Monel metal, sheet bars.....	.40
Tin, 5-ton lots.....	27.00
Lead, New York, spot.....	4.00
Lead, E. St. Louis, spot.....	3.95 @ 4.00
Zinc, spot, New York.....	7.00
Zinc, spot, E. St. Louis.....	4.75

OTHER METALS

Silver (commercial).....	oz.	\$0.56½
Cadmium.....	lb.	1.10
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.65
Cobalt.....	lb.	4.50
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00-75.00
Iridium.....	oz.	275.00 @ 300.00
Palladium.....	oz.	65.00
Mercury.....	.75 lb.	47.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	20.50
Copper bottoms.....	28.00
Copper rods.....	18.75
High brass wire.....	17.50
High brass rods.....	15.25
Low brass wire.....	20.25
Low brass rods.....	20.25
Brazed brass tubing.....	29.50
Brazed bronze tubing.....	34.25
Seamless copper tubing.....	22.00
Seamless high brass tubing.....	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	8.50 @ 9.00	18.50	10.00	10.50
Copper, heavy and wire.....	8.00 @ 8.25	16.50	9.50	9.50
Copper, light and bottoms.....	7.00 @ 7.50	14.50	9.00	8.50
Lead, heavy.....	3.00 @ 3.50	7.25	4.00	4.00
Lead, tea.....	2.00 @ 2.12½	5.25	3.00	3.00
Brass, heavy.....	4.25 @ 4.50	9.50	7.00	10.00
Brass, light.....	3.00 @ 3.25	8.00	5.00	5.50
No. 1 yellow brass turnings.....	4.00 @ 4.25	9.50	5.50	6.00
Zinc.....	2.00 @ 2.50	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	*Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes.....	\$3.60	\$3.80	\$3.47	\$3.58	\$3.37	\$3.58	\$3.47
Soft steel bars.....	3.80	3.70	3.52	3.34	3.27	3.48	3.52
Soft steel bar shapes.....	3.80	3.70	3.52	3.48	3.27	3.48	3.52
Soft steel bands.....	4.20	4.65	4.22	6.25	.....	.....	.....
Plates, ½ to 1 in. thick.....	3.80	4.00	3.67	3.78	3.57	3.78	3.67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

SELMA—G. W. Tidd and associates have plans under way for the erection of a new plant at Tuscaloosa, Ala., for the manufacture of cement brick and kindred products. The factory will be equipped for a daily production of about 25,000 bricks.

California

LOS ANGELES—The Co-operative Glass Co., Bank of Italy Bldg., has awarded a contract to the Pozzo Construction Co., 421 Macy St., for the erection of a new 1-story and basement plant at Daly and Richmond Sts., consisting of two buildings, 91 x 180 ft. and 40 x 75 ft., respectively. The plant will cost about \$48,000.

MERCED—The California Pottery Co. will construct a total of 32 kilns at its new local plant, now in course of construction, and it is planned to commence operations in certain departments of the plant during April. It will give employment to about 300 operatives.

Georgia

SAVANNAH—A portion of the plant of the Atlantic Turpentine & Pine Tar Co., Central Junction, near Savannah, was destroyed by fire, March 4, with loss estimated at \$75,000.

Illinois

CHICAGO—The American Vat Color Co., of Chicago, Ill., has leased a building at 3223 South Western Ave., for manufacturing purposes.

Indiana

HAMMOND—The Standard Oil Co. of Indiana has purchased a 160-acre tract of land located in the cities of Hammond and Whiting, Ind., to make space for contemplated additions to existing plant.

Iowa

NEVADA—The Mason City Brick & Tile Co., Mason City, Ia., is considering the erection of a new brick and tile manufacturing plant at Nevada, to cost about \$250,000 with machinery. B. C. Keller is head.

Louisiana

SHREVEPORT—The Great Southern Producing & Refining Co., Indianapolis, Ind., has plans under way for the erection of a new unit at its Shreveport oil refinery. J. F. A. Moore, 900 Euclid Ave., Cleveland, O., is engineer.

BRAITHEWAITE—The Braithewaite Paper Co. is planning for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at \$75,000.

BASTROP—The Bastrop Pulp & Paper Co. has plans under way for the construction of a new pulp and paper mill. The first unit of the plant, estimated to cost about \$75,000, will be devoted to pulp production, and at a later date will be followed by the proposed paper mill.

Maryland

BALTIMORE—Victor C. Blode, Caton and Carroll Sts., manufacturer of chemicals, is planning for the rebuilding of the section of his plant damaged by fire on March 3.

BALTIMORE—Fire, March 3, caused a considerable loss at the plant of the Martin Fertilizer Co., Clinton and Fourth Sts., with damage including the acid and condenser departments.

Massachusetts

SALEM—The John C. Dow Leather Co., recently incorporated with a capital of \$50,000, has acquired the local plant of the Berkovitch-Mishel Leather Co., and will specialize in the manufacture of sheep leathers from pickled sheepskins. The plant will be equipped for color production, including black. John C. Dow, 106 South St., Boston, heads the company.

STURBRIDGE—George Kanutzen and George Kanutzen, Jr., are planning for the operation of local graphite properties. It is proposed to develop an extensive capacity at a site previously operated, but closed down some months ago.

Michigan

KALAMAZOO—The Kalamazoo Vegetable Parchment Co. is planning to break ground early in May for the erection of its proposed new local paper mill, comprising a two-machine addition to its present plant, 80 x 900 ft., and estimated to cost about \$400,000 with machinery. Billingham & Cobb, Press Bldg., are architects and engineers. J. Kindler is president.

WELLS—The Delta Chemical Co. is reported to be planning for the rebuilding of its plant, destroyed by fire, March 8, with loss estimated at \$500,000, including machinery. R. B. Goetschaus is president.

Minnesota

ST. PAUL—The James Roe Glass Co., 109-13 East Ninth St., is planning for the rebuilding of the portion of its plant destroyed by fire, Feb. 27, with loss of about \$25,000.

New Jersey

TRENTON—Walter L. Collins, 64 Grove St., Milford, Mass., has made application to the local Chamber of Commerce for a plant or plant site, for the establishment of a new tile-manufacturing plant. The works will be used for the production of ceramic tiling under a new process. A company is now being organized by Mr. Collins. Secretary Conover, Trenton Chamber of Commerce, is in charge of the proposition.

BAYONNE—The Union Sulphur Co., 17 Battery Pl., New York, has acquired a tract of property in the Bergen Point district with frontage on the Kill van Kull of about 400 ft., and extending on First St. to the foot of Avenues C and D. The site will be used for a new works at a later date. At the present time the company will construct a large service building.

CARNEY'S POINT—E. I. du Pont de Nemours & Co., Wilmington, Del., is planning for the construction of a new color-manufacturing plant in this section. It is said that the proposed factory will be one of the largest dry color plants in the world, ultimately giving employment to over 20,000 operatives. The company is also reported to be arranging for the erection of a new lithopone plant.

New York

MASPEETH, L. I.—The Gleason Tiebout Glass Co., has filed plans for extensions and improvements in its plant on Flushing Ave., near Garrison St.

BROOKLYN—Fire, March 10, destroyed a portion of the Sone & Fleming Oil Works of the Standard Oil Co., Greenpoint and Kingsland Aves., with loss estimated at \$150,000. It will be rebuilt.

North Carolina

HENDERSON—The Vance Guano Works, a subsidiary of the American Agricultural Chemical Co., 2 Rector St., New York, is planning for the rebuilding of its local plant, with number of new extensions. The work, including equipment, is estimated to cost about \$500,000. A capacity of about 50,000 tons of fertilizer per annum will be developed.

GREENSBORO—The Guilford Mining Co., 335 Harrison Apartments, recently organized, is planning for the development of copper and other mineral properties in the vicinity of Guilford, N. C. Considerable machinery for operation will be installed at an early date. J. C. White and R. F. Titsworth, Knoxville, Tenn., head the company.

ROSE HILL—The Rose Hill Brick & Tile Co. has plans under way for the erection of a new local plant for the manufacture of cement tiling and kindred products. G. B. D. Parker, Chinquapin, N. C., is president.

Ohio

NEWARK—The American Bottle Co. has plans under way for the erection of a new building at its plant, 1-story, 250 x 500 ft.

The DeVore Co., 908 Nicholas Bldg., Toledo, O., is architect.

PIQUA—The American Strawboard Co., manufacturer of corrugated fiber products, has preliminary plans under way for the erection of a new 1 story plant. Headquarters of the company are at Akron, O.

BARNESVILLE—The Kearns-Gorsuch Glass Co., a subsidiary of the Hazel-Atlas Glass Co., Wheeling, W. V., is reported to be planning for the rebuilding of its local plant, destroyed by fire, March 3, with loss estimated in excess of \$500,000, including machinery. The company manufactures fruit jars, etc.

CAMBRIDGE—The Flannagan Pottery Co. is taking bids for the erection of an addition to its kiln department to cost about \$20,000.

WOOSTER—The Stellar Refinery Co. has completed plans for the erection of a new oil-refining plant in the vicinity of Cincinnati. The works will include a power house and pumping plant, and are estimated to cost about \$300,000 with machinery. E. M. Quincy is vice-president.

Oklahoma

TULSA—The Wilcox Oil & Gas Co. has preliminary plans under way for the erection of a new oil refining plant, with daily capacity of close to 5,000 bbl. The company has acquired a site, totaling about 150 acres, for the refinery and will expend about \$1,500,000 on the project. A new pipe line will be built from Bristow, Okla., to a point near St. Louis, Mo. Homer F. Wilcox is president.

PONCA CITY—James Gramme and associates are planning for the construction of a new lime-manufacturing works. The company has extensive limestone deposits in this district, and will devote initial operations to raw material production. A crushing plant will be installed at an early date.

Pennsylvania

MARCUS HOOK—The Union Petroleum Co. has construction under way on a new lubricating-oil works addition, about 200 x 200 ft. It is planned to place a portion of the plant in service at an early date. The tankage department will consist of 42 tanks, each 25 ft. in diameter and 30 ft. high, with 9 agitators and accessory equipment.

NORRISTOWN—A portion of the plant of the Norris Magnesite & Asbestos Co. was damaged by an explosion on March 9. An official estimate of the loss has not been made. It is said that the plant will be rebuilt at an early date.

HARRISBURG—The Harrisburg Bag & Box Co., 1550 Vernon St., manufacturer of paper specialties, will soon commence the erection of two new plant units, 1- and 2-story, about 64 x 125 ft., estimated to cost approximately \$200,000 with machinery. R. R. Markley, Spooner Bldg., Harrisburg, is architect. Samuel E. Eby is head.

Tennessee

MEMPHIS—The Memphis Packing Co. is considering the erection of a new local soap-manufacturing plant. Details are being arranged. Joseph Newburger is president.

Texas

DENTON—The Crescent Refining Co. has completed plans for the erection of a new oil refinery on a local site, with initial capacity of about 75 bbl. per day. J. A. Minnis is president.

Washington

SEATTLE—The Fisher Flouring Mills Co., Harbor Island, is negotiating with the Public Dock Commissioners, Portland, Ore., for the use of property at the Upper Albina ferry land in connection with its proposed new mills in this section, estimated to cost about \$800,000 with machinery.

West Virginia

MORGANTOWN—H. J. Booth, Pittsburgh, has preliminary plans under way for the erection of a new glass manufacturing plant in the vicinity of Round Bottom, W. Va. A site for the factory has been secured.

HUNTINGTON—The Huntington Tumbler Co., manufacturer of glass tumblers, etc., is planning for the erection of a new plant for increased output, to consist of a 1-story factory 80 x 275 ft., with two extensions, 60 x 60 ft. and 30 x 55 ft. respectively. The new works are estimated to cost about \$135,000 with machinery. A. F. Dickey, First National Bank Bldg., Huntington, is architect.

Wisconsin

JANESVILLE—George T. Simmons, R.F.D. 8, has broken ground for the erec-

tion of a new 2-story plant at Edgerton, Wis., 60 x 155 ft., to be equipped for the manufacture and assembling of porcelain spark plugs. The factory is estimated to cost about \$100,000.

Alberta

EDMONTON—The Imperial Oil Co. and the Edmonton Gas & Power Co. are seeking power from the Alberta Government, now in session, to enable them to construct pipelines for the purpose of conveying oil and gas, respectively, through the province. The line of route is not specified.

Quebec

MONTREAL—The Brompton Pulp & Paper Co. is arranging for a bond issue of \$3,000,000, a portion of the proceeds to be used for extensions, betterments and operations.

Industrial Notes

E. I. DU PONT DE NEMOURS & Co., Wilmington, Del., makes the following announcement of changes in organization, effective Feb. 1, 1921: The miscellaneous manufacturing department will be discontinued; substituted therefor within the production department, two new departments are created to be known respectively as the dyestuffs department and the paint and chemicals manufacturing department. The dyestuffs department will be in charge of C. A. Meade, V. P., with W. F. Harrington as director. The dyestuffs sales division and the dye manufacturing division have been transferred without change of personnel to form the selling and manufacturing divisions of the new dyestuffs department. The paint and chemicals manufacturing department will also be in charge of C. A. Meade, V. P., with Hunter Grubb as director and E. C. Thompson as assistant director. R. W. Sample has been appointed manager of paint and varnish sales, Eastern division, with headquarters at 35th and Gray's Ferry Rd., Philadelphia, Pa. The sales of paints and varnishes will be consolidated under Mr. Sample at Philadelphia for all of the company's selling branches, with the exception of Boston, Chicago, New York and San Francisco. The railway, industrial and architectural representatives of the paint and varnish section will also report to Mr. Sample.

THE AMALGAMATED METALS Co., producer of brass and bronze castings, has become affiliated with the Casey-Hudson Co., manufacturer of screw machines and other machine products at Chicago. The new offices will be located in the Casey-Hudson Co., 361 East Ohio St., Chicago, Ill.

FREDERICK JOHNSTON severed his connection with Marden, Orth & Hastings in order to direct the chemical sales division of the Michigan Iron & Chemical Co., Consumers Bldg., Chicago, Ill.

THE AUSTIN MACHINERY Co., of Louisiana, has been organized under the laws of the State of Louisiana for distribution of the products of the Austin Machinery Corp. in Louisiana, Arkansas, Mississippi and Tennessee. The general offices of the company are located at 1020 Maison Blanche Bldg., New Orleans, La.

F. J. RYAN & Co., Philadelphia, Pa., specialists in electric heating problems in both the chemical and the metallurgical industry, announce the election of the following departmental executives: S. H. Ourbacker, director of engineering, F. A. Hall, director of sales, and T. B. Bechtel, director of construction. F. J. Ryan & Co. was organized by Mr. Ryan, who has been allied with the electric-furnace development since its commencement in this country. The original company was organized in 1913, but was inactive for a period of three years when he occupied the position of director and general manager of the Electric Furnace Construction Co., and later as directing manager of the American Metallurgical Corp., the active business of which was terminated last October when F. J. Ryan & Co. was incorporated. The remaining contracts of the American Metallurgical Corp. have been completed by the new organization and practically all of the executives of the old organization have become members of the new. From this time on the new organization will specialize exclusively in electrometallurgy and electrochemistry. Departments for the manufacture of low-temperature ovens have been added, and structural and machine divisions created through associations with Philadelphia shops. A New York office has been opened recently at 21 East 40th St. under the direction of E. C. Melby. Mr. Melby will have supervision over the New York district and export field. His previous experience for a number of years in the export trade, specializing with the Scandinavian countries, makes him especially adapted to this district.

THE SURFACE COMBUSTION Co., Inc., 366 Gerard Ave., Bronx, New York City, manufacturer of industrial furnaces, has acquired the entire rights and interests of the Ratiometer Corp., Rochester, N. Y. The latter company has during the last few years manufactured ratiometers in Rochester, N. Y. The Surface Combustion Co., Inc., has established a separate manufacturing and sales organization in its own plant in New York City, where it will continue this business under the name of the Ratiometer Corp. The ratiometer is a mechanical device, invented by Ivar Lundgaard, for the automatic proportioning of gaseous fuels and the air used for their combustion. The manufacturers claim this device can be readily installed on any two-pipe system, automatic temperature control being maintained entirely through the gas line. Other patent rights recently acquired by the Surface Combustion Co., Inc., are the Clark principle of intermittent firing for enameling furnaces and the Langenberg-Fetterly furnace for heat-treating armor-piercing shells.

W. E. PRINDLE, who was formerly president of the Buckeye Dryer Co., has started the manufacture of direct, indirect and steam-heated driers, as W. E. Prindle Co., Columbus, O.

THE AMERICAN GAS FURNACE Co. announces that its entire personnel will henceforth be concentrated in a main office in Elizabeth, N. J., in which city its two plants are located; also that it has discontinued selling operations through its former sole agent, E. P. Reichhelm & Co., Inc. The results of this action will be the more thorough co-operation of the various departments and will place more intimately at the disposal of its patrons the entire organization of The American Gas Furnace Co.

THE CUTLER-HAMMER MFG. Co., Milwaukee, Wis., announces the following changes in the personnel and district office territory of Milwaukee and New York: G. S. Crane, who has been manager of the Cleveland office, will become manager of controller sales at the main office in Milwaukee. L. B. Timmerman will be in charge of the Cleveland office, and will act in the capacity of assistant to A. G. Pierce, manager of the central district. The Cincinnati office will become a part of the central district, with R. I. Maujer as branch manager. E. N. Lightfoot will assume the title of manager of the heating department, with headquarters at the New York works, and will be in full charge of all matters relating to the sale of electric-heating devices.

New Companies

THE AMERICAN WOOD CHEMICAL Co., Chattanooga, Tenn., has been incorporated with a capital of \$800,000 to manufacture chemicals and byproducts. The incorporators are R. L. Frost and John S. Wrinkle, Chattanooga.

THE INDUSTRIAL POTASH CORP., capitalized at \$30,000,000, has been incorporated at Salt Lake City, Utah, to exploit the alunite deposits at Marysville, Utah. The incorporators are Ross F. Beckstrom and Jacob H. Krause of Rockford, Ill., and Francis F. Hansen and Louis Grollman of Chicago.

THE BRAZILIAN RUBBER REFINING & MFG. Co., New York, N. Y., has been incorporated with a capital of \$400,000 to manufacture refined rubber and finished rubber products. The incorporators are J. T. Coggins, F. Chamie and J. E. Strowbridge, 812 Bergen St., Brooklyn.

THE WEST LEATHER BELTING Co., Room 1021, 39 South La Salle St., Chicago, Ill., has been incorporated with a capital of \$35,000 to manufacture leather belting and kindred products. The incorporators are K. H. West, Frederic O. Mason and Edward R. Adams.

THE AMERICAN PINE PRODUCTS REFINING Co., Savannah, Ga., has been incorporated with a capital of \$250,000 to manufacture refined oils. The incorporators are H. F. Hogeborn, Savannah; B. A. Deal, Jr., Nashville, Ga.; and H. B. Elliott, Salisbury, Md.

THE TROEGER PRODUCTS CORP., Brooklyn, N. Y., has been incorporated with a capital of \$50,000 to manufacture chemicals and chemical byproducts. The incorporators are F. S., E. A. and J. F. R. Troeger, 648 East Thirty-fourth St., Brooklyn.

THE KORTE PRODUCTS Co., 2858 Fifth Ave., Chicago, Ill., has been incorporated with a capital of \$25,000 to manufacture chemicals and affiliated products. The incorporators are Samuel L. Goldberg, Charles Weiss and Frank Korte.

THE EAST LONG BEACH OIL Co., Inc., Long Beach, Cal., has been incorporated with a capital of \$1,000,000 to manufacture

petroleum products. The incorporators are W. LeRoy Thomas, C. A. Willis and J. F. Collins, all of Long Beach. Swaffield & Swaffield, 529 First National Bank Bldg., Long Beach, represent the company.

THE UNITED STATES PULP PRODUCTS CORP., Newark, N. Y., has been incorporated under Delaware laws with a capital of \$1,750,000 to manufacture pulp specialties. The incorporators are Lindsey Hooper, Ernest L. Fox and L. G. Rowe, Newark.

THE MCCANN-SHIELDS PAINT Co., Pittsburgh, Pa., has been incorporated with a capital of \$15,000 to manufacture paints, varnish, etc. J. E. Shields, 1820 Metropolitan St., is treasurer.

THE CRYSTAL OIL Co., Richmond, Va., has been incorporated with a capital of \$2,750,000 to manufacture refined oil products. Whiting C. Faulkner, Richmond, is president, and W. E. Bryan, Denver, Colo., secretary.

THE GUASTI FINCH CHEMICAL Co., Vernon, Cal., has been incorporated with a capital of \$50,000 to manufacture chemicals and chemical byproducts. The incorporators are Secondo Guasti, L. S. Finch and J. I. Barlotti, all of Los Angeles, Cal.

THE PRINCE RE-ENFORCED RUBBER Co., Boston, Mass., has been incorporated with a capital of \$50,000 to manufacture mechanical rubber products. The incorporators are Howard P. Knox, J. D. Prince and Herbert B. Morse, 140 Oliver St.

WOHL, LETRAK & Co., New York, N. Y., has been incorporated with a capital of \$10,000 to manufacture glass products. The incorporators are R. Dolgin, G. G. Rosenberg and B. Rabinowitz, 261 Broadway.

THE ERWIN CHEMICAL PRODUCT Co., New York, N. Y., has been incorporated with a capital of \$30,000 to manufacture chemicals and affiliated specialties. The incorporators are W. W. Jordan, M. P. Matthias and L. B. Erwin, Forest Hills, N. Y.

THE SANITARY CHEMICAL SPECIALTIES Co., 208 North Wells St., Chicago, Ill., has been incorporated with a capital of \$15,000 to manufacture chemical products. The incorporators are John W. and Arthur C. Tretow, and Walter H. Shryock.

THE SYKESVILLE GLASS Co., Pittsburgh, Pa., has been incorporated with a capital of \$25,000 to manufacture glass products. Dusan Botic, 2612 Sarah St., is treasurer.

THE MIDLAND CHEMICAL Co., Indianapolis, Ind., has been incorporated with a capital of \$10,000 to manufacture chemicals and affiliated products. The incorporators are H. R. Doty, L. D. Millikan and B. E. Jones.

THE OCEAN VIEW OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$1,000,000 to manufacture refined oil products. The incorporators are W. G. Cline, F. H. Ballinger, Thomas F. Fitzgerald and J. H. Old, Los Angeles. George W. Bush, 431 Van Nuys Bldg., is representative.

THE HEPALIN CHEMICAL Co., Boston, Mass., has filed notice of organization to manufacture chemical products. Harry Belin and David Berman, 32 McClean St., head the company.

THE EMPIRE PAPER PRODUCTS CORP., New York, N. Y., has been incorporated with a capital of \$300,000 to manufacture paper goods. The incorporators are A. B. King, D. V. Sullivan and J. G. Miller, 261 Broadway.

THE MOULTON PRODUCING & REFINING CORP., Buffalo, N. Y., has been incorporated with a capital of \$300,000 to manufacture refined oil products. The incorporators are George Wroblewski and E. York Ames, Buffalo.

THE HERBETTA MFG. Co., Indianapolis, Ind., has been incorporated with a capital of \$85,000 to manufacture chemicals and affiliated products. The incorporators are R. L. Walker, E. E. Gates and J. C. Ralston, Indianapolis.

THE TWINING-LARGE LIME & CHEMICAL Co., Carpenterville, N. J., has been incorporated with a capital of \$50,000 to manufacture chemicals, hydrated lime and kindred products. The incorporators are Robert G. Griswold, Willis W. and Charles J. Smith, Carpenterville.

THE NATIONAL CORK PRODUCTS Co., Newark, N. J., has been incorporated with a capital of \$100,000 to manufacture cork specialties and affiliated products. The incorporators are Leonard S. Lerman, Morris Uram and James Deckert, N. M. Fruchtman, 156 Market St., is representative.

THE UNION RUBBER Co., Boston, Mass., has been incorporated with a capital of \$100,000 to manufacture rubber goods. The incorporators are Raymond D. Smith, Waltham, Mass.; Joseph W. Worthen, Winchester, Mass.; and M. E. Buchanan, Newton, Mass.

THE TUCK & RICHTER MFG. CO., Gloucester, Mass., has been incorporated with a capital of \$80,000 to manufacture ink products. The incorporators are Albert B. Tuck, Alfred O. Richter and L. D. Tuck, all of Gloucester.

THE WINCHESTER PAPER CO., White Plains, N. Y., has been incorporated with a capital of \$50,000 to manufacture paper goods. The incorporators are W. M. Gilbert, A. S. Diven and J. C. Brophy, White Plains.

THE HOME CHEMICAL MFG. & IMPORTING CO., New York, N. Y., has been incorporated with a capital of \$150,000 to manufacture chemicals and chemical byproducts. The incorporators are P. Richter, G. J. Bidel and B. Schmidt, 937 East Fifteenth St., Brooklyn.

THE POWER & CHEMICAL EQUIPMENT CO., Hoboken, N. J., has been incorporated with a capital of \$10,000 to manufacture chemical apparatus, brass goods, etc. The incorporators are Edward D. Grosso, F. T. Morgan and John J. Marnell, 77 River St.

THE NATIONAL RUBBER GOODS MFG. CORP., Akron, O., has been incorporated under Delaware laws with a capital of \$2,000,000 to manufacture rubber products. The incorporators are R. A. Stillwell, Akron; W. H. Hill and B. Williamson, Cleveland.

THE BEAUMONT MIDWAY OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$1,000,000 to manufacture refined petroleum products. The incorporators are J. Drew Funk, L. K. Strobel and C. A. Weaver, Los Angeles. Alfred Barstow, 600 Kerckhoff Bldg., is representative.

THE ESSEX CHEMICAL CO., 71 Paris St., Newark, N. J., has filed notice of organization to manufacture chemicals, lacquers, etc. George N. Beck, 97 Van Cleff St., Jersey City, N. J., is representative.

THE L. R. REICH DRUG & CHEMICAL CO., New York, N. Y., has been incorporated with a capital of \$50,000 to manufacture chemicals and affiliated products. The incorporators are L. M. Warshaw, S. and L. R. Reich, 66 Reade St.

THE CALCIUM CARBONATE CO., LTD., has been formed with a capital of \$50,000 for the purpose of manufacturing whiting from a deposit of decomposed shell-lime in Kane Valley, near Merritt, B. C. The initial unit will have a capacity of 10 tons daily. Up to now practically all the whiting used in Canada has been imported from Great Britain.

New Publications

BOOKS

LESSONS IN MECHANICS. By William S. Franklin and Barry MacNutt. Pp. 221; 178 figs. Bethlehem, Pa.: Franklin and Charles, 1919 (reprinted 1920). Price, \$2.

LESSONS IN ELECTRICITY AND MAGNETISM. By William S. Franklin and Barry MacNutt. Pp. 254; 188 figs. Bethlehem, Pa.: Franklin and Charles, 1919 (reprinted 1920). Price \$2.25.

LESSONS IN HEAT. By William S. Franklin and Barry MacNutt. Pp. 147; 41 figs. Bethlehem, Pa.: Franklin and Charles, 1920. Price \$2.

While these three companion volumes in a new series of physics texts were designed primarily to meet the needs of students taking a two-year schedule in college physics, chemists who wish to review physics will find them very helpful.

Realizing that students in the courses referred to will not have had higher mathematics the methods of calculus are introduced in the first volume of the series, so that strictly mathematical proofs do not have to be sidestepped. It is felt that this training in applied mathematics will help the student not only in the study of physics but in his work in pure mathematics.

The arrangement of the text is in strict lesson order. Descriptive and explanatory matter has been reduced to a minimum and the development of every topic leads as directly as possible to illustrative numerical problems. Lists of books for reference and for additional study are given in each volume, so that any phase of the subject can be taken up in more detail. Information about the national organizations and societies relating to physical science and engineering is also included, so that the student may become interested in the activities of these bodies early in his career.

Chemists will find "Lessons on Heat" especially interesting as an introduction to the study of thermodynamics. It includes chapters on: Temperature and thermometry, expansion; heat as a form of energy, calorimetry; thermal properties of solids, liquids and gases; transfer of heat; the properties of gases, the second law of thermodynamics.

INTRODUCTION TO GENERAL CHEMISTRY. By H. Copaux, professor of mineral chemistry at the School of Industrial Physics and Chemistry of the City of Paris. Translated by Dr. Henry Leffmann. Pp. 195; 30 illustrations. Philadelphia: P. Blakiston's Son & Co., 1920.

Prof. Copaux has written in compact yet clear form an introduction to the principles of physical chemistry. The treatment throughout is thoroughly modern. Dr. Leffmann has contributed a short appendix on hydrogen-ion concentration.

CHEMICAL ANALYSIS OF STEEL-WORKS MATERIALS. By Fred Iffotson, F.I.C., of the department of metallurgy, Sheffield University. Pp. 296; 21 illustrations. London and New York: Longmans, Green & Co., 1920. Price \$7.50.

This is a revision of those sections of "The Analysis of Steel-Works Materials" by Brearley and Iffotson which treated of the analytical chemistry of the raw materials and finished products of ferrous metallurgy, including refractories, slags, fuels, boiler feed water and boiler scale.

TESTING OF MOTIVE-POWER ENGINES. Second edition. By R. Royds, head of motive-power engineering department, Dundee Technical College. Pp. 392; 193 illustrations. London and New York: Longmans, Green & Co., 1920. Price \$7.50.

Detailed information is given in regard to the testing of: Locomotives, motor cars, etc.; steam engines and steam turbines; boilers; condensers and air pumps; internal combustion engines; gas producers; refrigerating equipment; air compressors; fans and blowers; water turbines and pumps.

BENZOL—ITS RECOVERY, RECTIFICATION AND USES. By S. E. Whitehead, F.C.S. Pp. 209; 65 illustrations. London: Benn Bros., Ltd., 1920. New York: D. Van Nostrand Co. Price \$5.

Experience gained during the war in the extraction of benzol from coal gas has been made available by Mr. Whitehead in the hope that the process may be made commercially attractive and profitable even in peace times. Careful consideration is given to the processes, equipment, operation and control methods used in the extraction of benzol from gas, the debenzolizing plant and the rectification plant. The chief uses of benzol and its products are treated briefly.

RUBBER MANUFACTURE. By H. E. Simmons, professor of chemistry, Municipal University of Akron, Ohio. Pp. 149; 55 illustrations. New York: D. Van Nostrand Co., 1921. Price \$4.50.

This book gives a general view of the geographical, physical, chemical and mechanical factors which make up the modern rubber industry. Topics treated include: Sources of crude rubber; colloids in relation to rubber; methods of coagulating the latex; theory of the constitution of rubber; synthetic caoutchouc; chemical and physical testing of crude rubber; manufacture and use of inorganic fillers, organic accelerators and rubber substitutes; vulcanization theories; reclaiming rubber; preparation of crude rubber for manufacturing; principles of compounding; chemical analysis of manufactured rubber; physical testing of compound samples. A description of the rubber laboratory equipment at the Municipal University of Akron is given in an appendix.

PAMPHLETS

THE COPPER DEPOSITS OF THE SEVEN DEVILS AND ADJACENT DISTRICTS, by D. C. Livingston and F. B. Laney. Bull. 8 published by the Bureau of Mines and Geology of the State of Idaho at the University of Idaho, Moscow, Idaho.

REFRATORIES FOR ELECTRIC FURNACES has been published by the Electric Furnace Assn., Niagara Falls, N. Y. This book contains the papers and discussions at the Columbus meeting of the Electric Furnace Association, Oct. 6, 1920.

THE FEDERAL WATER-POWER ACT is the title of a 40-page pamphlet published by Black, McKenney & Stewart, engineers, Washington, D. C. It contains a brief history of water-power legislation, a topical synopsis of the federal water-power act and a copy of the act itself.

Capital Increases, Etc.

THE SIMPSON CLARK GLASS CO., 164 West Randolph St., Chicago, has filed notice of capital increases from \$75,000 to \$100,000.

THE ALLIED OIL CORP., 15 East Fortieth St., New York, N. Y., has filed notice of increase in capital from \$12,500,000 to \$16,000,000.

THE LOS ANGELES SOAP CO., Los Angeles, Cal., has filed notice of increase in capital from \$250,000 to \$1,000,000.

THE NATIONAL BRASS CO., Grand Rapids, Mich., has filed notice of increase in capital from \$225,000 to \$450,000.

THE AMERICAN AGRICULTURAL CHEMICAL CO., 2 Rector St., New York, N. Y., manufacturer of fertilizers, etc., has arranged for a bond issue to total \$30,000,000.

THE ALLIED CHEMICAL & DYE CORP., New York, has filed notice of reorganization, to operate with an active capital of \$113,043,675 and preferred stock \$97,326,400.

THE KOKOMO OIL CO., Kokomo, Ind., has filed notice of increase in capital from \$15,000 to \$275,000.

THE FEDERAL CEMENT TILE CO., 110 South Dearborn St., Chicago, Ill., has increased its capital from \$150,000 to \$600,000.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29. Headquarters will be at the Hotel Rochester.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17.

AMERICAN PAPER & PULP ASSOCIATION will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

AMERICAN ZINC INSTITUTE will hold its annual meeting in St. Louis May 9 and 10.

BRITISH IRON AND STEEL INSTITUTE will hold its spring meeting May 5 and 6, at the Institution of Civil Engineers, Great George St., S. W. 1, London, England.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

HARVARD ALUMNI CHEMISTS' ASSOCIATION will meet Tuesday noon April 26 at Rochester, N. Y., for luncheon.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

NATIONAL PETROLEUM CONGRESS is meeting at the Hotel Baltimore, Kansas City, Mo., March 22 to 25.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27 to 29.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, N. Y., April 11 to 14.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: March 25, Society of Chemical Industry; April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of

ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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Managing Editor

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New York, March 30, 1921

Number 13

Let's Go After

"Two Per Cent for C.W.S."

THE third annual Chemical Warfare Service dinner, which will be held during April, should be the occasion not only for renewal of many friendships but also for vigorous action in the interests of this service. "The gathering of the clan" will give ideal occasion upon which to organize the effort which must be made if chemical warfare is to receive the attention it deserves. And upon that occasion we suggest that some organized effort be started to obtain from Congress "Two Per Cent for C.W.S."

Chemists and engineers in common with other civilized members of the American people desire and will strive for that time when extensive armed preparedness may not be essential. In keeping with this thought it would be difficult to get any large number of chemists who would support the idea of tremendous appropriations for chemical warfare as such. However, chemists and engineers are practical, sensible people rather than idealists and they realize that some military effort is essential without regard to our ideals for international relationships of the future. Moreover, they insist that in this plan must be included a reasonable provision for so essential a branch of the military as chemical warfare. In other words, they can be counted upon to line up unanimously in support of the slogan which we suggest, "Two Per Cent for C.W.S.," that is, provision of approximately 2 per cent of the Army appropriation for this branch of the service.

It takes no argument to convince chemists that gas masks and offensive gas material are as essential to the infantry, the cavalry and the artillery as knapsacks, saddle bags or guns. Without adequate protection against enemy gas attack all of the combatant branches of an army may be helpless. Without gas to shoot against an enemy they are as inadequately equipped as if outfitted with flint locks or popguns. It is only common sense, therefore, to provide a reasonable percentage for chemical warfare out of any appropriation, however large or small it may be in total. And certainly no one can dispute that 2 per cent is unreasonably large, yet this is all that is deemed immediately essential for C.W.S.

In national affairs even more than anywhere else the American people "Let George do it." With respect to the Chemical Warfare Service this policy is no longer safe, for continuation of such plan by the chemists and the chemical industries of the country will inevitably mean a shortsighted inadequate attention to its needs. At the forthcoming dinner we suggest that some official "George" be selected; not one man but a group of men, who will make it a part of their business to sell the big idea of gas defense and offense to those who must be convinced before these military activities will be adequately provided for. If the idea can be sold as it

should be, chemical industries will profit tremendously and the chemists of the country can rest assured that properly planned organized effort of their science will be feasible in case the unfortunate possibility of actual hostilities upon a large scale should again be met by this country.

The researches of chemical warfare are providing much information upon fundamental problems in organic industrial manufacture. Phosgene, chlorpicrin, chloracetic acid and dozens of other important compounds could be named as products of which we will know much more as a result of these studies. Also the theory and the practice of gas absorption and adsorption are being studied in a way that will tremendously interest many other industries. Activated charcoal, the well-known product of chemical warfare investigations, is already proving itself of an industrial value far beyond the total cost of the chemical warfare investigations, and many more such worth while results of this sort of activity can well be expected.

The time for action is at hand, for during the next three months Congress will be called upon to make provision of funds for the Army for next year. Obviously there is no time to delay. Moreover the policy thus fixed for the coming year will be of vital importance for several years to come, since any interruption in the essential research or development program at this stage would double the difficulty and multiply many fold the cost when the work is renewed at a later time. Everyone interested—and what chemist is not so concerned?—must bring his influence to bear immediately.

CHEMICAL & METALLURGICAL ENGINEERING has no hard and fast organization program to suggest. Let the discussion of all those who have been intimately associated in this branch of the service guide in this matter. But as chemists and as industrial men of common sense, let us no longer stand by unorganized in the support of chemical warfare. We have done only a small fraction of what we can and should do. Let us formulate some program which will have as its sole object the fostering for a few years to come of this important idea, "Two Per Cent for C.W.S."

An Unwise

Immigration Measure

THE Dillingham immigration bill, which was killed by a pocket veto of President WILSON in the closing days of his administration, is likely to be revived at once by the new Congress. This measure is decidedly unwise. It prescribes an artificial limitation of immigration to 3 per cent a year of the number now in the United States of the same country of birth. Thus, irrespective of anything else, the proportions of foreign born to be admitted are fixed by the numbers now in the United States, as if there were any virtue in the present proportion.

Getting bills through Congress is usually a very practical question, involving the finding of arguments that will go down and of securing enough votes. The argument of assimilability, on which alone a percentage like that of the Dillingham bill can be based, is quite superficial. It assumes in fact that all races are alike in quality of assimilability, the quantity of possible assimilation being this constant factor multiplied by the number of the race now in the country. We say "race," though as a matter of actual fact the Dillingham bill ignores race and refers simply to country of birth.

Several very practical and important objections to the Dillingham immigration measure were presented to President WILSON on March 1 in a brief by the Inter-Racial Council, with headquarters in the Woolworth Building, New York City. These need not be referred to here. Readers of this journal will find their own reasons for opposing such a bill. This country needs labor. It is rich in natural resources and commands much capital that seeks investment if it can secure a proper return. The country has almost unlimited capacity to employ labor. It will be made more prosperous, not less prosperous, by being given a greater supply of labor. The present industrial depression is due largely, not to there having been too much labor, but to there having been too little labor obtainable for a reasonable sum.

A survey of the flow of immigration in the past illustrates the absurdity of the Dillingham limitation to 3 per cent of the number of persons of a given country of birth now in the United States. From period to period the character of our immigration has changed. Long ago there were the Irish, who constituted the "paddies" of a couple of generations ago, and very useful they were. Successively there has been a flow from one country or another, in a sort of rotation. This natural selection resulted in men whose services were least in demand in their native country coming here where work was ready for them. What we want is that work should be done and we should admit those who are most ready to work. Any legislation framed along this line, if additional legislation is necessary, will be welcome.

One naturally asks himself who is back of this move embodied in the Dillingham bill. The accepted view is that it is "the labor interests." That is particularly curious, seeing that organized labor considers itself skilled, while immigrant labor is unskilled. In almost every undertaking there is both skilled and unskilled labor required. The more easily the unskilled part of the work can be done the more room is afforded for the employment of skilled labor. Does the plumber wish to force conditions whereby he will be obliged to dig ditches part of his time, or the bricklayer wish to become his own hod carrier? Apparently labor leaders cannot rid themselves of the fallacious view that there is precisely so much work to be done, that this work will be done, no matter what, and that if the supply of labor is restricted the total paid out for doing this work will be correspondingly increased.

The Dillingham bill, or such other measure along the same line as may be brought forth in the new Congress, should be vigorously opposed. If additional immigration legislation is requisite, a properly thought out plan should be devised. The argument for the Dillingham measure is specious and superficial, while the objections to it are numerous and fundamental.

A New Gateway To Chemistry

THE address of Dr. IRVING LANGMUIR at the anniversary meeting of the Chemists' Club on March 17 marks a milestone in the history of chemistry. Given a working hypothesis of the structure of atoms, and the path is straightway made clear for chemistry to become a deductive science. Our readers may remember a popular introduction to the consideration of the Langmuir Postulates published in this journal on July 16, 1919. The theory is based on the work of G. N. LEWIS in regard to the so-called cubical atom with that of other savants, co-ordinated and carried on by Dr. LANGMUIR to the state of a working hypothesis. The author makes abundant acknowledgment to the various contributors who have preceded him in the field.

Chemically speaking, the postulates were reasonable, but from the standpoint of physics the objection was raised that the proposed circumscription of electrons to restricted positions was impossible. The theory of BOHR, which has found favor from the standpoint of physics, in which the organization of electrons about a positively charged nucleus might be likened to a solar system, does not aid the chemist. Now Dr. LANGMUIR has succeeded in harmonizing the two theories, so that the developed hypothesis is plausible to the physicist while illuminating to the chemist.

The prospective results of new study with the aid of this enlightenment are amazing. Whereas we have long been engaged in the study of intramolecular phenomena, this opens up the intra-atomic field. It gives us a basis for the computation of the forces emanating from within the atom, so that the perplexing subject of valency may be explained and even valency itself calculated. It offers a reasonable proposal of how each atom is composed, and intimates not only its configuration but even describes the fields of force that surround it within the molecule group. It does not tell how atoms may be broken down, although it may even indicate the way along which such a consummation may be reached—none too soon, let us hope; for we are not good enough to wield such power as yet. But with such a working hypothesis as Dr. LANGMUIR presented, with the structure of each atom agreed upon, with the component forces emanating from every atom in a molecule duly computed, then we should be able to predict the physical qualities of a compound before it is synthesized. It brings within sight the dream of the physical chemist to reason out reactions from start to finish, and then to confirm them by experiment. It gives us the picture of molecules in three dimensions; it tells us of their design, their conformation, and the forces that play from within and about them, the spectral lines of the material product, its colors, its crystal forms, and its reactions.

The time is growing near when, if we are to maintain progress, we must open up this new doorway into the subject, beginning with the study of the reasons why reactions take place, so that with this as familiar information we may compute more and marvel less at the things that are known. And the more we know the greater will be our sense of the unknown infinity beyond us.

Much has already been done along the line of chemical philosophy, but without a definite concept of atomic structures the subject has been difficult, while exposition has been vague. The opening of such a new and illuminating doorway into chemistry will be rather

disturbing to those of us who are of a passing generation, but we are not the persons to be considered.

We have told the story before elsewhere, but it will bear repetition: An assistant of Prof. FRIEDEL in Paris asked him a question in organic chemistry. "Sais pas," answered the professor. "Look it up in Beilstein." After he had been told repeatedly to find in chemical literature answers to the questions that he asked, the assistant inquired of the master whether the instructions were given him for his own benefit, or because the professor did not remember. The old gentleman caught the young man by the arm, led him into the library, and, pointing to the shelves of books there, exclaimed, "Voila! There is all I know. Books are admirable instruments, and we should study them diligently. But why should I encumber my mind with details, making it like a warehouse of unused goods, when all this is available to me? The *general principles*, however, I must always keep alive in my mind!"

That is the way nearly all great chemists understand the subject. It is the true source of enlightenment. It is the way the subject should be taught.

All glory to the few men who, like IRVING LANGMUIR, stand in the watch towers above us, who see the dawn of understanding in these things and point out to us the advancing light!

Green Grass as a Mine for Vitamines

VITAMINES have captured the public fancy. There is the Fat-Soluble A which is found in butter fat, and consequently in milk, in cod-liver oil and in green vegetables, which is necessary for the growth of young animals, to prevent (it is believed) rickets in children, and an unpleasant eye trouble called xerophthalmia in many animals, including the human sort. The Water-Soluble B is needed to prevent beri-beri, which follows a prolonged diet which lacks it, and if taken in inadequate quantities we are subject to boils and skin eruptions, such as acne. The ingestion of food containing it acts as a cure, provided the eruptions are due to malnutrition and not to infection. It is found in milk, in fresh vegetables, in the hulls of rice and some other grains, and in yeast. It is believed also to stimulate the activities of certain glands. The Water-Soluble C is anti-scorbutic. Without it we are susceptible to scurvy, and foods containing it constitute the cure. It is also found in milk, in fresh vegetables and in citrus and other fruits. Unlike types A and B it is very susceptible to heat and its keeping qualities are much frailer unless in an acid medium. The subject is discussed more fully by a member of our staff in the current (March) number of *Harper's Magazine*. The molecular structure of these organic bodies is unknown, but it appears that they are rich in nitrogen, they do not contain phosphorus, and tests are developed to demonstrate their presence.

A good rule to assure ourselves of all the vitamines we need has seemed to be to drink a couple of glasses of fresh milk every day and to eat a good plate of salad. But now come along a group of five from the laboratory of the University of Minnesota, R. ADAMS DUTCHER, C. H. ECKLES, C. D. DAHL, S. W. MEAD and O. G. SCHAEFER, who publish in the *Journal of Biological Chemistry* (vol. 45, pp. 119-32, 1920) a note that is perplexing in regard to the amount of milk needed. "A glass or two" was as near as we dared come to prescrib-

ing. But Messrs. DUTCHER et al. tell us of tests that they made with the cows, giving them a vitamine-poor ration in winter, and with the same grains, but also turning them out to pasture, in summer. The green grass, of course, is vitamine-rich. The result was that "20 c.c. of summer milk was superior in nutritive value and anti-scorbutic potency to 60 c.c. of winter milk from the same cows." We knew there was a difference, more particularly in the anti-scorbutic Water-Soluble Vitamine C, between winter milk and summer milk, but this threefold difference was unsuspected.

In view of the growing need of biological chemistry in organic synthesis, we hope that the study of vitamines will find a more cordial welcome as a subject for research, even in industrial laboratories, than it would have found a few years ago. The Water-Soluble B type may be important in a number of protein reactions.

The Border Lines Of Colloid Chemistry

COLLOID chemistry has been a domain in itself, governed by its own special laws where legislation had influence and otherwise by hypothetical substitutes. Attempts to subject any considerable part of the colloid state to the laws of general physical chemistry are noteworthy undertakings. Perhaps in a century or two from now, when simplified octet chemistry is taught in the grammar schools, the children will study the history of science as well as of political events and each conquest in chemistry will give the basis for a tale as interesting as the conquests of America by the Spanish chevaliers.

Then Dr. JACQUES LOEB will be famous for annexing the amphoteric proteins to the more civilized chemical dominions of the hydrogen ion, the influence of which will be so well understood by both the young and old octet chemists that all explanatory remarks will be superfluous. Even the name hydrogen will perhaps have succumbed to some compound word, indicating nuclei and electrons, their number and positions.

On the basis of our present chemical status, the colloid chemist may pass off the contribution by Dr. LOEB in this issue with the statement that his observations have been limited to dilute solutions and that Dr. LOEB has only confirmed a common belief that any properly dispersed substance in a proper degree of subdivision will obey the gas laws and the others derived from them.

Arguments pro and con by the advocates of either side will take an indefinite amount of time and will not be settled perhaps until one side dies out, as has happened before in the case of phlogiston, fire-water-earth and so on. This will be a task for the theoretical chemists to fight out among themselves. The technologist will readily see where he comes in and will make use of the hydrogen ion concentrations in solving many of his colloidal problems. The gluemaker will wash his product in solution having the right hydrogen potential to give the isoelectric point where glue is insoluble. The water filtration chemical engineer will also receive guidance from the same source and will operate at the isoelectric point of his amphoteric aluminum hydroxide. Large-scale experiments have recently been undertaken at the city water filtration plant of Toronto, Canada, along this line which are proving that Dr. LOEB is right in practice as well as in theory as far as the factor of the hydrogen ion is concerned.

Readers' Views and Comments

The Language of Chemistry

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to your editorial in the issue of Feb. 2 on "The Language of Chemistry," permit me to suggest that writers on chemical subjects commonly exercise too little care in expressing their ideas, a fact to which all editors can doubtless attest. Accurate and precise expression when writing on a technical subject cannot be accomplished without the use of technical terms. I am afraid that those who chafe at the use of technical terms are like those who would write *vers libre* or paint Cubist pictures trying to express themselves without having mastered the technique of their art.

The writer sees no possible objection to the correct employment of technical terms. "Pyrolysis" and "pyrolytic," recently suggested by W. A. Hamor, are gems. We need a new word to express the decomposition of alcohols with the formation of water, improperly termed "dehydration"; we also need quite a number of precise terms to replace expressions crudely translated from the German, such as "splitting off" or "splitting out," also "raw" material.

B. T. B.

New York City.

British Research on Automobile Steels

To the Editor of Chemical & Metallurgical Engineering

SIR:—Will you pardon me if I point out that an article on the British Steel Research Committee's Report on Automobile Steels in your issue of Dec. 29, 1920, contains a rather serious error in that it describes the 0.35-carbon steel as a *case-hardening* steel? I think that a reference to the report will show that this steel is not described as a case-hardening steel, and is not intended for such a purpose.

The case-hardening steels used by the committee were much lower in carbon, either with or without nickel, as shown in the following tabulation:

	1H	1L	2H	2L	3H	3L	4H	4L
C.....	0.17	0.06	0.20	0.12	0.15	0.12	0.17	0.07
Si.....	0.24	0.01	0.11	0.05	0.05	0.07	0.39	0.06
Mn.....	0.72	0.25	0.99	0.71	0.61	0.32	0.34	0.18
S.....	0.04	0.01	0.07	0.08	0.02	0.02	0.01	0.02
P.....	0.05	0.05	0.05	0.05	0.01	0.01	0.01	0.01
Ni.....					2.60	2.40	6.00	5.10

BERNARD COLLITT, F. I. C.

Lincoln, England.

A Question of Therapeutic Value

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your Feb. 16 number is an article "Sulphur Dioxide May Have Therapeutic Value." Shoveling coal may be similarly valuable. During the influenza epidemic of 1918 the working force (over 250) of the American Medical Association was reduced nearly 20 per cent by cases of influenza, but in the engineering department not one of the four men employed there suffered from it. Of course it stands to reason that such evidence is valueless and utterly unscientific be it chlorine, sulphur dioxide or "coal dust."

Chicago, Ill.

PAUL NICHOLAS LEECH.

Bids Bon Jour to Benign Bovine

To the Editor of Chemical & Metallurgical Engineering

SIR:—While Mr. Ford is driving old Dobbin back to the tall uncut the daily press notes that Dr. Earl B. Carr of Melrose, Mass., is likewise herding the gentle cow along the trail toward the never-never land whence the buffalo has disappeared. Through the medium of barnyard chemistry he produces a synthetic milk, using the following formula:



Grind peanuts and oats in sausage grinder, leach with water, add salt and filter. Time required, five minutes.

Can it be that through all these centuries the cow has only been operating as a grinding and leaching plant? If so, the elephants in Central Park, which inhale a great many peanuts daily, may also be made to serve. Are our prize Jerseys and Holsteins to become just family pets along with the Pekingese and poodle? Will the goat which has so long been on the staff of our street-cleaning departments be relegated to the pension list? May we expect a bull movement in September oats and a further scarcity of peanuts in Crackerjack? In other words, and chemically speaking, Mr. Editor, is Dr. Carr's discovery a serious matter?

F. GISTON.

Armour Fertilizer Works

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to my articles on the "Armour Fertilizer Plant" which appeared in recent issues of CHEMICAL & METTALURGICAL ENGINEERING, I note that inadvertently I neglected to acknowledge the courtesy of officials of the Armour Fertilizer Works for the information and illustrations used. The writer is deeply indebted to Austin McGlennon, superintendent of works; to Fred C. Lodge, manager in charge of the Armour Fertilizer properties; and to C. H. MacDowell, president of the company, for releasing this information for publication. I note also that I neglected to state that the excellent piece of construction outlined in these articles was carried out under contract with Dwight P. Robinson & Co., Inc., which built both the acid plant and the general construction in the fertilizer plant. The Armour company engineers directed the placing of the mechanical equipment.

CHESTER H. JONES.

Chicago, Ill.

Investigations of the Chemical Literature

To the Editor of Chemical & Metallurgical Engineering

SIR:—May I call your attention to the portion of Mr. Barrows' fine paper on Chemical Literature, headed "Bolton—Select Bibliography of Chemistry" (page 426, CHEMICAL AND METALLURGICAL ENGINEERING, March 9, 1921)?

There is a second supplement to Bolton's Select Bibliography of Chemistry, published by the Smithsonian Institution in 1904. This continues the subject to the close of the year 1902, and contains about 3,500 additional titles.

NATHAN VAN PATTEN.

M. I. T. Library,
Cambridge, Mass.



THE Chemists' Club celebrated the tenth anniversary of the opening of its clubhouse on Thursday evening, March 17. Eight distinguished chemists were enrolled as honorary members, three of whom were present in person and five by representation. Reading from left to right, those seated on the platform in the photograph heading are:

Professor Emeritus Charles F. Chandler, first president of the club; Dr. Edgar Fahs Smith, Dr. William H. Nichols, his Excellency Rolando Ricci, Ambassador from Italy, representing Giacomo Ciamician; Consul General Gaston Liebert of France, representing Prof. Le Chatelier; Dr. Jacques Loeb, Ellwood Hendrick, president of the Chemists' Club; Dr. Irving Langmuir, Consul General Pierre Mali of Belgium, representing Dr. Ernest Solvay; Counsellor John J. Broderick, of the British Embassy; Dr. Alfred Springer of Cincinnati, representing Dr. John Uri Lloyd; Dr. Edward Weston.

President Ellwood Hendrick predicted that the meeting would take its place permanently among the events in the history of chemistry. Dr. Charles Baskerville, chairman of the committee of arrangements, spoke interestingly of the earlier days of the club and then called upon the several members who presented the honorary members as follows:

ERNEST SOLVAY

Presented by Dr. Bernhard C. Hesse

Mr. President, I present Consul General Mali, who stands in the place of Ernest Solvay, founder of the ammonia-soda process, for threescore years a pioneer and leader in industrial chemistry, whose activities have enormously developed the production and use of sodium products over all the world, and likewise have profoundly stimulated dependent and related industries; a leader in the application of scientific study to industrial problems; founder and indefatigable supporter of many institutions devoted to science, to public health and welfare and to the elevation of human intercourse and relations; a source of great strength to his country in her peril, and a shining mark for the vengeance of her despoilers. The members of the Chemists' Club proclaim their admiration and esteem by election to honorary membership.

HENRY LOUIS LE CHATELIER

Presented by Dr. Marston T. Bogert

Mr. President, I have the honor to present Consul General Liebert, as representing our ally the Republic of France,

who will receive for Prof. Le Chatelier the honorary membership which we have in mind to confer upon him. Henry Louis Le Chatelier is professor at Collège de France and at L'Ecole des Mines, member of the Academie des Sciences, for over forty-six years an active, resourceful, fruitful, daring and original investigator of the fundamental principles underlying chemical action and thermodynamics. He has enriched our knowledge with countless facts and with many sound and far-reaching theories based upon them; and he has greatly influenced and enhanced the arts of metallurgy, of electrometallurgy, and of applied chemistry generally. He was called on by his country in her time of stress to bring his profound knowledge and experience to bear upon the solution of problems vital to her preservation and necessary to her progress, and on the return of peace he was honored by her with many prizes and medals. To him the members of the Chemists' Club tender evidence of their profound esteem by election to honorary membership.

GIACOMO CIAMICIAN

Presented by Maximilian Toch

Mr. President, I have the honor to present his Excellency, Orlando Ricci, Ambassador from Italy, who represents Giacomo Ciamician, Senatore del Regno, professor of general chemistry at the University of Bologna, for more than forty-two years an active, ingenious, fruitful and original investigator in pure organic chemistry, applying it to determine the nature and mechanism of the origin of constituents of plants and animals, and the influence therein of sunlight, uncovering many facts which have finally enabled him so to correlate these phenomena that our view of them has become greatly clarified and much firm ground for further and beneficial advance in this most intricate field has been created. The members of the Chemists' Club elect him to honorary membership in recognition of his eminence in science and in appreciation of an associated ally in a holy cause.

SIR EDWARD THORPE

Presented by Dr. Walter S. Landis

Mr. President, I present Sir Edward Thorpe, represented by Counsellor Broderick of the British Embassy. Sir Edward Thorpe was born near Manchester. A student of science at Owens College, the Universities of Heidelberg and Bonn, a brilliant teacher in several colleges in his native land, at the age of three-quarters of a century he is professor of chemistry emeritus of the Imperial College of Science and Technology, South Kensington. For many years director of the Government Laboratories in London, his accuracy of methods of analysis and clarity in their exposition, coupled with a wisdom as to human purposes in the interpretation of law, gave a model for municipal experts in caring for the welfare of his fellow citizens. His delightful biographies of famous chemists are examples of charming literary style for others to study and follow. His Dictionary of Applied Chemistry is an authoritative work, turned to by all seeking full knowledge. His researches in pure chemistry

carried him to the presidency of the Chemical Society of London; his exposition and knowledge of technology were recognized a generation ago by a similar demand on the part of the Society of Chemical Industry, and his breadth of appreciation of all science likewise brought him the vice-presidency of the British Association for the Advancement of Science and the Royal Society. His eminence as a scientist, technologist and author, commanding several languages, for he had a large personal acquaintance with savants of foreign tongues, burdened him with honorary and corresponding memberships in numerous scientific, literary and philosophical academies and societies of other lands. Many times doctored, this Fellow of the Royal Society will long remain a teacher of power, even to many who may never hear his voice. We honor ourselves in electing him to be one of that limited number to whom the Chemists' Club can pay such tribute.

JOHN URI LLOYD

Presented by Victor G. Bloede

(Owing to the serious illness from pneumonia of Dr. Lloyd, he was represented by Dr. Alfred Springer of Cincinnati.)

Dr. John Uri Lloyd was born in New York State. He was a student of science, trained in a severe school of experience in Kentucky. He rose to the professorship of chemistry in the Cincinnati College of Pharmacy and became the president of the American Pharmaceutical Association. By his investigation in phytochemistry, especially applied to medicine, he created new knowledge of alkaloids, glucosides and the physiological variations in reactions of drugs, especially as colloids. A graceful and imaginative pen has augmented his contributions to scientific literature and perpetuated his close and accurate study of the dialect, superstition and folklore of the Blue Grass country. His "String Town on the Pike" alone has aroused interest in chemistry and given pleasure to a world of readers. He, with his brother, has handsomely housed one of the most complete libraries of botany and chemistry in the world, permanently endowed it, and given it in perpetuo to the city wherein he struggled as a youth, conquered as a strong man and now resides, surrounded by the love and esteem of his fellow men. Over threescore years and ten find him still active in the laboratory and public affairs. Numerous honors have come to him and are deservedly his. To them the members of the Chemists' Club take this, their best means, of adding appreciation of his diligent and fruitful labors for human welfare and happiness.

WILLIAM HENRY NICHOLS

Presented by Prof. Wilder D. Bancroft

Mr. President, I have the honor of presenting in person William Henry Nichols, for more than fifty years successfully engaged in those branches of industrial chemistry of fundamental importance to the development of our country, at many places and in every section of this continent; a firm believer in the application of science to industry and always its consistent follower in practice; a stanch and helpful leader and supporter in securely expanding the study of chemical science, research and application in all branches of our educational system; far-sighted in the promotion of international understanding among chemical associations and chemists and for many years with rare patience and discernment creating and fostering opportunities for scientific, technical and social co-operation among the chemists of the United States to the permanent benefit to all. His constructive capacity carried him to the presidency of the American Chemical Society, of which he was one of the founders. His world-wide recognition brought the presidencies of the Society of Chemical Industry and Eighth International Congress of Applied Chemistry. Among the numerous honors and distinctions which have come to him, we, the members of the Chemists' Club, desire to include our appreciation of his great services on behalf of science, business and the welfare of mankind, by electing him to honorary membership.

EDGAR FAHS SMITH

Presented by Dr. Charles L. Reese

Mr. President, I have the honor and take great pleasure in presenting Edgar Fahs Smith, again president of the American Chemical Society after a lapse of twenty-five years; one to whom that Society owes much for devoted and self-forgetful service in its pioneer days; connected with the University of Pennsylvania as educator and administrator for over forty years; a scientist whose researches have covered widely separated fields in electrochemistry, the rare

earths, and atomic weights; author of standard texts on electrochemistry, as well as translator of foreign texts; a historian who adds to a charming literary style the painstaking accuracy and attention to detail which have made him a brilliant teacher and scientist. To the innumerable evidences of esteem and affection on the part of students, colleagues and citizens, we, the members of the Chemists' Club, desire to add ours by his election to honorary membership.

EDWARD WESTON

Presented by Dr. Frederic G. Cottrell

Mr. President, I present Edward Weston, of English birth, for over fifty years an American chemist, physicist and inventor; a scientific investigator of absolute integrity, he has brought to the solution of physical and electrical problems the chemist's point of view. He has been an early worker in the electroplating field, he perfected the dynamo for use in that art; is inventor of the recently rediscovered flaming arc; was one of the pioneers in the development of the incandescent lamp and filament. He is the inventor of standard electrical measuring apparatus. This work involved detailed and long-continued researches on alloys, and the results have led to entirely new views on the nature of metals and non-metals. A wise counsellor in the affairs of the Chemists' Club, the members elect this friend and scientist to honorary membership as an evidence of affection and esteem.

Chemical and Physical Behavior of Proteins

BY JACQUES LOEB

Life is so completely linked to the chemical and physical properties of proteins that the knowledge of these properties must precede the attempt at unraveling the dynamics of living matter. The modern concepts of colloid chemistry have been used to supply this knowledge, and foremost among these concepts is the idea that the reactions of colloids in general and proteins in particular are not determined by the purely chemical forces of primary valency, but by the rules of adsorption; and that the influence of electrolytes on the physical properties of proteins is due to an alteration in the degree of dispersion or in the degree of hydration of the protein particles. The speaker has reached the conclusion that these views are based on a methodical error, so far as the proteins are concerned—namely, on the failure to take into consideration the hydrogen ion concentration, which happens to be the chief variable in the chemistry and physical chemistry of proteins. When this variable is duly considered, it is found that the laws of classical chemistry account for both the chemical and the physical behavior of the proteins.

ISOELECTRIC POINT

Proteins are amphoteric electrolytes the chemical behavior of which depends on the hydrogen ion concentration of the solution. When the hydrogen ion concentration exceeds a certain critical value—which is termed the isoelectric point of the protein—the protein can combine only with anions, forming salts of the type of gelatine chloride, sulphate, etc., according to the nature of the acid added. When the hydrogen ion concentration is below this critical point, the protein can form metal proteinates—e.g., Na gelatinate, Ca gelatinate, etc. At its isoelectric point, a protein can combine with neither anion nor cation. The natural method of freeing a protein from ionogenic impurities consists, therefore, in bringing the protein in powdered form to its isoelectric point and washing it with cold water.

STOICHIOMETRICAL RELATIONSHIPS

The proof that the proteins combine by the purely chemical forces of primary valency and in strictly

stoichiometrical proportions with acids and alkalis is furnished by the titration curves. If we add different acids to an isoelectric protein, we notice that in order to bring a protein solution to a definite p_H —e.g., 3.0 or 2.5—exactly three times as many c.c. are required of N/10 H_3PO_4 as of N/10 HCl or N/10 HNO_3 ; while equal numbers of c.c. of N/10 H_2SO_4 and of HCl are required for this purpose. When we titrate with alkali, we find that exactly as many c.c. of N/10 $Ca(OH)_2$ or of $Ba(OH)_2$ are required as of N/10 $NaOH$ or KOH . These and many similar experiments leave no doubt that acids and alkalis combine with proteins according to the purely chemical forces of primary valency. The proof has been furnished not only for gelatine but also for crystalline egg albumin and for casein.

It follows from these experiments that the anions of weak dibasic or tribasic acids combine with proteins in the form of monovalent ions. Thus the anion of gelatine phosphate is the monovalent anion H_2PO_4 and not the trivalent anion PO_4 ; while in the case of gelatine sulphate the anion is the divalent SO_4 ion.

PROPERTIES A FUNCTION OF HYDROGEN ION CONCENTRATION

These facts furnish the clue for the understanding of the influence of ions on the physical properties of proteins. Before these experiments were made it was customary to express the effect of ions on the physical

while the nature of the ion is of no significance. Thus gelatine chloride, nitrate, tartrate, succinate, citrate and phosphate have the same osmotic pressure, the same viscosity, the same amount of swelling (at the same hydrogen ion concentration and the same concentration of originally isoelectric gelatine), for the reason that in all these cases the anion with which the protein is in combination is monovalent. The osmotic pressure, swelling and viscosity of gelatine sulphate are, however, considerably lower than those of gelatine chloride of the same p_H and the same concentration of gelatine, for the reason that the SO_4 ion in combination with the gelatine is bivalent.

The fact that only the valency of an ion influences the physical properties of a protein, while the nature of the ion is of no significance (unless it causes a constitutional change in the protein molecule), is the crucial point in the interpretation of the influence of ions on the physical properties of proteins; since this fact suggests that this influence depends on simple equilibrium conditions and not on a change in the protein, such as hydration or degree of dispersion.

When increasing quantities of the same acid are added to isoelectric protein—e.g., a 1 per cent solution of isoelectric gelatine—the values for osmotic pressure, swelling, viscosity, first increase until a maximum is reached (at a p_H varying for the three properties between 3.6 and 3.0) and drop again with a further increase in acid added. Colloid chemistry explains such variations on the basis of variations in the degree of aggregation of the particles or of variations in the degree of hydration of the protein particles. When a neutral salt is added to a protein solution, the osmotic pressure, swelling and viscosity drop, and this is also ascribed to a depression in the degree of dispersion or hydration of the protein particles.

THE DONNAN EQUILIBRIUM

Recent investigations have led me to a different view—namely, that the influence of valency, hydrogen ion concentration and the addition of salt on the physical properties of proteins find their explanation in a field entirely foreign to colloid chemistry—namely, to a peculiar equilibrium condition the theory of which was worked out by Donnan. Donnan¹ has shown that when we separate two salt solutions by a membrane which is impermeable for one of the ions while permeable for all the rest, a peculiar equilibrium results at which the distribution of the ions on the opposite sides of the membrane is unequal. It is immaterial whether the ion which cannot diffuse through the membrane is a colloid or a crystalloid. Procter² made use of this Donnan equilibrium to prove that the swelling of solid gelatine chloride is an osmotic phenomenon which can be explained quantitatively on the basis of the Donnan equilibrium.

I started in my investigations with a measurement of the potential differences which exist between a 1 per cent gelatine chloride solution contained in a collodion bag and the surrounding water after osmotic equilibrium is established (e.g., after eighteen hours). It was found that the influence of the hydrogen ion concentration, the valency of the anion in combination with the gelatine and the addition of neutral salt on the

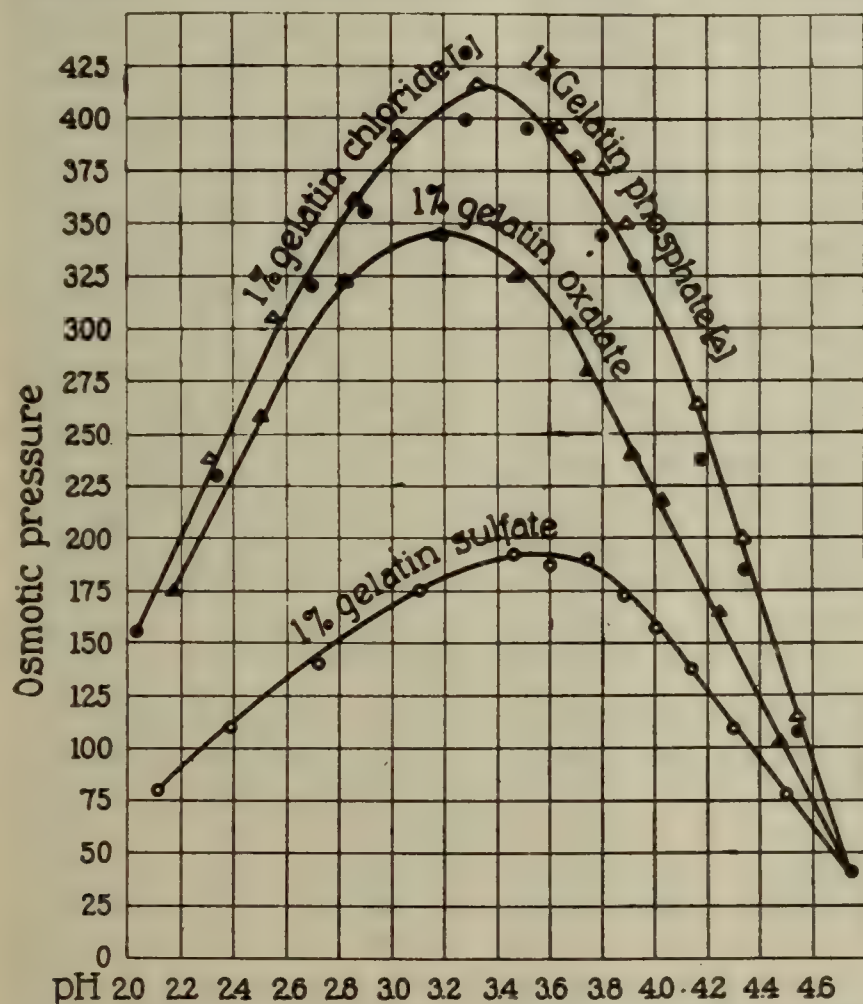


FIG. 1. OBSERVED VARIATION OF OSMOTIC PRESSURE WITH HYDROGEN ION CONCENTRATION

properties of proteins in terms of the so-called Hofmeister series. I have been able to show that these series are based on an error due to the fact that the influence of the variation in the hydrogen ion concentration was overlooked and erroneously interpreted as being the expression of a specific influence of the anion of the acid. If the effect of different ions is compared at the same hydrogen ion concentration, it is found that only the valency of the ion with which the protein is in combination influences the properties of a protein;

¹Donnan, F. G., *Z. Elektrochem.*, 1911, vol. 17, p. 572. Donnan, F. G., and Harris, A. B., *J. Chem. Soc.*, 1911, vol. 99, p. 1554. Donnan, F. G., and Garner, W. E., *J. Chem. Soc.*, 1919, vol. 115, p. 1313.

²Procter, H. R., *J. Chem. Soc.*, 1914, vol. 105, p. 313. Procter, H. R., and Wilson, J. A., *J. Chem. Soc.*, 1916, vol. 109, p. 307.

TABLE I. pH OF INSIDE AND OUTSIDE SOLUTIONS AT EQUILIBRIUM (AFTER 18 HOURS)

	Concentration of NaNO_3								
	M/	M/	M/	M/	M/	M/	M/	M/	M/
	0	4096	2048	1024	512	256	128	64	32
pH inside.....	3.58	3.56	3.51	3.46	3.41	3.36	3.32	3.29	3.25
pH outside.....	3.05	3.08	3.10	3.11	3.14	3.17	3.20	3.22	3.24
pH inside minus pH outside.	0.53	0.48	0.41	0.35	0.27	0.19	0.12	0.07	0.01

Original inside solution, 1 per cent originally isoelectric gelatine dissolved in various concentrations of NaNO_3 made up with HCl to pH 3.5.

Outside solution, same concentrations of NaNO_3 all made up with HCl to pH 30.

TABLE II. POTENTIAL DIFFERENCE BETWEEN GELATINE SOLUTION AND OUTSIDE SOLUTION

Concentration of NaNO_3	Calculated by Nernst's Formula from pH , Table I Millivolts	Observed Millivolts
0	31.2	31
M/4092	28.3	28
M/2048	24.0	24
M/1024	20.7	22
M/512	16.0	16
M/256	11.2	12
M/128	7.0	7
M/64	4.1	4
M/32	0	0

P.D. was similar to the influence of the three factors on the osmotic pressure, the swelling, and the viscosity of proteins. This in itself would have meant little more than that a fourth property of proteins had been found which varies like the other three properties mentioned, if it had not been for the fact that it was possible to correlate the variations of the P.D. quantitatively with the Donnan equilibrium.

When a gelatine chloride solution is separated from pure water by a collodion membrane, free HCl diffuses into the water, and when equilibrium is established, the concentration of acid in the water (the "outside solution") is greater than in the gelatine solution (the inside solution). This was observed by Procter for blocks of gelatine chloride surrounded by water, and by the speaker when a solution of gelatine chloride was separated from water by a collodion membrane. Procter has shown that on the basis of Donnan's theory the equilibrium is defined by the equation $x^2 = y(y + z)$, where x is the concentration of the H and Cl ions in the outside solution, y the concentration of the H and Cl ions of the free acid in the gelatine (inside) solution, and z the number of Cl ions in combination with gelatine.

If we write the equation in the form

$$\frac{y}{x} = \frac{x}{y + z}$$

$\frac{y}{x}$ becomes the ratio of the concentration of the hydrogen ions inside over those outside. If we assume that the P.D. measured in our experiments was due to the difference in the hydrogen ion concentration on the opposite sides of the membrane, then it would follow from Nernst's well-known logarithmic formula that the P.D. should be equal to $0.058 \log \frac{y}{x}$. Log y is, however, the pH of the inside solution and log x is the pH of the outside solution. Hence, if the Donnan equilibrium

was responsible for the P.D., the observed P.D. should be equal $0.058 (pH \text{ inside minus } pH \text{ outside})$.

CALCULATED AND OBSERVED POTENTIAL DIFFERENCES

It was found that the values for the P.D. calculated on this assumption were in good agreement with the observed values. This left no doubt that the influence of the valency, of the hydrogen ion concentration and of the addition of neutral salt on the variation of the P.D. found its complete qualitative and quantitative explanation on the basis of the Donnan equilibrium.

The close analogy between the influence of pH , valency and neutral salt on the P.D., and on osmotic pressure and swelling, suggested the possibility that these latter properties might also be determined by the Donnan equilibrium. I have calculated on the basis of the Donnan theory the influence of the valency of the anion and of the pH on the osmotic pressure of 1 per cent solutions of gelatine phosphate, chloride and sulphate, and albumin chloride and sulphate, and find the

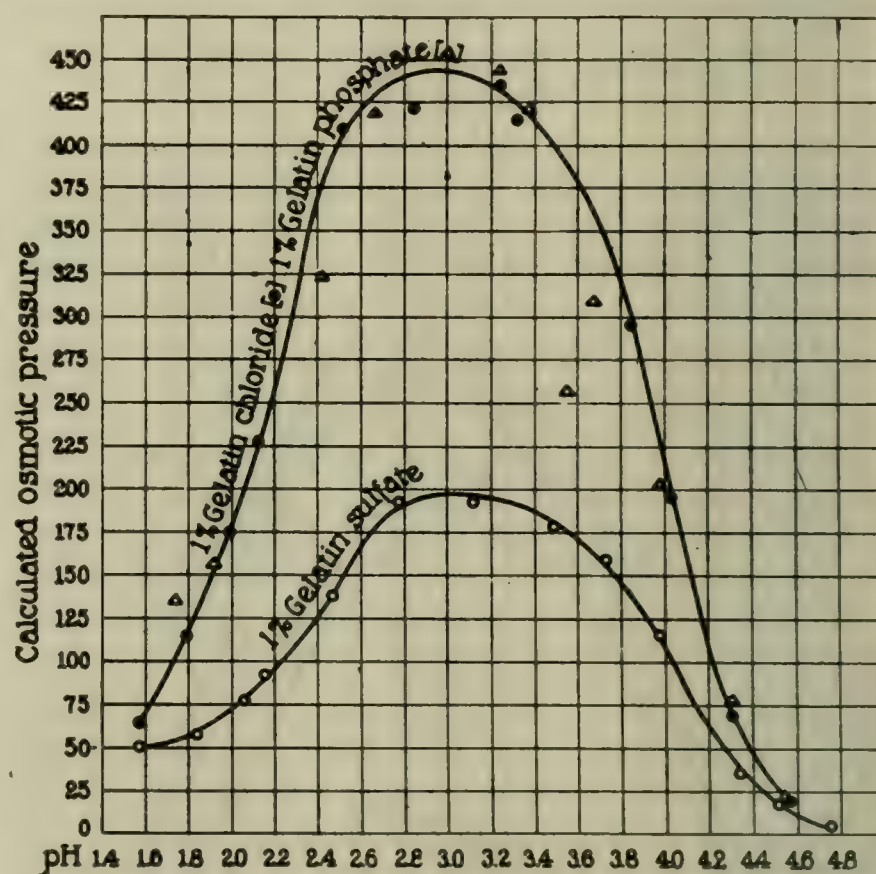


FIG. 2. CALCULATED VARIATION OF OSMOTIC PRESSURE WITH HYDROGEN ION CONCENTRATION

calculated values agree with the observed osmotic pressures not only qualitatively but practically quantitatively. Thus the curves of the observed osmotic pressure of gelatine chloride and gelatine phosphate (Fig. 1) when plotted over the pH as abscissæ are practically identical and so are the curves calculated on the basis of Donnan's theory (Fig. 2); and, what is more, the calculated and observed curves are, except for two minor variations, practically identical. Furthermore, the observed osmotic pressures for gelatine sulphate are not quite one-half of the observed pressures for gelatine chloride (of the same pH and concentration of originally isoelectric gelatine, Fig. 1). The same

TABLE III. INFLUENCE OF THE HYDROGEN ION CONCENTRATION ON pH INSIDE MINUS pH OUTSIDE AND ON P. D. OF GELATINE-CHLORIDE SOLUTION AT EQUILIBRIUM

	C.c. of N/10 HCl added to 100 c.c. 1 per cent isoelectric gelatine											
	1	2	4	6	8	10	12.5	15	20	30	40	50
pH inside.....	4.56	4.31	4.03	3.85	3.33	3.25	2.85	2.52	2.13	1.99	1.79	1.57
pH outside.....	4.14	3.78	3.44	3.26	2.87	2.81	2.53	2.28	2.00	1.89	1.72	1.53
pH inside minus pH outside	0.42	0.53	0.59	0.59	0.46	0.44	0.32	0.24	0.13	0.10	0.07	0.04
P. D. calculated, m.v.....	+24.7	+31.0	+34.5	+34.5	+27.0	+25.8	+18.8	+14.0	+7.6	+5.9	+4.1	+2.3
P. D. observed, m.v.....	+24.0	+32.0	+33.0	+32.5	+26.0	+24.5	+16.5	+11.2	+6.4	+4.8	+3.7	+2.1

difference exists between the calculated osmotic pressures for gelatine chloride and gelatine sulphate (Fig. 2).

Nothing brings out more clearly the difference between the viewpoint of colloid chemistry and the viewpoint of classical physical chemistry than this latter result. In the literature of colloid chemistry SO_4 is called a dehydrating ion which is supposed to diminish the swelling and the osmotic pressure of proteins through a modification of the protein. From our viewpoint the apparent dehydrating effect of SO_4 is merely the consequence of the fact that the valency of the ion with which the protein is in combination modifies the relative distribution of the crystalloidal ions on the two sides of the membrane.

The fact that the Donnan equilibrium is the basis of the variation in osmotic pressure explains also why only the valency and not the nature of the ion has any influence on the osmotic pressure, since the equilibrium equation is the same for all protein-acid salts with monovalent anion. The nature of the anion does not enter into the equilibrium equation.

QUANTITATIVE THEORY IN DEVELOPMENT

If we summarize all these results, we may say that the experiments based on the measurement of the hydrogen ion concentration have proved that the proteins combine with acids and alkalis according to the purely chemical forces of primary valency and in the same stoichiometrical relations in which acids and alkalis combine with crystalloids. They have led to the result that only the valency but not the nature of the ion in combination with a protein affects such physical properties as the P.D. and osmotic pressure and they have further led to the result that this fact finds its explanation in the Donnan membrane equilibrium. Moreover, it was possible to show that the influence of the hydrogen ion concentration on the P.D. and on the osmotic pressure of protein solutions can also be accounted for not only qualitatively but almost quantitatively by Donnan's theory of membrane equilibrium. Procter's experiments and some of the writer's experiments which are not yet complete suggest that the influence of the hydrogen ion concentration and of the valency of the anion on the swelling of gelatine-acid salts may possibly be explained in the same way. The classical laws of general and physical chemistry therefore furnish us with a quantitative theory not only of the chemical behavior of proteins but also of at least some of the physical properties.

Future Developments of Theoretical Chemistry

BY IRVING LANGMUIR

During these ten years that the Chemists' Club has been in this building, of course every chemist knows that great changes have taken place in his science. These are not only changes brought about by the great war, resulting in the stimulation of the chemical industries, but the theoretical work that has been done in chemistry and physics during these years has already had an important influence on theoretical chemistry, and will have an increasing effect as time goes on.

When we look back over the development of science and realize what important applications are made, for example, of the work of Faraday, in electrochemistry, and of Faraday and Maxwell in electrical engineering, and consider that the same kind of thing has happened

already in some fields of chemistry and must happen repeatedly in the future, we have to value very highly the purely scientific pioneer work.

CONCEPTION OF THE ATOM FROM THE ELECTRON ASPECT

During the last ten years a new viewpoint regarding chemical phenomena has been developed. This is the outgrowth of the work of Sir J. J. Thomson and his school. The discovery of the electron occurred only a little over twenty years ago. Up to ten years ago its applications were limited mainly to physical problems, discharges through vacua, conductivity through gases, radioactivity, X-rays, and so on. But beginning about 1911 this began to have deep significance to the chemists, because it gave definite knowledge of the constitution of the atom; and the atom, after all, to the chemist is the most fundamental thing that he has to deal with. If he understood the atom, knew how it is built and is held together, his science then would become a deductive science, it would become like mathematical physics, where from fundamental principles and rigorous reasoning the results of numberless experiments can be predicted with high precision.

THE NUCLEAR ATOM OF RUTHERFORD AND BOHR

About 1911 Rutherford proposed the theory of the nuclear atom, viz., that the atom has a nucleus of positive electricity at its center, and that the electrons are arranged in space about the nucleus.

In 1913 Bohr gave this theory a very definite form, a form which has been extremely valuable and stimulating, by assuming that these electrons are rotating in circular or in elliptical orbits about the nucleus. He also brought in a new element into the theory of atomic structure, the quantum idea, which was derived from the theory that Planck developed in 1903. That is, Bohr assumed that the energy of motion of electrons is determined not only by the ordinary laws of motion, such as Kepler's laws (like planets moving around the sun), but also by a condition which we call a quantum condition, that the angular momentum of the electron about a nucleus shall be a certain multiple of a definite unit. Thus, of all possible orbits consistent with the ordinary laws of orbital motion, only those must be selected which fulfill also these quantum conditions, so that instead of having an infinite number of possible orbits, you have a definite or discrete number of orbits. This quantum theory greatly simplifies the problem, makes it definite, whereas otherwise it would be indefinite.

Now this idea of Bohr has proved of extreme value. For the case of the hydrogen atom he has given us a picture which has been satisfactory quantitatively, that is, it gives us precisely, with an accuracy something like one part in two hundred thousand, nearly all the lines in the spectrum of atomic hydrogen. It has predicted new lines of helium, showing that certain lines which were thought to be lines of hydrogen were really lines of helium. It has shown that these new lines of helium should be slightly displaced from the positions of certain lines of hydrogen, and shown that this displacement is accounted for quantitatively as the effect of the difference in the atomic weight of helium and hydrogen. The theory in its later forms has also shown that these lines, which at first were thought to be simple lines, really have a finer structure; that is, with higher resolving power they can be shown to consist of two or three lines, and the displacement of those

lines from one another is given exactly by this theory. Such remarkable results certainly indicate that we are on the right track in dealing with spectral problems from the quantum point of view.

Then besides this work of Bohr we must consider the work of van den Broek and Moseley, who developed the idea of atomic numbers, that the number of charges on the nucleus is the same as the ordinal number of the element in the periodic table, giving us a clear picture of what the periodic table means from the chemical point of view. Of equal importance to the chemist is the work of Bragg on the structure of crystal by the X-ray method, which has given us definite knowledge of the arrangement of atoms in crystals, which in turn has revolutionized our ideas of valence, showing that in sodium chloride each chlorine is surrounded by six sodiums, and each sodium by six chlorines; that there are no molecules in sodium chloride crystals in the ordinary sense. All those things have come within the last ten years.

DEDUCTIVE CHEMISTRY

And these things mark the beginning, I believe, of a new chemistry, a deductive chemistry, one in which we can reason out chemical relationships without falling back on chemical intuitions. Chemical science in the past has been in a way like biology, botany, geology and so on, in which we deal with general relationships, where we cannot express results quantitatively. We have had, of course, certain fundamental quantitative laws, thermodynamic laws, laws of combining multiple proportions, for example; but although these have been of great importance, they have been capable of accounting for only an insignificant proportion of chemical phenomena.

Now, if we look ahead what do we see as the most probable development in purely theoretical chemistry during the next few years? I believe the field of atomic structure will dominate theoretical chemistry, because a knowledge of atomic structure will enable us to deduce the chemical and physical properties of atoms and molecules.

I have spoken of chemical intuition. The organic chemist of experience knows what the properties of a compound that he has not yet made are likely to be. He has an idea what the color of a certain dye is going to be before he makes it. He tries to make a dye of a certain color. He tries to make a substance which will have certain medicinal properties, and very often succeeds.

Now it is almost impossible to explain the methods by which those results are arrived at, for example, to a physicist. They are not exactly deductive methods; they are more or less intuitive methods, based on large experience, experience which cannot be summarized in a few words, but results in a kind of feeling, a "hunch," that certain results will follow. Now the chemist has accomplished wonders by just that kind of method. Those outside of the field of chemistry do not sufficiently appreciate the value of this method. For instance, the physicist usually does not have much faith in theories of valence. He sees that there are varying values given for valence, and he does not see how reliable predictions of the properties of new compounds can be made on such a basis. But the chemist values those more or less indefinite ideas more highly, and knows how to discount them where needed. He knows that he must not always take the valence of

nitrogen as 3; he must use his judgment in interpreting and making his predictions.

Now the question arises, can this chemical intuition be supplemented by anything which is more powerful? Can we derive with much more precision and certainty, what the properties of compounds are going to be before they are made? Can we tell why it is that the compounds that we have already discovered are the only ones that we have observed; why they are the stable ones, why other compounds whose formulas you might write down on paper are not so stable?

THEORY OF VALENCE SUPPLEMENTED

Within the last month or so I have been trying to analyze the theory of valence, which was developed a few years ago by G. N. Lewis and myself; I have been attempting to analyze that theory more from the point of view of the physicist. In attempting to explain the theory of valence, deriving it from conceptions of atomic structure, I have found physicists extremely skeptical as to the possibility of predicting the properties of compounds. I have not found that difficulty with chemists at all, but the physicist has convinced me that there is a real difficulty there which he experiences because he has not the chemical intuition to help him along. He wants the whole story, not just the part of it which will supplement our ordinary chemical knowledge. That is, he will not grant any ordinary chemical knowledge, he wants the basis for all of it. And the viewpoint is an extremely valuable one, and I think is one which we must lay more stress on in the future, if we want to make chemistry a deductive science.

As an example of what I mean, from the theory of valence which I call the octet theory you can calculate by counting up the number of electrons in an atom (which we know very definitely in every case) how many pairs of electrons could be held in common between the atoms in a molecule. Now, G. N. Lewis has shown that each pair of electrons in common is what the chemist has called in the past a chemical bond.

Since you can count up the number of such electrons, you can say that there cannot be more than a certain number of bonds, or in some cases you may say that there cannot be less than a certain number of bonds. There must be a certain number of bonds in the molecule, but that theory does not tell you yet where those bonds must be. For example, if you try to apply the theory to a compound consisting, say, of four chlorine atoms and one carbon atom, your theory tells you there must be four bonds, but it does not say where. Now, to a chemist you do not have any difficulty in saying that you put the carbon atom in the middle and the four chlorines around, and that gives you carbon tetrachloride and that satisfies the chemist and looks simple enough; but the physicist says, why put the carbon atom in the middle? Why not put one of the chlorines in the middle and the carbon off to one side? You see, that is a very important question from the physicist's point of view. If you are not going to assume any chemical knowledge whatever, why should you not put the chlorine in the middle and have the carbon off all by itself on one side, held by one bond?

Well, the chemist says of course the carbon has a valence of 4. But why should it have a valence of 4? So I have been trying to find out what new points of view we want to bring in, in order to make the octet theory of valence much more definite, and to be able to

predict that the carbon must be in the middle and the chlorines around it, when the four bonds are to be placed among those five atoms.

And I found that to do that, all you need is to call upon Coulomb's law, which is simply the law of inverse square attraction and repulsion between positive and negative charges. From that simple, well known law you can supplement the theory of valence to a degree which seems to me to almost eliminate the necessity for chemical intuition in regard to determining what compounds will be stable and which ones will not be stable. You can then readily derive mathematical formulas to calculate the energy of a given molecule. The potential energy of the electrons with respect to the nuclei and of the electrons with respect to each other can be calculated on the basis of any geometrical model. This potential energy determines how much energy it will take to pull those particles apart, and determines the relative stabilities of different kinds of molecules. I believe, although I have not yet made many quantitative calculations, that on the basis of a very few reasonable assumptions regarding the dimension of the models of molecules, we will be able to calculate with considerable precision the heats of reaction of various chemical substances. Qualitatively, as far as I have worked the thing through, you can consider enormous numbers of substances, and figure out immediately which ones will be the most stable. As far as I can see there is a general close agreement, based on the simple conception that the most stable structure is the one in which the total potential energy is a minimum.

Another way of stating that result is simply this, that the most stable arrangement is that in which there is the most uniform distribution of positive and negative particles. The reason that carbon tetrachloride does not have a chlorine atom in the middle and a carbon off to one side is that that would not be anywhere near as uniform a distribution of positive and negative electricity. If you figure out the potential energy it comes out that way. It is nearly as uniform a distribution as one in which the carbon is placed in the centre. You can very readily put this theory in a simple quantitative form suitable for convenient application.

PREDICTING PROPERTIES OF CHEMICAL MOLECULES

A few months ago I had occasion to talk before a body of physicists on the subject of atomic structure, and was discussing this possibility of predicting the properties of chemical substances without definite chemical knowledge, on the basis simply of certain fundamental principles regarding the stability of certain groupings of electrons. From the position of the inert gases in the periodic table, we can take it as a fact that two electrons around the nucleus as in the helium atom, for example, give a very great stability.

Now, accepting that as a fact, the question was what can be deduced from it. I found a good deal of skepticism among these physicists as to what really could be done from such simple assumptions, until finally I proposed to one of the members who was most active in the discussion or criticism of the theory—in a constructive way, however—that he should answer the question himself as to what a physicist could deduce in regard to the properties; I therefore asked him what compounds there would be between hydrogen and lithium, and if he could tell me what the properties of that substance would be, if there is such a substance. He replied that he had no knowledge of any compounds of

lithium and hydrogen; but by applying the fundamental idea that a pair of electrons around a nucleus will form a very stable configuration, and also by using his knowledge of Coulomb's law and other well known electrical laws he was able in a very few minutes to derive these conclusions: That lithium hydride should have a formula LiH ; that it should be a white crystalline solid body under ordinary conditions, a non-conductor of electricity when solid, but if molten should conduct electricity electrolytically, and hydrogen should appear at the anode, which is not where hydrogen usually appears. Now many of the properties of lithium hydride were not known until recently; but G. N. Lewis predicted those facts in regard to the electrolytic conductivity of lithium hydride, and only recently, within six months or so, Prof. Nernst has had published an article on electrolytic conductivity of lithium hydride, showing that the hydrogen is liberated at the anode instead of at the cathode. Those were predicted in this case by a physicist who had never heard of lithium hydride, and doubted very much whether such a thing existed.

FUTURE CHEMICAL EDUCATION

Now I give this illustration to emphasize a point which I believe it is necessary to consider in a discussion of the future development of science, particularly chemistry. As a science like chemistry progresses it becomes more and more complex. We learn more and more facts. We cannot expect every student of chemistry to go through the whole historical development of chemistry and learn all the facts that we have had to learn. The student who is to study chemistry twenty years from now will need to spend much of his time learning the facts that will be discovered during these next twenty years and will not have nearly as much time as we have to study the discoveries of the last 100 years. To cover the ground he will need to be able to deduce a large part of what we now know from a few simple and almost obvious principles unknown to us.

At the meeting of the body of physicists that I referred to a short time ago there was a discussion as to how chemistry should be taught, and it was maintained by one professor of chemistry that the atomic theory should be taught only after all the general chemical facts are known; that is the teaching of chemistry should follow the historical sequence but with Dalton left out. The students should have all the knowledge that chemists had when they got their ideas of atomic structure, in order that the students may realize how useful the theory is as a method of summarizing the results of experiment.

Now it seems to me that is fundamentally wrong. What we must do now is to present to the student just enough knowledge for him to understand and realize the experimental basis for our ideas of atomic structure, and then use that knowledge of atomic structure in order to deduce practically all the knowledge that most of us have on chemical facts. I think that within a few years we will be able to deduce 90 per cent of everything that is in every text book on chemistry, deduce it as you need it, from simple ordinary principles, knowing definite facts in regard to the structure of the atom. If you know your atoms you will know how they will behave when you put them together. Now if you do that, you can cut down the amount of effort on the part of the student to such a point that he can then go ahead and learn the facts that are going to be discovered in the next twenty years, and will not have to

spend his whole course of instruction in learning what we have had to learn.

It seems to me that we must realize that as each science progresses it gets more complex in some ways, but it also gets more simple in other ways, so that you get broader principles, which allow you to correlate great numbers of facts and put them into simple form.

DIFFERENCES IN BOHR'S AND LEWIS'S THEORIES NOT IMPORTANT

How can those things which we know by experience or by a long process of education be made to appear obvious to the future student, on the basis of certain things that he knows about the atoms? Of course, to go as far as we should like in that direction we will need to know a great deal more about the atom than we do now, for there are some serious difficulties at present. G. N. Lewis in 1916 gave us a picture of atoms with the electrons stationary, held in equilibrium in some unknown way. This is quite opposed to Bohr's theory, in which the electrons are rotating about the nucleus, held out by centrifugal force.

Now from a chemical point of view it really makes very little difference whether you have one or the other. It is a matter that is not of vital importance. You can get a large part of what I have been speaking of, general relationships, by merely considering certain broad geometrical factors, such as the arrangements of electrons in a form having cubic symmetry as distinguished from one with tetrahedral symmetry. This distinction does not depend on any knowledge of whether the electrons are in motion or are at rest. All the chemist usually needs to know is how many electrons are there, and how many are held in common between two atoms. Well, they can be held in common possibly by being stationary between them, or they can be held in common by rotating in a circle between the two atoms. It makes no difference to the chemist when dealing with general relationships.

CALCULATIONS OF QUANTITATIVE DATA

But when we want to go further than general relationships, when we want to get quantitative data, when we want to tie down our chemical facts to observations on spectra, if we want to make use of every spectral line—and there are thousands and thousands of lines in the spectrum of iron—if we want to make use of every one of those lines, in order to predict with precision what the properties of the iron atoms are, we have to know quantitatively what the electrons are doing, and therein I think lies the great future in chemistry. Find the laws of attraction and repulsion and motion of the electrons in atoms, as Bohr has done it for the hydrogen atom, and then from the knowledge of those forces be able to predict or calculate the heat of reaction of a substance with the same kind of accuracy.

Now, of course, to begin with we will be quite content with accuracy within 10 per cent; then later within 1 per cent; but I think that the future holds out for us the possibility of being able to predict heats of reaction, densities, all physical and chemical properties of substances, more accurately than we can determine them by direct methods. I think that is coming, and not so very far off. Already in Germany, Born and Landé have calculated the compressibility of the alkali halides from atomic structural data. They have calculated the heats of reactions; they have predicted on the basis of atomic structure what the energy would be, the heat of

reaction in other words, when an electron combines with a chlorine atom; and they struck it right within a few per cent. It was determined experimentally by Foote and Mohler a year later, and the prediction was verified.

Now, when you can predict heats of reaction, vast possibilities are opened up to the chemist. Thus by deductive means, possibly from the spectra of the elements or from certain fundamental facts in regard to the atomic structure, we may be able to get very much further than we can by ordinary experimental methods.

ORBITAL MOTION CAN PROVISIONALLY BE NEGLECTED

The fundamental question in my mind is whether these electrons are moving or are relatively stationary. The evidence of Bohr's theory has seemed to be almost overwhelming that they are moving in orbits. If this is the case the calculation of the properties of substances seems fundamentally extremely complicated, for the astronomer has never been able to work out orbits of even *three bodies* accurately. Just recently I have found that all the fundamental equations of the Bohr theory can be deduced without assuming any motion of the electrons at all. You can get the Balmer series, you can get all the lines of the hydrogen atom with the same precision that Bohr gets; you can get some of the fine structure (not all of it—just how far we may be able to go it is hard to say yet, because this work is only a few weeks old, and Bohr's theory is eight years old). But at any rate it seems to me significant that we can get the outstanding facts of Bohr's theory by one assumption in regard to a law of force between electrons and positive nuclei. If we assume that in addition to the ordinary force that we know of, the Coulomb force of attraction, we have also a force F of repulsion varying inversely as the cube of the distance r

$$F = \frac{1}{mr^3} \left(\frac{nh}{2\pi} \right)^2$$

Here m is the mass of the electron and h is the quantum constant; n is an integer denoting the quantum state of the electron.

Taking that law (which is about as simple a law as you can imagine that would indicate the necessary factors), you find that electrons reach certain equilibrium positions, and in passing from one equilibrium position to another, they would radiate energy in exact accordance with Bohr's theory, and in fact you get precisely the same formulas that Bohr gets, not only for the energy of the atom, but for the distance between the electrons and the nucleus, and the frequency of vibration of the electron about this equilibrium position comes out the same as the frequency that Bohr got for the rotation around the nucleus.

Now it is too early to say that this is proof the electrons do actually have definite equilibrium positions in the atom. It simply affords an alternative way of looking at it. It seems to me that is the most immediate problem for the chemist, to find out whether these electrons are moving or stationary. If they are stationary the problem is a beautiful chemical problem. It is a comparatively simple matter, if you once know the law of force, to find these positions of equilibrium, to figure out where the electrons are in the atomic structures. On that basis the atomic and molecular models that I proposed a couple of years ago could be used almost as they are, with very few changes. That problem, then, is one in which it looks as though we ought to make extremely rapid progress.

On the other hand, if it is a question of orbits, that is going to be a very very difficult problem to work out in detail. But even if it is a difficult problem, there are ways of generalizing, there are ways of getting approximate solutions.

The kinetic theory of gases affords a parallel. The actual phenomena involved in the myriads of collisions between molecules in a gas are of amazing complexity. Nevertheless, by simplifying assumptions such as spherical, hard elastic molecules with attractive forces varying inversely as some power of the distance, it has been possible to account for practically all the properties of gases. Similarly, in the study of chemical relationships, even before we can calculate the exact positions or possible orbits of electrons in atoms and molecules, we may be able to solve enormous numbers of problems by assuming repulsive forces between charged particles, even if these are merely fictitious forces used to replace the unknown centrifugal forces resulting from certain quantum conditions.

In either case, then, whether the atom proves ultimately to be fundamentally static or dynamic, we may hope that chemical relationships and the prediction of chemical and physical properties of compounds can be based upon simple knowledge of atomic structure, and that this knowledge will largely supersede what must now be classed as chemical intuition.

Knowledge of atomic structure thus promises to make chemistry a deductive science, and a science fundamentally simple compared to what it now is.

Pulp and Paper in 1920

The Federal Trade Commission has recently issued a statistical summary of the paper and pulp industry for 1920. The data on the different grades of paper include: Domestic production, shipments and stocks on hand by months for 1919 and 1920; stocks on hand first of year and end of year and total quantity produced and shipped during year, 1917 to 1920 inclusive. Domestic productions, shipments and stocks of pulp are given by grades for 1917 to 1920 inclusive. Import and export figures on pulp and paper are also tabulated for 1917 to 1920.

From this report the accompanying tables have been prepared, showing production of and foreign trade in pulp and paper during 1920.

Production of paper is classified in grades as follows:

Total newsprint includes all *standard news* and special grades of newsprint, but excludes hanging paper, which is shown separately.

Standard news is the principal subdivision of *total newsprint*, being 32-lb. paper used for printing newspapers.

Book includes all periodical paper and miscellaneous grades of machine finished, supercalendered, coated, etc.

Total paperboard includes all grades of board, such as box, straw, chip, tag, press, fiber, binder, leather.

Boxboard, the principal subdivision of *total paperboard*, is shown separately beginning with March, 1920.

Wrapping includes kraft, manila, fiber, and miscellaneous grades such as glassine, grease-proof, etc., but excludes bag paper which is shown separately.

Bag includes paper made into flexible commercial containers such as grocery bags, flour sacks, etc.

Fine includes writings, bonds, ledgers, etc.

Tissue includes toilet, crepe, fruit wrappers, etc.

Hanging includes paper ultimately intended to be

used for purposes of interior decoration, such as No. 2 hanging, oatmeal, tile paper, etc.

Felt and building includes roofing, felt, sheathing and other grades of building paper.

Other grades include a great variety of specialties that do not classify under any of the above captions.

DOMESTIC PRODUCTION OF PULP BY GRADES, 1920

	Production for Year, Tons	Used During Year, Tons	Shipped During Year, Tons	Increase of Production Over 1919, Per Cent
Ground wood pulp.....	1,578,300	1,456,198	131,495	9
Sulphite, news grade.....	843,514	717,986	126,261	17
Sulphite, bleached.....	578,081	316,037	262,213	12
Sulphite, easy bleaching.....	72,394	45,309	27,159	9
Sulphite, Mitscherlich.....	82,687	50,404	31,479	4
Sulphate pulp.....	212,888	144,926	65,601	31
Soda pulp.....	431,971	235,808	195,296	14
Other than wood pulp.....	7,821	6,788	1,162	*21
Total, all grades.....	3,807,656	2,973,456	840,666	12

* Decrease.

Note:—The pulp used and the pulp shipped during each year represent pulp produced in the establishment using or shipping same.

DOMESTIC PRODUCTION OF PAPER BY GRADES, 1920

	Number of Mills, (Approximate)	Production, Net Tons	Increase of Production Over 1919, Per Cent
Total newsprint.....	87	1,511,968	10
Standard news.....	71	1,380,239	12
Book paper.....	95	1,104,464	27
Total paperboard.....	250	2,313,449	18
Boxboard.....	144	1,378,166	(a)
Wrapping paper.....	148	831,889	20
Bag paper.....	42	211,923	21
Fine paper.....	111	389,322	13
Tissue paper.....	100	177,447	14
Hanging paper.....	24	113,824	24
Felt and building paper.....	53	366,941	30
Other grades.....	92	313,387	50
Total, all grades.....	—	7,334,614	18

(a) Figures for boxboard prior to March, 1920, were included under total paper board.

IMPORTS AND EXPORTS OF PULP, 1920

	Imports, Net Tons
Chemical wood pulp:	
Bleached sulphite.....	128,206
Unbleached sulphite.....	344,969
Bleached sulphate.....	17,277
Unbleached sulphate.....	182,697
Ground wood pulp.....	233,148
Paper stock other than wood pulp.....	254,755
Total.....	1,161,052
	Exports, Net Tons
Domestic wood pulp.....	32,133
Rags and other material made from vegetable fibers.....	42,282
Total.....	74,415

IMPORTS AND EXPORTS OF PAPER, 1920

Imports	Lb.	Value
Newsprint.....	1,459,737,288	\$68,600,950
Book paper.....	4,340,425	496,132
Wrapping.....	4,941,824	460,289
Hanging.....	.....	353,791
All other grades.....	.....	2,741,238
Total.....	.....	\$72,652,400
Exports	Lb.	Value
Newsprint.....	91,951,913	\$5,983,611
Book paper.....	95,689,512	13,765,694
Paperboard.....	.....	5,553,094
Wrapping.....	61,264,501	6,994,381
Bag.....	.....	2,593,459
Fine.....	.....	8,908,230
Tissue.....	.....	2,654,529
Hanging.....	.....	1,251,743
All other grades.....	.....	11,091,952
Total.....	.....	\$58,796,693

Chilean Nitrate Exports for 1920

According to figures kept by individuals engaged in the nitrate business, compiled from periodical official announcements, the total exports of nitrate from Chile in 1920 amounted to 60,679,834 Spanish quintals (1 Spanish quintal = 101.4 lb.). The number of Spanish quintals shipped per month were as follows: January, 9,039,452; February, 6,081,230; March, 5,417,956; April, 5,057,414; May, 5,237,182; June, 2,411,158; July, 3,104,021; August, 4,274,873; September, 5,479,125; October, 4,626,940; November, 3,581,938; and December, 6,368,545.

Copper:Nickel Alloys

**Brief Notes on Structure and Properties of Alloys Used for Driving Bands, Condenser Tubes and Coinage
—Various Names and Analyses for Nickel Silver Are Tabulated,
With Notes Upon Their Most Common Uses**

By PAUL D. MERICA

Superintendent of Research, International Nickel Co.

ALLOYS of copper and nickel are undoubtedly among the earliest known to man. Thus Muspratt¹ mentions Bactrian coins containing 77 to 78 per cent copper and 22 to 23 per cent nickel dating from 235 B.C. This composition is almost identical with our present nickel coinage alloy. In spite of their antiquity, the pure copper:nickel alloys have not come into the commercial prominence which their unusual properties should perhaps give them, although the recent war, with its large requirements of these alloys for bullet-jackets and driving bands, has served to stimulate interest in them.

Nickel and copper form solid solutions in all proportions, as may be seen from Fig. 1, which gives the equilibrium diagram of this binary series. In conformity with this type of equilibrium the physical properties of the alloys vary continuously with composition, maximum and minimum values being encountered within the series. Fig. 2 shows the electrical resistivity,² its temperature coefficient,³ the thermo-electromotive force³ and the hardness⁴ as they vary. Throughout the entire range of composition the alloys are ductile and malleable; their tensile strength and hardness reach a maximum in the neighborhood of 40 to 60 per cent of copper. Table I gives typical values of the tensile properties for commercial compositions of copper:nickel alloys in different forms.

Baucke⁵ has shown that small amounts of nickel increase the toughness of copper as indicated by the notch-bar impact test. He obtains the following results on forged and annealed test bars:

Per Cent Nickel	Specific Impact Work in Kg.-M.
Electrolytic Copper	14.1
0.17	20.0
0.31	22.0
1.52	28.0

Even in small amounts nickel decolorizes copper and its alpha alloys. Thus bullet-jacket stock containing 15 per cent of nickel is practically colorless when freshly cut or polished.

Alloys containing less than 60 per cent of nickel are not perceptibly magnetic, but above that percentage of nickel the magnetism of the alloys may readily be detected with a small magnet.

There are several compositions of copper:nickel alloys in common commercial use. The most prominent are:

(1) Two and one-half per cent (2.5 per cent of nickel) cupronickel for driving bands of shells.

(2) Fifteen per cent cupronickel, used largely for bullet-jackets and by the U. S. Navy for condenser tubes

and feed water heaters, containing from 14 to 16 per cent of nickel.

(3) Nickel-bronze, or coinage-bronze, used for baser currency and containing 25 per cent of nickel.

(4) Copper-nickel, containing 50 per cent of nickel, used for remelting in the manufacture of nickel:copper alloys, and

(5) Constantan, used as one element in the construction of thermocouple pyrometers and also as electrical resistance wire, containing 45 per cent of nickel. Their properties will be noted elsewhere in company with other nickel alloys used for special electrical properties.

Of these perhaps the most interesting, in view of its large use during the war, is the bullet-jacket composition commonly known as cupronickel. These alloys are generally made by melting copper in crucibles together with shot or electrolytic nickel following the practice in melting brass and bronze. The metal has a strong affinity for gases and oxygen and before casting is usually deoxidized with from 0.5 to 1 per cent of cupromanganese in order to secure a sound ingot; it may also

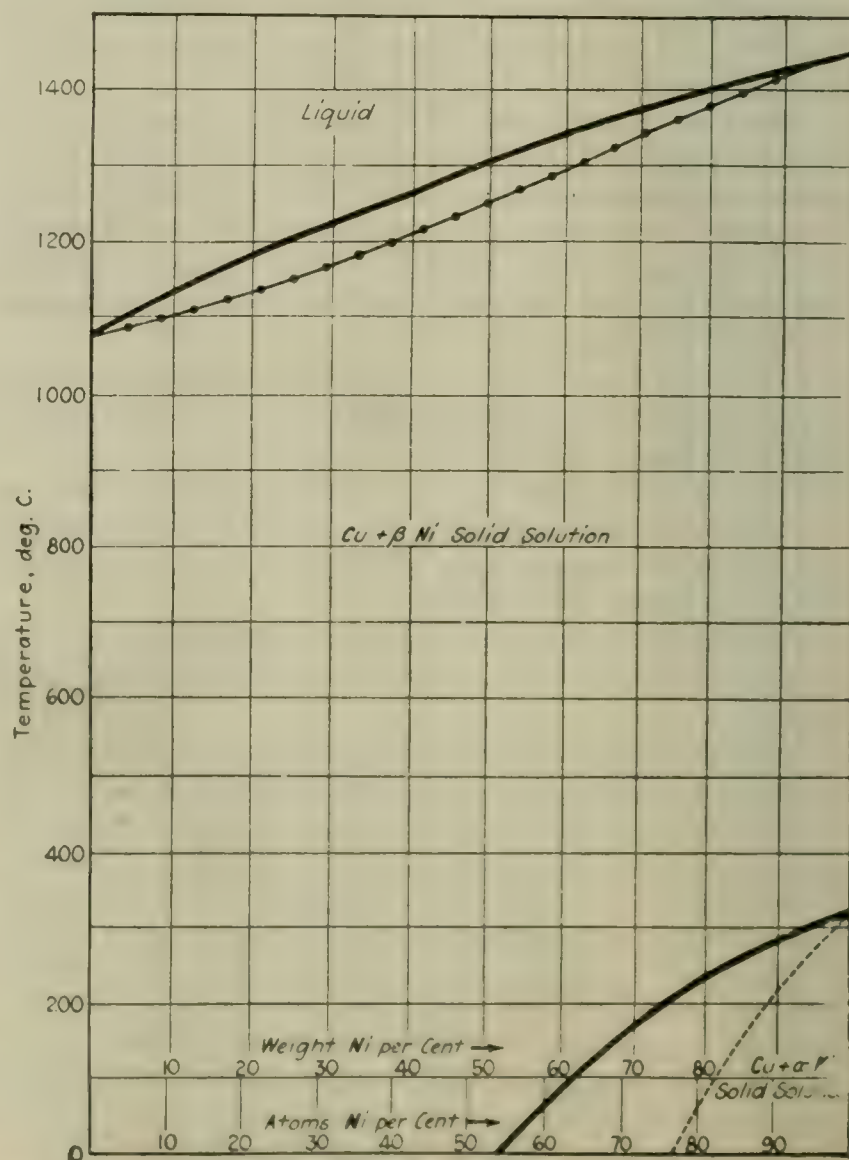


FIG. 1. EQUILIBRIUM DIAGRAM OF COPPER:NICKEL ALLOYS ACCORDING TO GUERTLER'S "HANDBUCH DER METALLOGRAPHIE"

¹Published by permission of the Director, Bureau of Standards.

²*Chemie*, vol. 6, p. 1195 (1898).

³Feussner and Linde, *Abh. physik. Reichsanstalt*, vol. 2, p. 503 (1895).

⁴Bash, *Bull. Am. Inst. Mining Eng.*, No. 153, p. 2409 (1919).

⁵Kurnakoff and Rapke, *Z. anorg. allgem. Chem.*, vol. 87, p. 269 (1914).

⁶*Intern. Z. Metallog.*, vol. 4, p. 9 (1912).

TABLE I. TYPICAL VALUES OF THE MECHANICAL PROPERTIES OF COMMERCIAL CUPRONICKEL COMPOSITIONS

Chemical Composition		Form	Yield Point Lb./Sq. In.	Tensile Strength Lb./Sq. In.	Elongation Per Cent
Per Cent Ni	Per Cent Cu				
2	98	Tubes, soft†		39,000	44
2	98	Tubes, hard†		63,500	5.5
5	95	Sheet, soft†		39,200	50
5	95	Sheet, hard†		67,500	4
20	80	Sheet, soft†		47,200	35
20	80	Sheet, hard†		90,000	4
25	75	Sheet, soft†		60,500	31
2.5	97.50	Driving band†	14,340	31,770	69.6†
2.5	97.50	Wire (0.08 in. diam.), hard †		72,150	1.6†
10	90.0	Strip, annealed†		48,450	28.4*
15	85	Strip, hard†		71,000	3.0*
15	85	Strip, annealed†		47,000	28.0*
20	80	in. rod, hard†	57,800	61,500	14.8*
20	80	in. rod, annealed†	18,000	47,600	40.0*
25	75	in. rod, hard†	58,000	64,000	17.0*
25	75	in. rod, annealed†	21,000	51,600	39.0*
40	60	in. rod, annealed†		69,400	28.0*

* Elongation in 2 in.

† Values quoted by Hiorns, "Mixed Metals."

‡ Values supplied by an American manufacturer.

be readily deoxidized with magnesium. These ingots are cold-rolled to the size required and annealed at about 700 deg. C.

A striking property of this composition is its greater malleability, as evidenced by the fact that a cast bar 1.25 in. thick may be cold-rolled to 0.040 in. or even thinner, without intermediate annealing. Webster⁶ has determined the effect of cold reductions upon the tensile properties of cupronickel as shown below:

History	Tensile Strength, Lb. per Sq. In.	Elongation in 4 In., per Cent	Reduction of Area, per Cent
Normalized.....	50,000	28	63
20 per cent reduction.....	60,000	5	58
40 per cent reduction.....	70,000	3	56
60 per cent reduction.....	80,000	2	53

A typical analysis and tensile test of bullet-jacket material is as follows:

	Per Cent		Per Cent
Copper.....	85.16	Manganese.....	0.11
Iron.....	0.23	Carbon.....	0.029
Nickel by difference.....			14.47

Tensile strength after cold-rolling to 0.040 in. and annealing, lb. per sq. in. 46,900
Yield point, lb. per sq. in. 22,300
Elongation in 2 in., per cent 35.4

⁶Proc., Intern. Assoc. Testing Materials, vol. 7, p. 6 (1912).

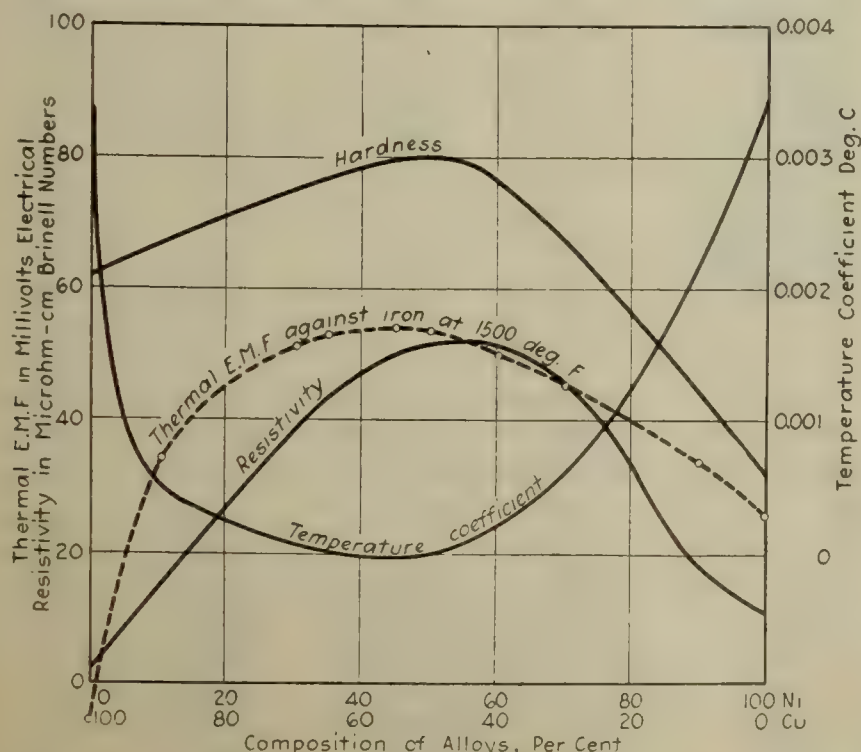


FIG. 2. SOME PHYSICAL PROPERTIES OF Cu:Ni ALLOYS
Hardness is taken on rolled and annealed samples, using a 10-mm. ball and a 500-kg. load

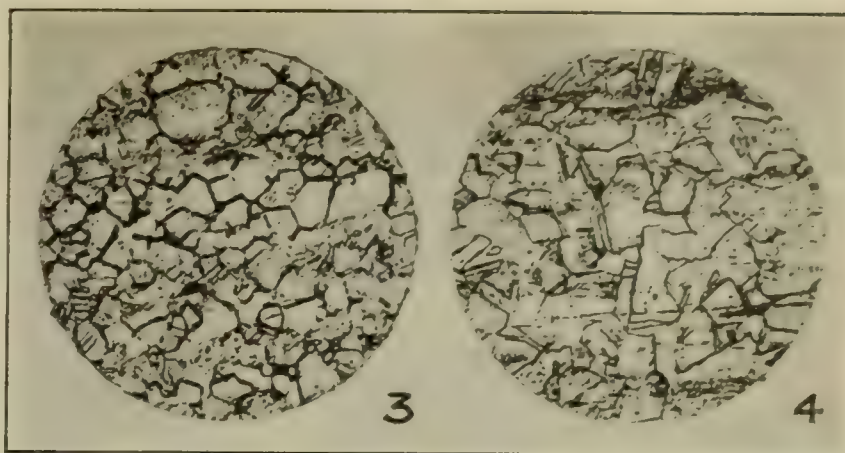


FIG. 3. Cu:Ni HAVING INTERCRYSTALLINE BRITTLENESS. $\times 150$

FIG. 4. NORMAL CUPRONICKEL. $\times 150$

Both microstructures etched with 20 parts concentrated HNO_3 and 40 parts glacial acetic acid in 40 parts acetone.

These alloys are also quite resistant to corrosion and are therefore in wide use as Benedict metal for condenser tubes; see U. S. Navy Department specifications 46N1a of 1917. The following values of the tensile properties are typical for this material in tube form:

Outside Diameter, In.	Wall Thick., In.	History	Tensile Strength	Elongation
0.517	0.038	Annealed	43,080	39.0% in 10 in.
0.516	0.036	Light drawn	51,520	8.1% in 10 in.
0.750	0.047	Medium drawn	60,300	4.2% in 8 in.
0.750	0.047	Hard drawn	75,800	2.0% in 8 in.

Bengough⁷ has studied the effect of high temperatures on the tensile properties of a 20 per cent copper:nickel alloy.

This metal is subject to a curious type of intercrystalline brittleness at present insufficiently understood. After annealing it frequently is so brittle that it will bend only a few degrees. Under the microscope it presents the appearance shown in Fig. 3, whereas normal annealed cupronickel has a structure shown in Fig. 4, consisting of an aggregate of grains of copper:nickel solid solution. The intercrystalline appearance in the embrittled metal is rather similar to that which occurs on "burning" nickel and Monel metal. By some (see Thompson and Barclay⁸) this brittleness is considered as being associated with the precipitation of graphitic carbon and on this account manufacturers of this metal aim to keep the percentage of total carbon below about 0.04.

The cupronickel alloys are found not to be subject to corrosion- or season-cracking as are the brasses, bronzes and also the nickel:silver alloys.

The composition used for nickel coinage—i.e., containing 25 per cent of nickel, is a very old one. This material has essentially the color of pure nickel, is hard and resistant to abrasion and corrosion; being softer than pure nickel, it is not so difficult to stamp as is the latter. It is manufactured in much the same manner as cupronickel. It is estimated that the total amount of nickel used in nickel coinage is not over 15,000 tons.

A series of alloys containing copper, nickel and zinc is also of very old origin, having been known in China under the name of packfong, or white copper. The most common name for them at one time was German silver, but since the war the trade has accustomed itself to the term nickel silver. The name "nickelene" has been recently suggested by the non-ferrous nomenclature committee of the American Society for Testing Mate-

⁷J. Inst. Metals, vol. 7, p. 182 (1912).

⁸J. Soc. Chem. Ind., vol. 38, p. 130 (1919).

rials. In France, the name maillechort is used for this series of alloys.

Compositions which are in commercial use are quite numerous; they will vary usually within the following limits: Copper, 52 to 80 per cent; zinc, 10 to 35 per cent; nickel, 5 to 30 per cent.

Particularizing, the compositions of nickel silver in common commercial use in the United States are as follows:

	Nickel, per Cent	Copper, per Cent	Zinc, per Cent	Lead, per Cent
Cutlery and knife stock	15-25	55-65	14-20	Fe $\frac{1}{2}$ -1 $\frac{1}{2}$
Key stock.....	8-18	55-65	15-35	1-2
Jewelers' wire.....	5-25	53-63	25-32	...
Brazing solder.....	8-20	35-40	40-55	...
Watch case metal.....	10-28	55-65	16-30	0-1
Spoon and fork stock..	10-20	57-66	20-30	...
Platers' bars and cores.	5-25	56-70	18-24	...

Nickel silver is marketed in several grades, depending chiefly on the nickel content, high-grade alloys containing about 20 per cent and low-grade ones less than 10 per cent. Abroad, these are called firsts, seconds, thirds, fifths, etc., but in this country are named according to their nickel content (Table II). An idea of the various trade names which have been given to these alloys may be obtained from Table III.

These alloys are largely used as substitutes for silver and as base metals for plated silverware of all sorts, their suitability for both purposes being due to the fact that their color is very similar to that of silver. They are used in the production of a large number of ornamental fittings and stampings for which an attractive finish and resistance to corrosion are desired and also in the form of wire for small springs and for electrical purposes. Their color varies from a nearly white, nickel color with the higher percentages of nickel to a yellowish white color in the compositions of lower grade or nickel content.

As above noted, the compositions of nickel silver used for any specific purpose are quite variable. It will be understood that lead is added when ready machinability is desired (1 to 2 per cent in key stock); however, it is kept out in material which is to be spun or drawn, as it diminishes the ductility of the alloy.

Analyses of two typical compositions of nickel silver follow:

	No. 1, per Cent	No. 2, per Cent
Copper.....	63.03	63.39
Lead.....	None	None
Iron.....	0.12	0.13
Manganese.....	0.037	...
Nickel.....	16.69	18.37
Zinc.....	Remainder	17.98

The alloys are produced by melting copper together with nickel silver scrap in graphite crucibles, adding the nickel and zinc, deoxidizing with from $\frac{1}{4}$ to $\frac{1}{2}$ per cent of cupromanganese and pouring into ingots, which are cold-rolled, with annealing and pickling, into the sheet or strip required, or drawn into wire. The presence of zinc renders this alloy much easier to cast in a sound condition than cupronickel. Annealing is carried out usually at 700 deg. C. in a muffle furnace excluding air.

Copper, zinc and nickel in the proportions used in nickel silver unite to form a single solid solution; these alloys are therefore similar structurally to high and low brass or to copper:nickel alloys, and consist of one (alpha) constituent only. They may be etched with ammonium hydroxide and hydrogen peroxide in the manner used for high brass.

TABLE II. TYPICAL COMPOSITIONS USED IN AMERICAN MANUFACTURED PRODUCTS

Name	Common Use	Per Cent Nickel	Per Cent Copper	Per Cent Zinc	Per Cent Lead
30 Per cent	.....	30	46.67	23.33	....
25 Per cent	.....	25	50	25	....
20 Per cent	Spoon stock....	20	60	20	....
20 Per cent	.....	20	53.33	26.67	....
18 Per cent	Spoon stock....	18	65	17	....
18 Per cent	.....	18	72	10	....
18 Per cent	Bolster silver..	18	65.50	16	0.50
18 Per cent	Spring silver....	18	54.67	27.33	....
18 Per cent	Spinning silver..	17.50	67	15.50	....
16 Per cent	Spinning silver..	16	67	17	....
16 Per cent	Bolster silver..	16	56	28	....
15 Per cent	.....	15	60	25	....
15 Per cent	.....	15	56.67	28.33	....
12 Per cent	.....	12	58.67	29.33	....
12 Per cent	Spinning silver..	12	66	22	....
12 Per cent	Key stock.....	12	60	26	2.0
12 Per cent	Key stock.....	12	65	22	1.0
10 Per cent	.....	10	62	28	....
10 Per cent	.....	10	60	30	....
8 Per cent	.....	8	61.33	30.67	....
5 Per cent	.....	5	72	23	....
5 Per cent	.....	5	63.33	31.67	....

TABLE III. SOME NAMES AND COMPOSITIONS OF NICKEL SILVER

	Cu	Ni	Zn	
Extra white metal....	50	30	20	.....
White metal.....	54	24	22	.....
Arguzoid.....	48.5	20.5	31	.....
Best best.....	50	21	29	.....
Firsts or best.....	56	16	28	.....
Special firsts.....	56	17	27	.....
Seconds.....	62	14	24	.....
Thirds.....	56	12	32	.....
Special thirds.....	56.5	11	32.5	.....
Fourths.....	55	10	35	.....
Fifths, for plated goods	57	7	36	.....
Alfenide.....	50-70	10-20	5-30	.....
Alpakka.....	65.2	13	19.5	.....
Amberoid.....	.....	.....	.....	.....
Argentan.....	50-70	10-20	5-30	.....
Argentan solder.....	35	8	57	.....
Argentin.....	.....	.....	.....	.....
Argiroid.....	.....	.....	.....	.....
Argozoid.....	54	14	28	.....
Arguzoid {	55.78	13.45	23.2	Sn2; Pb2; Orn. Casting
Argyrolith.....	48.5	20.5	31	Sn4.03; Pb3.54
Aterite.....	50-70	10-20	5-30	.....
Carbondale silver.....	55-60	12-18	13-20	Pb 1-2.5; Fe 6-10
Colorado silver.....	66	18	16	.....
China silver.....	57	25	18	.....
Craig gold.....	50-70	10-20	5-30	.....
Electro plate.....	80	10	10	.....
Electrum.....	50-70	10-20	5-30	.....
German silver.....	51.5	26	22.5	.....
Keens alloy.....	.....	.....	.....	.....
Lutecin.....	.....	.....	.....	.....
Maillechort (typical	.....	.....	.....	.....
French analysis)....	66.2	16.4	13.4	Pb 0.15; Fe 3.2; Sn.22
Markus alloy.....	.....	.....	.....	.....
Neogen.....	58	12	27	Sn 2; Al 0.5;
Nevada silver.....	.....	.....	.....	.....
New silver.....	.....	.....	.....	.....
Nickelin.....	68-55	31-32	0-13	For resistance wire
Nickelin.....	74.5	25	.....	Fe 0.5
Nickel oreide.....	66-87	5-10	0-10	.....
Platinoid.....	54.04	24.77	20.42	Fe 0.5; Mn 0.5
Platinoid.....	60	14	24	W 1-2
Popes Island metal....	70	14	15	I
Potosi silver.....	.....	.....	.....	.....
Ruolz alloys.....	.....	.....	.....	.....
Spoon metal.....	.....	.....	.....	.....
Silveroid.....	.....	.....	.....	.....
Silverite.....	.....	.....	.....	.....
Silverine.....	.....	.....	.....	.....
Sterline.....	68	17-18	13-14	Fe $\frac{1}{2}$ - $\frac{1}{4}$
Sterlin.....	68.5	17.88	12.84	Pb 0.76
Suhler white copper....	40.4	31.6	25.4	Sn 2.6; Co 0.5 - 0.6
Tutenay.....	45.7	17.3	37	.....
Victor metal.....	.....	.....	.....	.....
Virginia silver.....	.....	.....	.....	.....
Weiss kupfer.....	.....	.....	.....	.....
White metal.....	.....	.....	.....	.....
White copper.....	.....	.....	.....	.....
Wessells silver.....	51-65	19-32	12-17	Ag 2; FeO $\frac{1}{2}$

An idea of the tensile properties of the copper-nickel-zinc alloys may be obtained from the following table, which gives some typical values for commercial material:

Per Cent Nickel	Per Cent Copper	Per Cent Zinc	Form	Tensile Strength, Lb. per Sq. In.	Elongation in 2 In., per Cent
30	47	23	Strip, hard	130,000	2
30	47	23	Strip, annealed	73,000	32
25	55	20	Strip, annealed	71,000	38
18	64	18	Strip, hard	94,000	2.5
18	64	18	Strip, annealed	58,000	33
18	55	27	Strip, hard	107,000	2
18	55	27	Strip, annealed	69,000	29
10	62	28	Strip, hard	92,000	4
10	62	28	Strip, annealed	53,000	48

Studies in Colorado Shale Oils

Lighter Hydrocarbon Oil Fractions Found to Be More Saturated Than Heavier Fractions—
Methods Used in Obtaining Data—Graphical Analysis of Distillation Cuts,
Showing Temperatures, Saturations and Specific Gravities

BY ARTHUR J. FRANKS

WITHIN the past few years the American shale oil question as an industry has emerged from its position in nebular speculation and is now being fast recognized, not as a mere potential possibility but as a proximate reality. Realizing the intense scientific as well as popular interest in shale oils, the author is pleased to submit this paper as a small contribution to our knowledge, hoping that it will further accelerate the building of an industry that is rapidly assuming definite form.

This investigation was made for the purpose of studying the general character of the crude oils and their fractions and also the distribution and character of the saturated, unsaturated, sulphur and nitrogen compounds in these fractions. Owing to the great difficulty attending the accurate determination of some of the constituents and the identification of others ordinarily found in mineral oils this paper must be considered as the result of preliminary studies only. More thorough investigations are already planned for the future.

The oils studied were all obtained in the Ginnet retort by low-temperature carbonization of shales found in the vicinity of De Beque, Col. These oils were produced during experimental operation. As the shales were from different strata and the conditions obtaining during the various carbonizations were not always identical the oils must show consequent differences. It was to classify and if possible explain these dissimilarities that the first part of this work was undertaken.

METHODS OF ANALYSIS USED

Since shale oils possess certain inherent characteristics which differentiate them from petroleums, and for other recognized reasons, it was found necessary to depart somewhat from a number of the more or less standard methods of analysis generally used in petroleum technology. In order that the analyses given herein may be of the most value these departures will be given detailed consideration.

Except where otherwise stated the volume of oil taken for a distillation analysis was 500 c.c. A sample of this magnitude yielded fractions large enough for all subsequent investigation. Fractionations were made in 1,000 c.c. Pyrex distilling flasks, except where only small samples were available, in which case a 500 c.c. flask was used. The standard flasks recommended by the United States Bureau of Mines¹ are not suitable for the analytical distillation of shale oils because the high necks, especially when filled with beads, cause excessive cracking of the heavy fractions and great irregularities in the last part of the analysis. Even when proceeding as described above the last oils can escape undue decomposition only by meticulous regulation of the gas flames by the operator. The distillation rate was main-

tained as nearly as possible at two drops per second for the 500 c.c. samples, and at a proportionately lesser rate for the smaller ones. The oils were distilled into 10 per cent fractions, the percentages being expressed by volume. This system of fractionation is superior to that in which the cuts are made on a temperature basis, because the results with the former are more readily and comprehensively represented graphically. Except in one case distillations were carried to complete dryness. All temperatures are given in degrees Centigrade, and are uncorrected for the emergent stem. Bunsen burners were used as a source of heat. The naked flame is required to drive over the last fractions of the oil. Since the gas was often poor and the pressure frequently variable, the temperatures near the end of the distillation sometimes fluctuated more or less. In drawing the distillation curves this was considered and the mean values taken as the true temperatures.

The specific gravities were, in each case, obtained from the Baumé value by conversion with standard tables, and are always expressed at 25 deg. C., which is a convenient and practical basis of comparison. While it is, of course, understood that the ordinary hydrometer is not a very precise instrument for the measurement of specific gravities, it is nevertheless capable of greater accuracy than is possible in the rest of the distillation analysis and is therefore entirely suitable for the present purpose.

SATURATION PERCENTAGE

The "saturation" of crude oils and fractions is that percentage of volume which is not attacked by concentrated sulphuric acid. This is determined in the following manner. A 9.8 c.c. sample of the oil is measured into a 9 or 18 g. Babcock cream test bottle, the smaller size being used when the expected saturation is less than 50 per cent and the larger size when it is more. Twenty c.c. of concentrated sulphuric acid is then added, the bottle is corked, and the mixture simultaneously cooled and slowly shaken until all violent action has ceased. It is then thoroughly shaken for one minute. Concentrated sulphuric acid is then added until the level of the liquid has risen to the neck of the bottle, which is now immersed to nearly its full length in hot water. When the mixture is quite warm it is immediately centrifuged for about two minutes, the centrifuge running at high speed. Acid is then poured carefully into the bottle until its level below the supernatant oil is plainly visible above the lowest graduation mark, and the centrifuging is repeated until a constant reading is obtained. When the 9 g. bottles are used the percentage saturation may be read directly on the bottle. With the 18 g. bottles the readings must be multiplied by 2 to give the correct value. In the case of very light oils the warming of the mixture before

¹Bulletin 125.

TABLE I. ANALYSES OF CRUDE OILS

Oil No.	1	2	3	3a	4	5	6	7	8	9
Sp. gr.	0.903	0.901	0.896	*	0.892	0.911	0.946	0.833	0.921	0.933
Saturation	15.0	12.0	15.3	35.0	18.0	17.0	11.7	27.4	*	19.0
Sulphur	0.64	*	0.44	0.43	*	0.52	*	0.51	*	0.53
I.b.p.	65.0	68.0	78.0	73.0	65.0	65.0	*	68.0	90.0	75.0
Water	None	None	2.4	None	1.0	None	0.6	0.2	0.6	8.0
Coke	11.0	8.3	*	*	7.7	11.8	5.3	10.1	11.0	500
C.c. sample	500	500	500	300	200	500	500	500	500	500

*No determination made.

centrifuging is unnecessary and is to be omitted, since there is danger of losing part of the unabsorbed constituents by volatilization. The probable sources of error and the accuracy of the method described are discussed in a publication of the United States Bureau of Mines.²

It has been customary heretofore to determine the unsaturated rather than the saturated compounds in mineral oils, this being expressed as that percentage by volume which is dissolved by concentrated sulphuric acid. The remainder was assumed to be the saturated³ hydrocarbons. But since it is the saturated portion of the oil that is actually measured, and mainly because that part of the oil which is attacked by the sulphuric acid is not necessarily composed entirely of "unsaturated hydrocarbons," it is incorrect to speak of it as such. This error is especially to be avoided in the case of shale oils, since they contain bases and other compounds soluble in sulphuric acid which are not hydrocarbons at all, nor are they even "unsaturated." Therefore the author has discarded entirely this loose expression and uses and recommends the term "saturation" to express that percentage of the oil not acted upon by concentrated sulphuric acid. If it is still desired to express the value of an oil for refining in terms of that percentage which is absorbed rather than

unabsorbed by the acid, then another term, such as "sulphuric acid absorption," should be used, especially for shale oils.

The initial boiling point (i.b.p.) is herein considered as that temperature at which the first drop is seen in the condenser. For oils containing only a small percentage of low-boiling constituents this is more nearly the true boiling point than the temperature at which the first drop is observed in the receiver.

The water is expressed in volume per cent and was determined during the distillation. In cases where more than 1 per cent of water was present the distillation was carried to about 180 deg., the water separated from the light oil and the latter returned to the distillation flask. The fractionation was then carried out as usual.

The coke is expressed in weight per cent of the original oil. The weights of coke were obtained by weighing the flasks before and after the distillation, the differences being, of course, the coke.

The sulphur is given in per cent by weight, and is the average of duplicate analyses which checked fairly well. The method of determination (using nitric acid in the decomposition of the oil) will be described in a subsequent paper.

In Table I are found the analyses of the original crude oils. The data for the distillation analyses are given in Table II, and the saturation of the fractions in Table III.

TEMPERATURE, SPECIFIC GRAVITY AND SATURATION CURVES

All the data are represented graphically by the curves in Figs. 1 and 2 which portray the properties of the

TABLE II. DISTILLATION ANALYSES.

Oil No.	1	2	3	3a	4	5	6	7	8	9
Per cent Fraction										
5	147		138	135	102	161	201	107	192	160
10	173	160	169	164	137	189	216	120	221	188
20	226	223	198	200	178	237	231	135	257	245
30	276	263	222	239	211	286	256	152	290	278
40	319	305	252	275	259	314	288	170	322	317
50	320	334	306	303	295	329	310	206	335	340
60	312	347	325	335	305	342	330	264	340	365
70	339	350	350	375	340	346	342	325	345	373
75				380	345		327		348	
78.5				340						
80	338	350	350		340*	352	365	340	354	375
81			150							
83.3										320
84.7							280			270
85	315								343	
86.6		295							160	
90						360		360		
90.5						340				
94.4								370		
95								345		
96.2								230		
No. of Fraction										
1	0.757	0.754	0.774	0.760	†	0.770	0.828	0.729	0.809	0.783
2	0.816	0.814	0.824	0.797	0.771	0.829	0.867	0.758	0.830	0.838
3	0.853	0.856	0.863	0.835		0.867	0.893	0.763	0.880	0.875
4	0.886	0.886	0.883	0.863	0.842	0.892	0.913	0.780	0.897	0.893
5	0.892	0.893	0.892	0.883		0.906	0.924	0.805	0.905	0.895
6	0.892	0.897	0.900	0.897	0.897	0.906	0.926	0.843	0.897	0.887
7	0.880	0.896	0.903	0.912		0.906	0.918	0.886	0.899	0.881
8	0.892	0.900	0.859	0.921	0.906	0.908	0.900	0.906	0.914	0.881
9	0.875	0.930	†		†	0.933	0.979	0.900	0.914	0.893
10								0.925		

*Distillation not carried to dryness.

†Sample was so small that specific gravities had to be taken on 20 per cent fractions during this analysis.

‡No determination made.

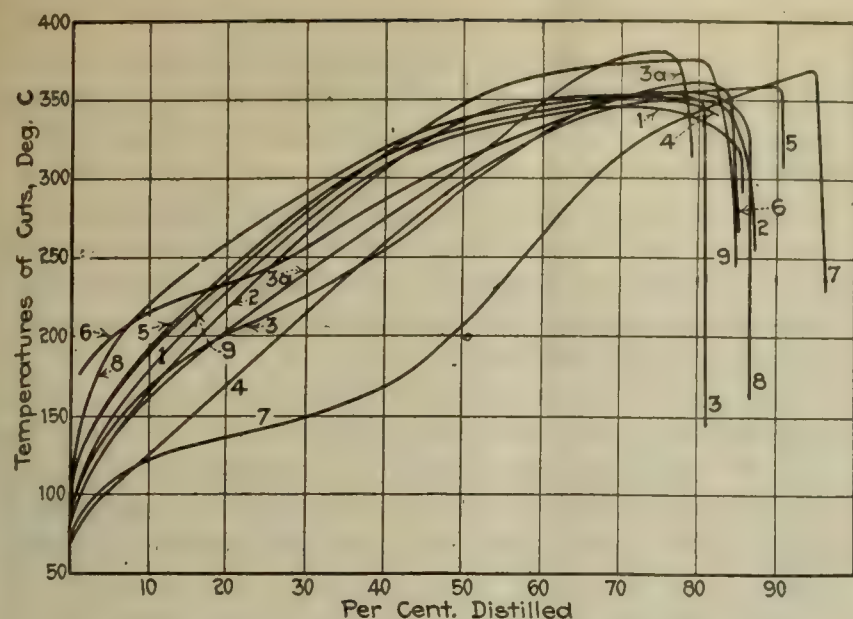


FIG. 1. TEMPERATURE CURVES FOR CRUDE OILS

different oils and their fractions in a very condensed but interesting form. Fig. 1 contains the cut-temperature curves, in which the percentages of oil distilled are plotted as abscissæ and the temperatures as ordinates. Since the boiling point of a complex mixture of homologous or otherwise related compound always rises gradually during a fractionation, the curves representing the distillation should be smooth and free from too sudden irregularities. Great fluctuations must be due to variations in the source of heat, and consequently in the rate of distillation. Hence the curves were drawn with these considerations in view, their paths being through the mean or theoretical values. In Fig. 2 are found the specific gravity and saturation curves, the percentages distilled being again plotted as abscissæ and the specific gravities and saturations as ordinates. Here, as in Fig. 1, the curves are drawn smoothly and strike the mean values wherever fluctuations are marked. In almost every case, however, the curves pass through or very close to the determined points.

Before discussing and interpreting the data from the analyses it is advisable to have more definite information concerning the individual oils other than the general location of the deposits of shale from which the oils were produced. The shales were all crushed to pass a $\frac{1}{2}$ -in. screen before being carbonized.

Oils 1 and 2 were obtained from samples of shale taken from the same deposit, the exact location of which is not known. It is in the vicinity of De Beque, Col., which is the general source of all the shales herein mentioned. Oil 3 was produced from shale found in the "rubber stratum," on the property of the Monarch Shale Oil Co. Oil 3a is a composite of the fractions obtained from the distillation of No. 3. Oil 4 was made from Mount Logan shale which yielded 45.3 gal. of oil per ton. No agitation was used during the retorting of this

charge. Oil 5 was obtained from shale which yielded 38 gal. of oil per ton. The exact location of the shale deposit is not known, since the sample was gathered at the foot of a high cliff. Oil 6 was made from the same shipment of shale as No. 5; however, the condensers were not functioning properly during the process of retorting and a large portion of the light oil escaped condensation. Oil 7 is a composite of ten samples of oil obtained from the secondary condenser, or that section of the condenser in which the light fractions were condensed. Oil 8 is the composite taken from the primary condenser during the same series of operations. Oils 7 and 8 were both produced from the same shale that was used in making oils 5 and 6. Oil 9 was the product of the carbonization of another sample of shale from the rubber stratum.

DISCUSSION OF RESULTS

Little need be said about the temperature curves in Fig. 1, since they are self-explanatory. They are all similar in shape, which shows that the oils differ in degree rather than in character. It is remarkable that all the curves show more or less sharp turning points at about 350 to 360 deg., which represents the temperature interval within which cracking occurs in the end fractions. The cracking begins as low as 300 deg., but is very slight at this temperature as compared to that at 350 to 360 deg., which seems to be the range of temperatures in which certain constituents of the crude oils are unstable. It might be expected that the oils which do not crack are those of a more stable nature. This supposition is substantiated by the curve for oil 3a (already once distilled), which shows a less sharp turning point and a steady rise up to 380 deg., the highest temperature reached by any of the oils. The temperature curves for the other oils tend to straighten out at about 350 deg., showing that the light oils formed by the cracking lower the vapor pressure of the heavy oils, and hence the boiling point fails to rise, and even falls rapidly as the cracking becomes more and more pronounced.

The temperature curves for oils 7 and 8 are of special interest since they demonstrate that it is not possible to condense fractionally the oil vapors with any degree of success. This is obvious because the product from the first stage condensers (oil 7) contains a considerable amount of light oils, while that from the secondary condensers (oil 8) contains more than an appreciable amount of the heavy fractions. These results must, unfortunately, explode the theories propounded by a number of inventors of oil shale retorts.

The specific gravity curves in Fig. 2 substantiate the conclusions drawn from the temperature curves. The similarity in shape of the former is further evidence of the likeness in character of all the oils. The more or less sudden rise at the end of most of the curves indicates a sudden increase in heavy fractions and a decrease in their cracking. This is due to abnormal rises

*Secured by personal communication from A. M. Kivari.

TABLE III. PER CENT SATURATION OF 10 PER CENT FRACTIONS

Oil No.	1	2	3	3a	4	5	6	7	8	9
No. of Fraction										
1	47.0	49.0	42.0	46.0	...	49.0	39.8	53.6	43.8	49.0
2	40.0	45.0	34.0	44.0	47.0	42.0	34.2	57.2	38.4	42.4
3	33.0	35.5	29.0	42.0	...	35.0	30.5	56.4	35.2	34.8
4	29.0	30.5	23.0	39.0	36.0	31.2	27.1	52.9	31.2	31.6
5	28.0	33.0	27.0	33.0	...	28.7	25.1	48.5	29.6	33.9
6	30.0	28.0	29.0	31.0	26.0	29.1	28.5	41.5	31.0	36.9
7	35.0	27.0	31.0	30.0	...	30.0	32.7	34.0	34.7	41.9
8	33.0	28.0	40.0	30.0	24.0	30.8	37.7	29.9	32.6	43.5
9	42.0	24.0	*	...	*	27.3	...	35.1	30.1	37.3
10	...	...	...	...	...	...	...	28.6	...	...

† No determination made.

in temperature near the end of the distillation caused by the overheating, which resulted in attempts to maintain a constant rate of distillation. With more uniform conditions this would not have occurred and the curves would then have resembled the one for oil 3, which is typical for all crude shale oils (from De Beque shales) when properly distilled. However, it was almost impossible to obtain such conditions with the gas that was used as a source of heat. This will be obvious to anyone who has attempted work of this kind under the conditions that are given.

LIGHTER FRACTIONS MOST SATURATED

The significance of the results for the saturation of the different fractions, given in Table III, can be fully appreciated only when studied in connection with the curves in Figs. 1 and 2. The fact that the lighter oils are the most saturated is at once apparent, as well as the generalization that the saturation decreases with increase in boiling point and specific gravity, up to the point where cracking begins. The most remarkable of all the results which this research yielded is now to be noted: the knowledge that the cracking of the unsaturated and unstable oils in the heavy fractions produces lighter oils of higher saturation.⁵ This phenomenon, a stranger to petroleum technologists, occurs in every destructive distillation of crude Colorado shale oils that has been attempted, to the best of the author's knowledge. The general trend of the data seems to indicate that the more pronounced the cracking the greater is the increase in the saturation and the fall in the specific gravity and distillation temperature. This is the inevitable conclusion that must be drawn from the fact that each depression in the temperature curve is followed by a corresponding fall in the specific gravity curve and

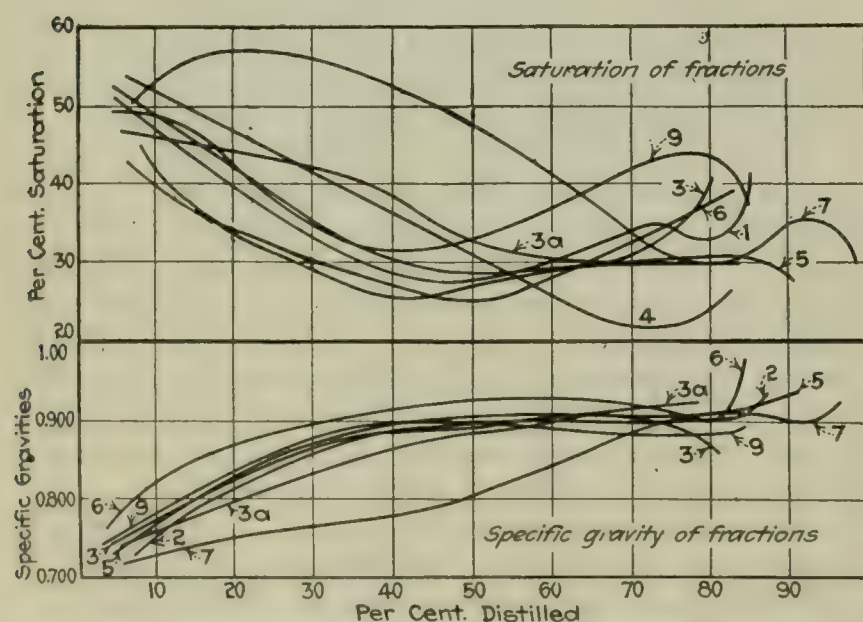


FIG. 2. SPECIFIC GRAVITY AND SATURATION CURVES

a rise in the saturation. The consistency of these phenomena has caused considerable speculation and theorizing concerning their causes, but no entirely satisfactory hypothesis has yet been propounded. The only explanation seems to lie in the fact that it is possible to obtain saturated compounds from certain types of unsaturated compounds, such as resins, or in the possibility that the saturated compounds in the crude oil and the thick, heavy fractions cannot be correctly determined. The first suggestion is by far the most plausible;

yet it is difficult to understand how such a relatively small amount of cracking can result in such an increase in saturation as is found in oil 3a over that obtained for oil 3, the gain in saturation being over 100 per cent. Research is now under way at the Colorado School of Mines with the purpose of determining the causes of and factors that influence the phenomena, so no more will be said about it at present. The reader is free to speculate with the data at hand, and can draw what conclusions he will.

The author takes pleasure in giving credit to C. P. Hackett, who made most of the distillation analyses, and to J. P. Bacca, who made most of the determinations for saturation of the fractions. Thanks are also due to Prof. A. H. Low for his valuable criticisms and suggestions.

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Corrosion of Soft Metals

The commercial soft metals include aluminum, tin, zinc and lead. It was shown in Scientific Paper 377 of the United States Bureau of Standards that a type of deterioration designated as "intercrystalline brittleness" may occur in lead under certain conditions whereby the metal crumbles to a coarse crystalline powder. The individual grains of this powder retain all the intrinsic properties of lead, but the bond between the grains has been destroyed.

During the past year a series of corrosion tests has been carried on to demonstrate to what extent such deterioration may occur in other soft metals. The intercrystalline brittleness appears to be largely dependent upon the purity of the metal, and in the pure materials used in the test very slight evidence of such deterioration was obtained. A series of stress corrosion tests has been conducted to supplement Scientific Paper 377 and it has been shown that the simultaneous application of tensional stress to a specimen while corrosion is in progress is a powerful adjunct to deterioration by "intercrystalline brittleness." This is of practical importance, inasmuch as lead—because of its great weight—is often subjected to very considerable stress while in service. Thus the tendency to corrode and become embrittled is accentuated.

Canada's Foreign Trade in 1920

Calendar-year figures published in the *Weekly Bulletin* of the Canadian Department of Trade and Commerce show for the Dominion's foreign trade in 1920 an aggregate of \$403,882,150 in excess of 1919 and \$485,847,223 greater than in 1918, last year's total of \$2,639,726,135 comparing with \$2,235,843,985 in 1919 and \$2,153,878,912 in 1918. The share of the United States kept pace with the increasing total trade of the Dominion, forming 55 per cent thereof in 1918 and 1919 and 57 per cent in 1920. On the other hand, trade with the United Kingdom declined, as the following summary shows:

Calendar Years	Total Trade With		
	All Countries	United Kingdom	United States
1918.....	\$2,153,878,912	\$659,442,645	\$1,193,232,897
1919.....	2,235,813,985	626,633,484	1,231,656,516
1920.....	2,639,726,135	574,699,070	1,507,651,094

With imports amounting to \$1,336,921,021, exports to \$1,272,657,442, and re-exports to \$30,147,672, the calendar-year balance of trade against the Dominion was \$34,115,907, contrasted with a favorable balance of \$353,816,759 in 1919 and one of \$333,580,632 in 1918.

⁵Similar results were reported on other shale oils in a paper by C. W. Botkin before the Colorado Section of the American Chemical Society, Nov. 27, 1920, and in a personal communication to the author before this work was undertaken.

Influence of Copper on Some Physical Properties of Iron and Steel

A Number of Ferrous Alloys Were Made and the Physical Properties of Forging, Filing, Grinding, Chiseling and Bending Determined—It Was Found That Copper Caused Iron to Be Red-Short and That Manganese or Chromium Removed This Difficulty

BY E. A. RICHARDSON AND L. T. RICHARDSON

DURING the past several years a somewhat comprehensive study of the corrosion of copper-bearing irons and copper-bearing steels has been under way, for the carrying out of which a number of iron alloys containing copper were made. In the preparation of these alloys for the corrosion tests and supplementary to these tests certain properties of a physical nature were investigated. This was considered necessary, since the commercial value or the actual use to which any rust-resisting alloy can be put will depend to a large extent upon the various physical properties; in fact these properties will determine whether an alloy would be adapted to a general or to only a specific use. The present paper proposes to deal with these physical properties. The results of the corrosion tests have been already presented before the American Electrochemical Society.*

The physical properties upon which tests were made were as follows: Forging, filing, grinding, chiseling, bending.

FORGING

Considering the iron alloys of copper from the general literature, it appears that the forging properties have not been very extensively or thoroughly studied. Although numerous references can be found relating to the effect of copper upon the forging properties of iron and steel, it is a rather surprising fact that the conclusions reached by different investigators are so greatly at variance. However, if one analyzes the results more carefully and divides the alloys into iron:copper alloys and steel:copper alloys, the confusion is not so great. For instance, in five references that were found relating to the effect of copper on the forgeability of iron, four authors^{1,2,3,4} state that copper renders iron red-short, while one⁵ who worked with wrought iron states that as high as 0.50 per cent of copper causes only traces of red-shortness. Hence, in iron at least, most authorities believe that copper is detrimental to the best forging properties.

In the case of steel, on the other hand, out of twelve references only one⁶ states that copper causes red-shortness, ten^{7 to 16} say that in reasonable amounts (0.50 per cent copper or less) copper produces no red-shortness, while one¹⁷ even says that copper when added to steel decreases red-shortness. In addition to this, one of these investigators¹⁴ finds that 0.50 per cent of copper is necessary before red-shortness occurs in steel, another¹⁰ believes that 1 per cent copper is needed, while yet another¹³ states that 4.70 per cent of copper is necessary to produce red-shortness. Moreover, one man¹⁷ draws his conclusions from laboratory tests and another¹¹ from many thousands of tons of bessemer rails

containing copper. In the case of steel the fact seems to be that copper in reasonable amounts does not harm the forging properties.

Hence one would conclude from the published literature that copper when added to iron is more likely to cause red-shortness than when added to steel, and that in steel a certain limit exists above which copper causes red-shortness.

Some years ago, while studying at the University of Wisconsin under Prof. C. F. Burgess, one of the authors made a series of alloys of copper and electrolytic iron and in forging these alloys noted this property of red-shortness. Red-shortness shows itself in a very abrupt change from a forgeable to a non-forgeable state; a piece of copper-bearing iron upon being forged down from a white heat would at first be very soft and could be forged with ease, but as a lower temperature was reached the metal suddenly became brittle and would crumble into many fragments under a few blows of the hammer. The resulting fracture had a granular appearance as if rupture had occurred between the grains. Since the present authors hold that the existence of intergranular material has a great effect upon corrosion, and the phenomenon of red-shortness of copper:iron alloys was known before the alloys were made for the corrosion investigation of which this paper is a part, in forging these alloys especial attention was paid to the hot-working properties.

The composition of the alloys made, together with their forging properties, is given in Table I. The alloys were made by melting commercially pure iron in an electric furnace and adding the carbon-free alloying elements to the molten iron. The forging properties were obtained by heating the ingots to a bright red heat and then forging continuously with a hammer to a black heat, this operation being repeated five to ten times (depending on the hardness of the alloy) before the desired shape and size were obtained. The forgings were then thoroughly annealed and the other properties obtained upon such forged and annealed material.

A study of the forging data given in Table I brings several fundamental facts to light. In the first place, it is evident that very small amounts of copper make metal brittle in forging, but that this property appears only during a certain temperature range and that above or below this range forging can be accomplished. Furthermore, our experience has been that the greater the copper content the greater is this interval of non-forgeability and the more difficulty is encountered in obtaining a satisfactory forging. Thus with an iron containing 4.65 per cent of copper (alloy M) forgings can be made only at very low temperatures and much work must be expended.

This phenomenon is also met with in the hot-working

*See CHEM. & MET. ENG., vol. 23, p. 724, Oct. 13, 1920.

TABLE I

TABLE I									
Alloy	Composition		Forging Properties	Physical Properties				Alloy	
	Copper	Manganese		Filing	Grinding	Chiseling	Bending		
A	0.04	0.00	Forged at high and low heats. Smashed at cherry red heat.....	Soft	Soft	Soft	Bent flat	A	
H	1.97	0.02	Forged at high and low heats. Smashed at cherry red heat.....	Soft	Soft	Soft	Bent flat	H	
T	3.22	0.06	Forged at high and low heats. Smashed at cherry red heat.....	Soft	Soft	Soft	Bent flat	T	
M	4.65	0.01	Forged at high and low heats. Smashed at cherry red heat.....	Soft	Soft	Soft	Bent flat	M	
F	0.04	0.44	Forged at all temperatures.....	Soft	Soft	Soft	Bent flat	F	
Y	0.41	0.48	Forged at all temperatures.....	Soft	Soft	Soft	Bent flat	Y	
P	0.48	0.32	Forged at all temperatures.....	Soft	Soft	Soft	Bent flat	P	
Z	0.62	0.48	Forged at all temperatures.....	Soft	Soft	Soft	Bent flat	Z	
N	0.92	0.32	Slightly red—short at cherry red.....	Soft	Soft	Soft	Bent flat	N	
Fl	0.36	0.69	Forged at all heats.....	Sl. hard	Sl. hard	Sl. hard	Bent flat.	Fl	
B	0.86	0.69	Forged at all heats.....	Sl. hard	Sl. hard	Soft	Bent flat	B	
K	0.04	0.93	Forged at all heats.....	Soft	Soft	Soft	Bent flat	K	
Cl	0.36	1.13	Forged at all heats.....	Soft	Soft	Soft	Bent flat	Cl	
El	0.30	0.96	Forged at all heats.....	Soft	Soft	Soft	Bent flat.	El	
R	0.50	1.29	Forged at all heats.....	Sl. hard	Sl. hard	Sl. hard	Bent flat	R	
E	1.53	1.13	Forged at all heats.....	Sl. hard	Med. hard	Med. hard	Bent flat	E	
Q	1.87	1.27	Forged at all heats.....	Sl. hard	Med. hard	Med. hard	Bent flat	Q	
G	0.04	1.60	Forged at all temperatures.....	Soft	Soft	Soft	Bent flat	G	
L	0.05	1.75	Forged at all temperatures.....	Med. hard	Med. hard	Med. hard	Bent flat	L	
Gl	0.51	1.90	Forged at all temperatures.....	Med. hard	Med. hard	Med. hard	45 deg.	Gl	
Hi	1.00	1.81	Forged at all temperatures.....	Med. hard	Med. hard	Med. hard	45 deg.	Hi	
J	0.05	3.11	Forged at all temperatures.....	Hard	Hard	Hard	90 deg.	J	
Sl	0.32	2.34	Forged at all temperatures.....	Hard	Hard	Hard	135 deg.	Sl	
S	3.03	2.78	Forged at all temperatures.....	Hard	Hard	Hard	135 deg.	S	
W	3.54	2.51	Forged at all temperatures.....	Hard	Hard	Hard	135 deg.	W	
I	0.04	0.21	Forged at all temperatures.....	Soft	Soft	Soft	Bent flat	I	
O	0.04	3.30	Forged at all temperatures.....	Hard	Hard	Hard	150 deg.	O	
U	0.05	3.58	Forged at all temperatures.....	Hard	Hard	Hard	150 deg.	U	
Alloy	Copper	Chromium	Forging Properties						
A	0.04	0.00	Forged at high and low heats.....	Soft	Soft	Soft	Bent flat	A	
DI	0.05	0.21	Slightly red, short at cherry red.....	Soft	Soft	Soft	Bent flat	DI	
II	0.05	0.40	Forged at all temperatures.....	Soft	Soft	Soft	Bent flat	II	
AI	0.05	0.46	Forged at all temperatures.....	Soft	Soft	Soft	Bent flat	AI	
BI	0.04	1.18	Forged at all temperatures.....	Sl. hard	Sl. hard	Sl. hard	Bent flat	BI	
NI	0.05	1.67	Forged at all temperatures.....	Sl. hard	Sl. hard	Sl. hard	Bent flat	NI	
MI	0.45	0.18	Red-short at cherry red heat.....	Soft	Soft	Soft	Bent flat	MI	
LI	0.59	0.20	Reds-hort at cherry red heat.....	Soft	Soft	Soft	Bent flat	LI	
UI	0.58	1.76	Forged at all temperatures.....	Sl. hard	Sl. hard	Sl. hard	Bent flat	UI	
PI	1.14	0.60	Red-short at cherry red heat.....	Soft	Soft	Soft	Bent flat	PI	
YI	1.02	1.33	Forged at all temperatures.....	Sl. hard	Sl. hard	Sl. hard	Bent flat	YI	
T	3.22	0.00	Very red-short.....	Soft	Soft	Soft	Bent flat	T	
QI	2.81	1.63	Forged at all temperatures.....	Med. hard	Med. hard	Med. hard	Bent flat	QI	
TI	3.81	2.03	Forged at all temperatures.....	Med. hard	Med. hard	Med. hard	45 deg.	TI	
Alloy	Copper	Composition		Forging Properties					
		Chromium	Manganese						
VI	1.09	0.52	1.19	Forged at all temperatures.....	Med. hard	Med. hard	Med. hard	Bent flat	
XI	1.13	0.88	2.00	Forged at all temperatures.....	Med. hard	Med. hard	Med. hard	45 deg.	
WI	1.09	1.09	1.98	Forged at all temperatures.....	Med. hard	Med. hard	Med. hard	45 deg.	

NOTE.—Sl = slightly. Med. = medium. In bending test angles given are interior angles, at which failure occurred.

of a well-known commercially pure iron, which contains copper from 0.03 to 0.04 per cent. The existence of this red-short range has been recognized by the manufacturers of this iron, who advocate that their material should not be worked between the temperatures of about 800 deg. C. and about 1,000 deg. C. Apparently they have never recognized this peculiarity of their product as due to the presence of copper in small amounts, but either have offered no explanation for it or have ascribed it to the well-known transformation of α to β iron that takes place at about this same temperature.¹⁶ Quite recently another explanation has been given for the brittleness of this iron, in which the cause of red-shortness is said to be due to an intergranular film, possibly iron sulphide.¹⁹

The writers agree that this phenomenon of red-shortness is probably due to intergranular material, because the fracture has every appearance of being between the grains. However, we believe that the film which becomes weak in the brittle range is copper or some alloy or compound of copper. The fact that the appearance of the fracture, the method of breaking and the brittle temperature of this commercially pure iron are identical with our copper:iron alloys tends to substantiate this belief. The idea that this structure may have some effect on the corrosion of copper:iron alloys has already been enlarged upon in the paper on corrosion.

Another conclusion that can be drawn from the data which is fully as important as the belief that copper

causes red-shortness is the certainty that this can be removed by the addition of manganese or chromium. This easily explains and reconciles the differences noted by earlier investigators where copper was found to make iron but not steel red-short. Iron contains no manganese and the harmful effect of copper is not removed, while in steel the manganese present is sufficient to do this unless the copper is very high. It also suggests that the forging properties of commercially pure iron could be improved by small additions of manganese or chromium. That this would not impair but would improve at the same time the rust-resisting properties has already been shown in another paper.

To illustrate this combined action of copper and manganese, we may cite alloy N, containing 0.92 per cent copper and 0.32 per cent manganese, which was slightly red-short, while alloy P, containing 0.48 per cent copper and the same amount of manganese, forged at all heats. This suggests that for each percentage of copper a certain quantity of manganese is necessary to eliminate red-shortness.

FILING, GRINDING, CHISELING AND BENDING

These tests are all of a somewhat similar nature. In the alloys made commercially pure iron was used and carbon-free alloying elements were added. For this reason the alloys are all low in carbon. The results of these tests are given in Table I.

From these data it is evident that when carbon is low,

copper at least up to about 5 per cent does not make iron harder and it does not impair the cold-working properties of iron. Manganese makes iron harder and more difficult to work and when about 2 per cent is reached the resulting alloy is too brittle and hard for ordinary commercial uses. In the same way chromium above about 2 per cent makes the alloy hard and tough and difficult to work, although not brittle.

SUMMARY

We may summarize the findings as follows:

1. Copper added to iron produces red-shortness over a certain temperature range. The degree of brittleness and the temperature over which it occurs increase with an increase of copper content. It is believed that this brittleness is due to an intergranular film of copper or an alloy or compound of copper.

2. The red-shortness due to copper is removed by the addition of manganese or chromium, but the amount necessary depends on the copper content. This observation explains why copper added to iron causes red-shortness, while it does not cause red-shortness in steel unless added in excessive amounts.

3. The addition of copper up to at least 3.50 per cent apparently does not impair the cold-working properties of the alloys. Beyond 2 per cent of manganese the alloys become too brittle to work, while with more than 2 per cent chromium the alloys become hard and tough.

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Reconstruction of Sugar Refineries in France

The refining of sugar in northeastern France was particularly affected by the war. Nearly all the French sugar refineries were located in the Departments of Aisne, Ardennes, Marne, Nord, Oise and Pas-de-Calais, and in these regions sugar beets were raised in enormous quantities. Of 217 refineries in France, 170 were established in these departments, and 145, valued at \$50,000,000 prior to the war, were destroyed.

The annual pre-war production, which averaged approximately 750,000 tons, fell to 180,000 tons. The present production amounts to about 300,000 tons. Immediately after the war refiners showed some hesitancy in regard to rebuilding their establishments, but Consul Paul H. Cram at Nancy reports that work is going on rapidly at present, and it is expected that practically all the refineries will be in operation in 1925. Of the 47 destroyed in the Department of the Aisne, 22 will resume operation in the course of the present year.

Problems in the Preparation of Copra and Coconut Oil

BY HARVEY C. BRILL

IN A RECENT number of *CHEMICAL & METALLURGICAL ENGINEERING* (1920, vol. 23, p. 37) Dr. Alvin J. Cox, director of the Bureau of Science, Manila, 1912-19, discussed the various products of the Philippine Islands which assume some importance as commercial commodities to the United States. Among these he gives coconuts and copra a very high rank. According to figures compiled by Dr. Cox (*Bureau of Science Press Bulletin*, 1916, No. 54) the annual crop produced in the islands in 1916 amounted to nearly 500,000,000 nuts. The copra exports were 72,277 long tons and the coconut oil exports 16,091 long tons for 1916.

Since this time the exportation of oil has increased and the copra shipments have fallen off. In other words, more copra is being converted into oil in the islands and this oil is then shipped.

THE DRYING OF COPRA—NATIVE METHOD

For the production of oil from coconuts several operations are necessary: The native methods are—where possible—to husk the nuts, divide them into halves and place them in the sun until the meat dries sufficiently to break loose from the shell. They are then removed from the shell and allowed to dry for a further period of time in the sun. When sufficiently dried to be acceptable to the buyer the copra is bagged and sold. The preceding method obviously can be operated only when sufficiently sunny weather prevails to bring about drying, and when one learns that the tropical regions quite often have a marked rainy season he understands that this method would not be successful for year-around operation. It has other handicaps, but the one just enumerated is sufficiently great to make a better method desirable. The second method used by the Filipino is to dry the halved nuts on a grill or tapahan. A trench is dug and over this a furnace is built, which is covered with a bamboo grill. The halved nuts are piled on this grill and a fire of shells and husks is made in the furnace for the purpose of drying the meat. Shells and husks make a poor fire and as a consequence the meat is badly smoked and poorly dried. If an honest attempt is made to dry the meat much of it is scorched and smoked before the exterior of the pile has dried at all.

It is apparent that not enough can be done in the improvement of the methods described to warrant their continued use.

USE OF SULPHUR DIOXIDE IN DRYING PROCESS

The Bureau of Science carried out a series of experiments in which the meat was first treated with sulphur dioxide much as dried fruit is treated in California. The results were promising. A twelve-hour treatment with sulphur dioxide was found to give favorable results. The meat lost 37 per cent of its total water content during the treatment and at the end of ten days, during which it was placed in a shed most of the time due to the almost continuous rainfall, it had lost 73 per cent of its total water content. Two effects were produced by sulphuring: (1) The cell walls of the meat were softened and the copra dried more readily afterward; (2) the presence of small amounts of sulphur dioxide prevented the growth of micro-organisms. The disadvantages of the method are the cost of the small sheds

in which the treatment might be given and the length of time needed for drying the copra after sulphuring. However, the oil obtained from such copra is almost water white and will need little refining. The cost of refining oil is estimated at \$4 per each 1 per cent fatty acids per ton of oil, so that oil free from fatty acids is very desirable.

Attempts have been made to introduce artificial driers, making use of hot air. These attempts have met with very little success thus far for two reasons: The machine is expensive in cost and in operation, and a prejudice exists against artificial drying. The belief prevails that a loss of oil results as a consequence of artificial drying. Experiments carried out by the Bureau of Science would tend to disprove this belief.¹ However, Dr. Sherman of the Visayan Oil Co. at Cebu contends that oil collects in its driers in the air outlets. A good opportunity for investigation exists here. What is the best temperature for drying? Is a vacuum advantageous? (Recent developments in drying vegetables prove that vacuum drying is preferable.) And of course the type of drying machine should be considered—one that will minimize handling of copra would be best.

EFFECT OF FUNGUS GROWTH

Investigation has shown that the molding of copra will proceed as long as the moisture content is 10 per cent or more. Much of the copra of the Island of Luzon will run as high as 20 per cent moisture content. Such copra when put in a storehouse becomes hot after a short period of storage, and large quantities of carbon dioxide are given off due to the metabolic processes of the fungi. This carbon dioxide reaches a maximum after an interval of three or four days' storage, the temperature recedes and the quantity of carbon dioxide given off decreases. Molding apparently ceases. Has the high temperature been caused by the activity of the fungi? And have they been destroyed by this high temperature? Copra which has undergone such an experience comes out a black, moldy mass with an acid number as high as 25 in many cases calculated as oleic acid. Such oil cannot be refined to an edible oil except at great expense and high loss in oil. Such an experience should not be permitted to occur. Besides the causing of acidity and rancidity of the oil, the molds destroy much of the oil when they grow. Investigations conducted by the Bureau of Science showed that this varied from 20 to 50 per cent of the total oil present.

EXPRESSION OF THE OIL FROM THE MEAT

To obtain the oil from copra, the copra is first ground and the heated meat sent through expellers. The most advantageous temperature for this operation is not known in the Philippine Islands. Such data should be determined. The influence of the moisture content on the operation has not been thoroughly investigated and deserves such investigation—i.e., is a residual quantity of moisture helpful in obtaining a high percentage of the oil by expression? Some mills leave a residual oil content as low as 8 per cent after the expeller treatment, others insist that this is not economical because of the wear and hardship on the machinery, and the latter prefer to leave in an oil content of 12 to 15 per cent. They then steam this copra meal and subject it to hydraulic pressure. Here a good solvent would be an efficient helper. A solvent for use in the tropics

must not have too low a boiling point, because of the high temperature of the condensing water.

The copra meal remaining cannot be used as a fertilizer because of its oil content; it cannot be disposed of as a cattle feed, since cattle raising does not flourish in the islands; and for the last five or six years it could not be shipped elsewhere for cattle feed because of the prohibitive freight rates. This emphasizes the need for a solvent and the installation of an extracting process which would leave a cake which because of the absence of any oil would be available for fertilizer purposes.

OTHER METHODS SUGGESTED TO SEPARATE THE OIL

It seems that the process of converting coconut meat into copra might be avoided by making use of some method that would take the oil from the fresh meat. Indeed, O. Vyner of British North Borneo reports a recently patented method which does this. When the Bureau of Science attempted to repeat his experiments the experimenters were unable to duplicate his results.

The Filipinos do this on a small scale by pulping the meat, allowing it to ferment for several days, which brings about a disintegration of the cellular matter by the bacteria, warming over a direct fire and then separating the liquid portion from the solid material by means of crude presses. Their yield of first-class oil is small, but the product commands a higher price than the average coconut oil that is on the market.

In the attempt to separate the oil from the fresh meat a number of difficulties are met. The freshly grated coconut meat does not give up its oil readily by pressing. By treating the meat with water and live steam for three hours before pressing, 80 per cent of the oil can be removed by one pressing. Further steaming and pressing would remove a large part of the residual portion. The liquid obtained by pressing is a white emulsion, consisting of cellular tissue, oil and water. How to remove the oil from this is a complicated problem. A De Laval cream separator works fairly well until the bowl becomes packed with the cellular matter. A specially constructed centrifuge, possibly modeled after the wringer used to dry explosives, might be used.

When this liquid was cooled to a temperature of 15 deg. C. and allowed to stand twenty-four hours, then gently warmed to room temperature or slightly above, the oil could be readily separated.

Treatment of the ground meat with hot solutions of acids, bases and various salts either at atmospheric pressure or in an autoclave did not facilitate the separation, but resulted in deterioration by hydrolysis.

The establishment of the drying and pressing method would mean that the nuts would be assembled and the oil manufactured from them at some central point. This would likely be as advantageous for the islands as a whole as the establishment of sugar centrals and the abolishment of the crude, wasteful, native sugar mill has proved to be. It would mean one other thing: that the press cake would be sweet and wholesome and fit for human food and not a nuisance as it now is.²

The solution of these problems pointed out and the preparation of pure coconut oil without subsequent refining need two things—men experienced in plant operation and acquainted with chemistry, and men with capital and a willingness to spend some of this in experimental work.

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¹Brill, Parker and Yates, *Phil. Jour. Science*, (1917), vol. 12, Sec. A, p. 55.

²See Parker and Brill, *Phil. Jour. Science* (1917), vol. 12, Sec. A, p. 87.

Determination of Melting Points

General Disagreement in Melting Point Values as Given in Handbooks—Suggestions on Methods to Be Used in Determining the True Values—The Melting Point of Potassium Chlorate by a New Method

By CLIFFORD D. CARPENTER

WHEN one wishes to know the melting point of a substance it is most convenient to refer to some handbook containing a table giving a list of substances and their important physical constants. In the case of the important organic substances the melting points are rather definitely stated and not much doubt is indicated, although in a few cases two values are given differing by one or two degrees, but they are oftener given in the tenths. It is quite a different case when one desires to know the melting point of an inorganic compound. If it is listed, a single value may be given, but many are indicated by two results differing from ten to thirty degrees or more. If the value desired to be known has only one value given, it might readily be assumed that it was very definitely known, but if one is unfortunate enough to look into two handbooks, he will likely end in doubt, as it often happens that such tables do not agree. Take, for example, the melting point of potassium chlorate. The values given in three typical handbooks on physical constants are 334 deg.,¹ 357 deg.,² and 370 deg.³

There are two main reasons why the data for the organic compounds are so much more satisfactory than those for the inorganic. Most of them melt at relatively low temperatures where the mercury glass thermometer is satisfactory, when properly standardized, to measure such temperatures. Then, too, the purity of an organic compound is ordinarily defined by its physical constants, usually its melting and boiling point, making a knowledge of such facts especially valuable.

In the case of the inorganic compounds, most of them are beyond the range of a mercury glass thermometer, or at least in the upper part of such range, where considerable difficulty arises in defining the absolute temperature. Then, too, it is not so difficult to determine the purity of inorganic substances, as there are well known analytical methods. When a search of the literature is made it is found that very few of the melting points of inorganic substances have recently been determined. Since the development of accurate temperature-measuring instruments, platinum resistance thermometers, thermocouples, etc., and a careful study of well-defined points for their calibration have taken place only in the last few years, it would seem that much of the present lack and inaccuracy in data for the melting points of inorganic substances is due to the fact that no careful attempt has recently been made to redetermine them. The main considerations in melting point determinations are: The method used in bringing the compound to the desired temperature, the kind and accuracy of instrument used in measuring the temperature, the physical evidence used in recognizing the point at which the compound melts, and the purity

of the compound. The first two involve the question of apparatus. The last two depend upon the nature of the compound under consideration.

APPARATUS

A practical apparatus for the determination of many melting points and its arrangement is illustrated in Fig. 1. It includes a stirrer, well-lagged beaker and a platinum resistance thermometer with its Wheatstone bridge, galvanometer and reading scale. The special feature of the stirrer is its adjustability with regard to speed, having three different size pulleys, both on the motor shaft and stirring rod. The stirring rod can be raised and lowered to accommodate the height of the beaker. While the one illustrated is an iron rod with a

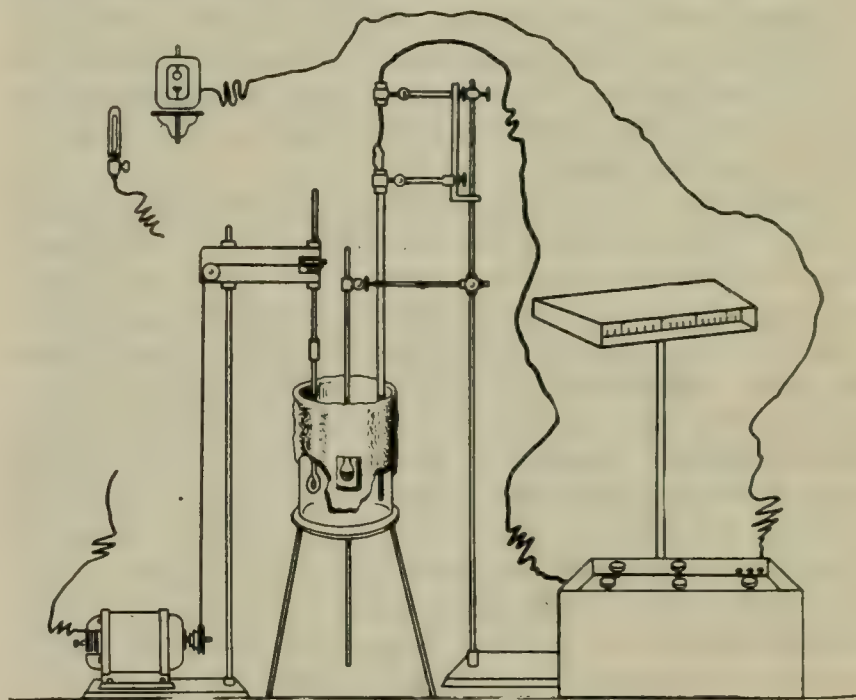


FIG. 1. MELTING POINT APPARATUS

loop in the end of it, a glass rod may be substituted when desirable. The stirring apparatus is an entirely independent unit and can be moved without disturbing any of the other apparatus.

Another convenience is the clamp which carries the platinum resistance thermometer, which prevents the loosening or breaking of the leads at the head of the thermometer. The beaker is lagged by wrapping with moist asbestos paper until about $\frac{1}{2}$ in. thick. Two small holes are cut in the asbestos, one opposite the other, for windows. A light is placed in front of the one on the opposite side and the experimenter can then observe the behavior of the compound when the tube or bulb that contains it is lowered in the bath until it is in front of the window.

The bath is a mixture of potassium and sodium nitrate with a melting point close to 220 deg.⁴ As the

¹Chemiker Kalender.

²Van Nostrand, Chemical Annual.

³Kaye and Laby.

⁴Cawth, *J. Phys. Chem.*, vol. 2, p. 207; Scudder, *J. Am. Chem. Soc.*, vol. 25, p. 161; Smith and Menzies, *J. Am. Chem. Soc.*, vol. 32, p. 899.

molten nitrate is colorless and transparent, it offers no obstruction to observing the changes in the compound. The temperature of the bath can be kept within very narrow ranges, ± 0.2 deg. or less, even at 400 or 500 deg. C. The heat capacity of the molten liquid is great enough that its rate of cooling or heating is slow so that the platinum resistance thermometer registers the slightest change in temperature. With vigorous stirring the bath keeps a uniform temperature. The platinum resistance thermometer and its accessories are assembled as directed by the Bureau of Standards.⁵

NATURE OF THE COMPOUND

Some typical cases are discussed below. In the first three, the disappearance and reappearance of solid are the physical evidence. In the fourth case the "rest" in a cooling curve is taken as the point. The fifth case is the typical freezing point curve of a two-component system. In the first four cases it is assumed that the pure substance can be easily obtained.

CASE I

Stable above its melting point, inert toward glass or quartz. The apparatus above described is used. If temperatures much above 600 deg. C. are to be employed, a transparent quartz beaker as bath and a similar tube containing the compound must be used. The compound is introduced into a long closed tube and lowered into the bath until it is in front of the window. The bath is heated and the temperature is recorded when the solid disappears. The bath is then allowed to cool down slowly and when the solid reappears the temperature is again noted.

Should there be much difference between the temperatures of disappearance and reappearance of solid phase, the undercooling may be prevented by dropping a small crystal into the melt when the temperature is lowered a fraction of a degree below the temperature at which the solid disappears. In practice it has been found that the heating and cooling of the bath by alternately increasing and decreasing the heat may be so controlled that its temperature will change only a small fraction of a degree over any period of time. This makes it possible to keep the disappearance and reappearance of the solid within a very small temperature range. After several operations as described above, the true melting point is obtained as an average of the observations.

CASE II

Undergoing very slow decomposition, or acts very slowly upon quartz or glass. The compound is introduced into a tube as described in Case I and its approximate melting point determined. After the approximate melting point is known, the bath is set near that temperature and a new sample of the compound in a new tube is introduced and the temperature slowly raised until nearly all the solid melts and then cooled, until the crystals reappear. The temperature of appearance of new crystals and the time which the tube containing the compound is put into the bath and of appearance of new crystals are noted and recorded. The bath is alternately heated and cooled and the temperature and time of each appearance of new crystals are noted and recorded. The lowering of the temperature on each successive reading, as a result of the increase in amount of decomposition products or of reaction between the containing tube and the compound,

is a function of the time, and the effect may be indicated as a time temperature line. By a very small extrapolation of the line the true melting point of the pure compound is determined.

CASE III

Volatile below or undergoing rapid decomposition at its melting point. The pure compound must be sealed in a heavy walled tube. The quantity of solid introduced should nearly fill the tube. It may then be tied to a glass or quartz rod by a thin iron wire and lowered into the bath until in front of the window. In such cases the tripod supporting the bath should stand in a large iron pan, and should be well surrounded by a jacket with observation windows to prevent serious accidents in case the decomposition pressures should burst the tube. The platinum resistance thermometer should also be protected by a partition between it and the tube containing the compound.

CASE IV

Acts vigorously on transparent tubes, glass and quartz, but is inert toward metals or carbon. This case is a typical cooling curve problem. The use of this

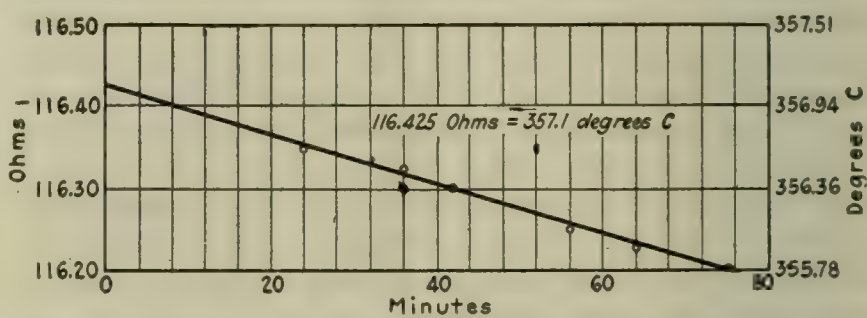


FIG. 2. EXTRAPOLATION LINE SHOWING RATE OF DEPRESSION OF MELTING POINT OF POTASSIUM CHLORATE DURING PYROLYSIS

method is typically illustrated in recording the melting point of a metal in a graphite crucible as employed in calibrating the resistance thermometer.⁶

CASE V

Melting points of hydrates; or a substance difficult to obtain pure but readily estimated when mixed with a second component. The melting points of the pure substances, the addition products (hydrates, etc.) can be estimated by extrapolation of the "freezing point" curves of such two component systems.

THE MELTING POINT OF POTASSIUM CHLORATE

In the determination of the melting point of potassium chlorate, the apparatus described above was used. The temperatures were determined by the aid of a platinum resistance thermometer calibrated against the three points, ice water, water steam, and sulphur-sulphur vapor, as described by the Bureau of Standards.⁷

The method employed was the one described in Case II. Pure potassium chlorate was obtained by repeated recrystallization of a c.p. Merck sample.

Pure potassium chlorate decomposes very slowly at its melting point. If then it is melted and slowly cooled, the reappearance of crystals will take place at a temperature slightly below its melting point. If the temperature is again raised and lowered, the second reappearance of crystals will be at a still lower temperature. If the raising and lowering of the temperature

⁵Reprint 121.

⁶Loc. cit.

⁷Reprint 124, loc. cit.; J. Am. Chem. Soc., vol. 41, p. 748 (1919).

are kept within narrow limits, this lowering will be a function of the time. During the course of this experiment the temperature was kept within ± 2 deg. of a mean. The crystals were never allowed to disappear completely as the temperature was raised, thus preventing undercooling as the temperature is lowered. The bath was slowly cooled and the appearance of new crystals was especially striking and was accepted as the point at which the temperature was to be noted. The data and its interpretation are given below.

The temperature is recorded in terms of ohms. The record of the readings are given:

	Time.	Ohms.
Introduction of tube.....	2:30	116.35
First appearance of new crystals.....	2:54	116.32
Second appearance of new crystals.....	3:06	116.30
Third appearance of new crystals.....	3:12	116.25
Fourth appearance of new crystals.....	3:26	116.23
Fifth appearance of new crystals.....	3:34	116.20
Sixth appearance of new crystals.....	3:45	

It is seen that the extrapolation of the line running through the points taken intersects the ordinate at zero time at 116.425 ohms. The temperature corresponding to 116.425 ohms resistance is 357.10 deg. C.

CONCLUSIONS

A brief résumé of methods used and some proposed improvements in determining melting points have been given. The melting point of potassium chlorate has been redetermined by a new method.

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Legal Notes

BY WELLINGTON GUSTIN

Corporation Casting Metal Furnished by Contractor Held "Manufacturer"

Who is a manufacturer under the internal revenue act was decided by the Federal District Court in the recent case of Dayton Brass Castings Co. vs. Gilligan. The plaintiff corporation was formed for the purpose of manufacturing and selling brass, bronze, aluminum, white metal and all other kinds of metal castings. The Recording & Computing Co. had a contract with the Canadian Car & Foundry Co. for delivery of a large number of time fuses for shrapnel shells for the Russian Government. Each fuse, when assembled and completed, consisted of forty-five parts. The Dayton company entered into contracts with the Recording company to make for use in fuses, from ingots and patterns to be supplied by such company, certain rough castings, to be paid for by the pound and to be delivered at such company's plant.

The work done by the Dayton company concerned but four of the forty-five parts entering into a completed fuse. None of such four parts was at the time of their delivery fitted for insertion into fuses, but the Recording company was required to further prepare them before they were perfected for use. Therefore the Dayton company contended it was not subject to the war munitions tax imposed by Congress and approved Sept. 8, 1916. For failure to make a return within the statutory time the company was directed to pay as a tax the sum of \$18,860.83 and a penalty of

50 per cent additional (\$9,430.42). This was paid under protest and a claim was preferred for a refund of the tax and penalty, on the ground that it was not subject to such tax. The Commissioner of Internal Revenue ordered a repayment of the penalty, but otherwise rejected the claim. The company began suit to recover, on the grounds that the articles cast and delivered by it were parts of fuses, that in the performance of the work it was not engaged in manufacturing and was not a manufacturer, and that in delivering the castings in the manner provided in the contract it did not sell or dispose of them within the terms of the act.

However, the court held the company was a manufacturer, under the act, and that it was not necessary that a manufacturer produce a finished product. It said castings made for use in shell fuses, though still in their rough condition and requiring numerous processes to prepare them for such use, cannot be used without further treatment for any purpose other than that for which they were designed and are relatively complete parts. It further said that a corporation casting metal and delivering it to the owner "disposes of" such castings.

Again the provision of the act, for determining the munitions tax in case of articles sold below the fair market price to evade the payment of the tax, does not prevent the imposition of the tax on a manufacturer of castings for shell fuses from metal furnished him by the maker of the fuses.

The corporation which received from a munition maker metal owned by such maker, and made therefrom castings for shell fuses, which it returned to such maker, had a lien on the metal for its labor thereon and its profits, which made it a special owner of the metal, taxable under the act imposing a tax on war munitions.

Sale Contract Held Subject to Rule Fixing Percentage of Estimated Output

In the action by the N. P. Sloan Co. against the Standard Chemical & Oil Co. the U. S. Circuit Court of Appeals affirmed judgment in favor of the plaintiff. The action was on a contract for the sale of the season's output of the seller, estimated at a stated quantity. Both parties were members of a voluntary association called the Interstate Cottonseed Crushers' Association, and the court said such contract was subject to the rule of the association that the seller is required to deliver at least 85 per cent of the estimate, where the contract did not contain an express exception from that rule as required by another rule of the association permitting specific written contracts at stated special conditions.

The contract estimate called for 2,000 bales of linters at 3c. per lb. The Standard Chemical & Oil Co. delivered only 1,324 bales and claimed full compliance with its obligations because it delivered its entire season's production. On the other hand, the Sloan company claimed it was entitled to 1,700 bales, or 85 per cent of the contract estimate. It went upon the market and bought 376 bales of linters, representing the difference in controversy, and paid 8½c. per lb., thereby losing 5½c. per lb. on the contract price. The net loss to plaintiff, Sloan company, at 5½c. per lb. was \$7,312.16 and judgment was rendered for this amount. Further, it was contended by the Standard Chemical & Oil Co. that there had been a settlement of the difference in controversy by an accord and satisfaction. But

such company's own testimony that the Sloan company agreed to accept a specified shipment of 213 bales of linters in full satisfaction of its demands also showed the goods in that shipment were rejected by the Sloan company, with the other's acquiescence, because of their condition.

The arbitration was had in accordance with the rules of the association. The Standard Chemical & Oil Co. did not sign the letter of submission, but received it, and had due notice of the arbitration. The committee's award was that to fulfill the contract a minimum quantity of 1,700 bales of linters, of an average of 475 lb. per bale, at 3c. per lb. was necessary. This award was the same as the judgment rendered after trial.

Defendant contended that the agreement to arbitrate was revoked. The court said it was true that defendant failed to sign the submission and declined to authorize the purchase of linters on its account, but that would not constitute a revocation. Revocation comes about by act of the parties or by operation of law. Now there was no claim of such by operation of law, and before there could have been such by act of the parties there would have to be notice to the arbitrators. Failure to sign the submission was not sufficient.

Again, the court said, an award fixing the number of pounds which should have been delivered according to the average weight of the bales was not beyond the submission of the question whether the seller should deliver a stated number of bales to the buyer. Instead of speaking in terms of bales of linters, it deals in pounds, and fixed the average weight per bale.

Non-Riparian Owner Has No Right of Action for Pollution of Stream

In a memorandum decision the Court of Errors and Appeals of New Jersey affirmed judgment rendered against the Egyptian Lacquer Manufacturing Co. in its suit brought against the Chemical Co. of America. The plaintiff has a factory in Rahway, N. J., for the manufacture of chemical products requiring a large quantity of water which was supplied to it by the city. In its suit it set out that the Chemical Co. of America had a factory located at or near the Rahway River and emptied therein refuse from its factory above the intake of the city, which so polluted the water furnished by the city that the Lacquer company was injured in its use and the conduct of its business was thereby prevented, to its great injury, and that the defendant knew that the water from the stream was being used by the city to supply its inhabitants.

It was not alleged that either of the parties, or the city, was a riparian owner other than that the Chemical company carried on its business "at or near" the Rahway River. But, said the court, assuming that both defendant and the city are riparian owners, it is clear that the plaintiff, Lacquer company, is not and that there was no contractual relation existing between the Egyptian Lacquer Co. and the Chemical company or between the defendant Chemical company and the city, as to the supply of water. Therefore the question presented in this suit was whether the Lacquer company had the right to maintain an action against the defendant, since plaintiff was not a riparian owner.

The court said: "We may assume in this case that a liability existed in favor of the city as a lower riparian owner for the pollution of the stream by a higher riparian owner; but there the obligation ceased,

for the right of action would not pass to a non-riparian owner merely because the latter had contracted with the city for the furnishing of the water, for his right depends upon his contract with the city, which might provide for the very character of water which was supplied. The liability of the defendant, if any, rests upon his violation of the legal right of a lower riparian owner, unless it had contracted with the plaintiff."

It was not contended that there was any contract between the parties. Neither was this a case of an indictment for creating or maintaining a public nuisance, or for the violation of any law against the pollution of a running stream, but a suit for damages resulting from a special injury based upon the non-performance of a duty which the Lacquer company claimed was due to it from the Chemical company. But the court found that the claims did not present or show the violation of a riparian duty to the injury of another riparian owner; neither did they show any contract between the defendant and the city, even if such a contract could inure to the benefit of plaintiff (which the court was of opinion it could not). Neither was it claimed there was a contract between the plaintiff and the city, nor that defendant, as a riparian owner, owed any general duty to the public, or a special one to the plaintiff.

Right of Stockholder to Inspect Records of Chemical Company

Seeking to inspect the books of the corporation, C. S. Goddard instituted mandamus proceedings against the General Reduction & Chemical Co. of Salt Lake City, Utah. It was alleged that Goddard wished to examine the books and records of the corporation in order to secure a list of its stockholders for the purpose of selling them stock in the Congressional Oil Co.

The Chemical company further alleged that it was engaged in the business of equipping and operating its plant for the general chemical reduction of ore at Salt Lake City and the manufacture of paint, and to raise funds for such purpose had sold a large amount of its own treasury stock on contracts and part payments; and that plaintiff was sending through the mails representations to such stockholders to induce them to break their contracts with such Chemical company and to buy stock from the plaintiff, to his gain.

Because of such use to be made of the list of stockholders, as alleged, the corporation contended such to be unlawful and the plaintiff not entitled to be permitted to have access to its stock ledger. Further, it was set up by the corporation, plaintiff desired the inspection to make a list of stockholders to whom he could send through the mails misleading and fraudulent advertisements, as he had done on a former list. But this charge, not supported by proof, was held to be insufficient as an excuse for refusing access to the books of the corporation to a stockholder.

Again the Chemical company alleged that the plaintiff was a cut-rate stockbroker and that his purpose in seeking the inspection of the books was to procure a list of its stockholders for threatened blackmailing purposes and for the unlawful sale to the stockholders of stock in another corporation, and to enable him to induce the stockholders to breach their contracts to pay for its stock. This, the court said, states no defense, since the acts alleged were not illegal, and the charge that they were for blackmailing was a mere conclusion.

Recent Work on Chromium:Tungsten Steel

— Methods of Magnetic Analysis

First of a Series of Articles Reviewing the Literature on Chromium:Tungsten Steels, Especially the Work of Japanese Investigators—This Article Contains a Description of the Methods of Magnetic Analysis Extensively Utilized

BECAUSE of the importance of chromium and tungsten in the manufacture of high-speed tool steels any publications of assistance to a rational understanding of the effects of these elements, alone and in combination, are of considerable interest and importance, especially as our knowledge of the constitution of these alloys is incomplete and metallurgists still disagree in interpretation of observed phenomena.

A series of such papers by Honda and other Japanese investigators has appeared, beginning about 1911, which is of added interest because of the pioneer methods of investigation which have been used. A list of the more important ones is appended. They are not readily accessible to English readers, in some cases German translations alone being available; so that a somewhat extended summary appears justified and will be attempted in succeeding issues of *CHEMICAL & METALLURGICAL ENGINEERING*. Magnetic methods of analysis, together with microscopic examination, have been largely depended upon, though other forms of testing, such as thermal analysis and expansion measurements, have also been used and correlated with the magnetic properties. In the present review, a brief description of the apparatus adaptable for metallurgical study will be presented.

EXPERIMENTAL METHODS USED

Four types of magnetic apparatus have been used in analysis of metals and alloys at normal and elevated temperatures. They are:

- (1) Beam balance.
- (2) Torsion balance.
- (3) Magnetometer.
- (4) Ballistic galvanometer.

Methods (1) and (2) both depend upon the measurement of the force exerted on a specimen placed in a

non-uniform magnetic field. They are the most sensitive and are particularly applicable where feeble magnetization is obtained. The magnetometer utilizes the deflection of a freely swinging magnetic needle caused by a magnetized specimen and has probably the widest range of sensitivity. The apparatus for the ballistic method consists primarily of a test coil surrounding the specimen and connected to a ballistic galvanometer. Neither of these two latter methods will be here described, as the principles involved in their use are well known and widely used.

THE BEAM BALANCE

The first of the four types of apparatus mentioned above is shown in Fig. 1, in which *ab* is an aluminum lifting arm suspended from a steel knife edge *c* and controls a pointer with a Wollaston wire 0.003 mm. in diameter, the position of which is sighted through a

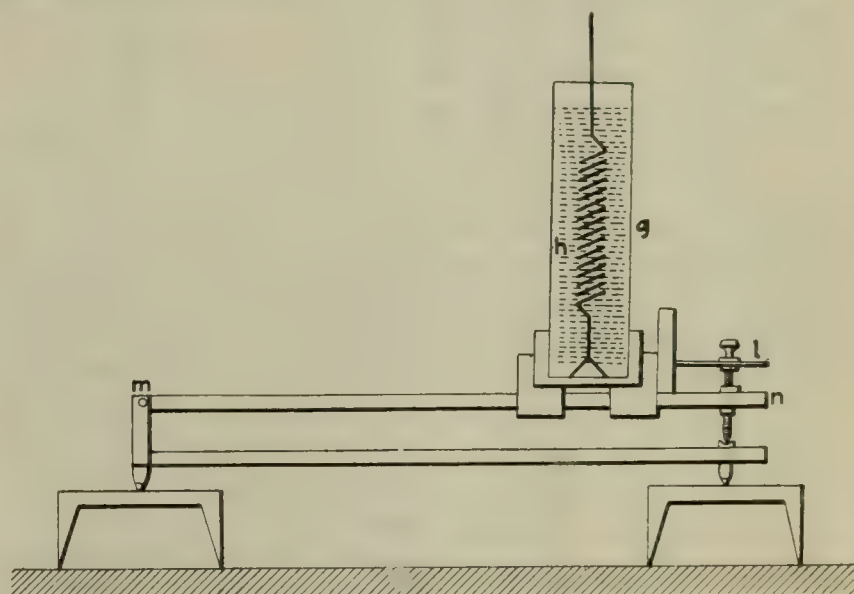


FIG. 2. DETAILS OF SPRING AND OIL FLASK SHOWN IN FIG. 1

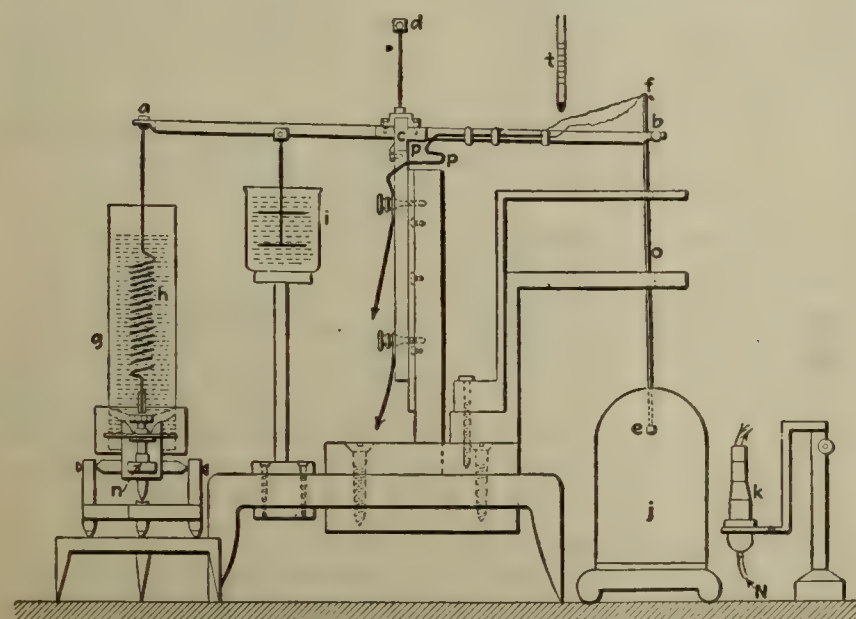


FIG. 1. BEAM BALANCE

microscope. The upper end of a steel spring *h* is attached to one end of the lifting arm, while the lower end of the spring is fastened to the bottom of a Dewar flask containing oil (to prevent rapid temperature changes). This oil flask can be moved up and down the weighing system very slowly while its total dislocation may be read on the torsion head *l*, as shown in Fig. 2, a twist of 1 deg. being equal to a flask movement of $\frac{1}{250}$ mm. The weighing system is also equipped with an oil stabilizer *i*. A small shell in which the weights are placed is shown at *f*, while suspended from the lower end of a magnesia tube *o* by platinum wires is a magnesia crucible *e*, in which the test-piece is held. Temperatures in the crucible are accurately determined by a rare-metal thermocouple, while the magnetic field in which it

¹On the Susceptibility of Iron, Steel, Nickel and Cobalt at Elevated Temperatures, K. Honda and H. Takagi, *Sci. Reports*, Tohoku University, vol. 1, p. 229.

is placed is drawn from the poles of a du Bois electro-magnet j ; k is an electric furnace, at the bottom of which is a narrow porcelain tube for the introduction of nitrogen in order to minimize oxidation of the sample. The position of the furnace may also readily be adjusted.

The field strength and its gradient may be measured by the induction method. In using the apparatus residual magnetism must first be removed by reversal of current before experimental readings are taken. The force exerted on the specimen may be weighed by this apparatus and is a measure of the magnetic susceptibility of the steel.

THE TORSION BALANCE

The torsion balance² used by Honda in his early experiments is shown in Fig. 3, and is substantially as follows:

A is an aluminum tube (with a movable counter-weight E) hung horizontally from a silver wire F 0.17 mm. thick, fastened to a torsion head G calibrated in degrees and which can be slowly adjusted by a screw. The free wire length can be measured up to its maximum by reference to the fixed peg K . At one end and at right angles to the tube A there is attached another similar tube B which is likewise attached to a magnesia tube C carrying a small crucible D suspended by platinum wires. To the other end of

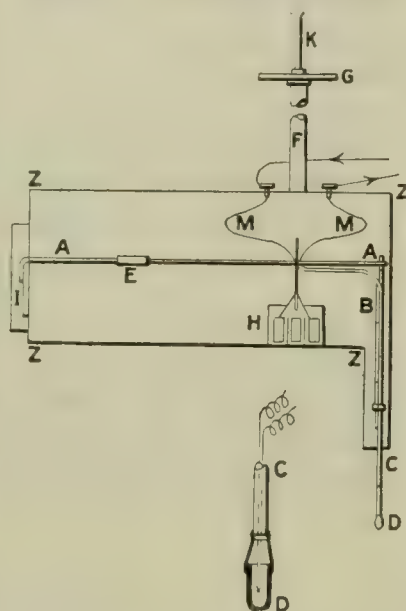


FIG. 3. TORSION BALANCE

the tube A is fastened a vertical pointer moving before an adjustable scale. A damping apparatus H hangs freely under the tube A in a flask containing benzene and glycerine, by which arrangement the movement of the arm A becomes almost aperiodic. The entire apparatus is inclosed in a

zinc box ZZ . The specimen to be tested is placed in crucible D and its temperature obtained at any time by a platinum thermocouple which passes through the magnesia and aluminum tubes without disturbing the freedom of motion of the arm A .

A scheme for making field measurements² is shown in Fig. 4. A test coil S is hung vertically by a cord which is guided by the holder H and passes over two pulleys P_2 and P_1 to Q , which is used to pull up the coil. The stand R can quickly be moved through a short distance by L_1 and L_2 to measure the

field gradient. The apparatus is placed between the poles of an electro-magnet, S being vertical to the lines of force, while a ballistic galvanometer is used to meas-

ure induction. The settings are so made that at the upper end of H the test coil S is altogether out of the magnetic field. As was the case with the beam balance, magnetic susceptibility of the steel is measured, the intensity of magnetization of the specimen being proportional to the angle of rotation of the arm A in Fig. 3.

Both beam and torsion balance have a distinct advantage over the other magnetic methods of analysis mentioned in that they are applicable to alloys which are worked with difficulty or not at all, as they do not require specially finished test-bars.

Modifications of the equipment as described have been made from time to time in the various researches carried out by these Japanese investigators, but will not here be described, as a bibliography listing the various publications is given below. In these papers may be found details of various modifications used as well as more elaborate descriptions of the apparatus and methods employed.

MORE IMPORTANT METALLURGICAL PAPERS APPEARING IN "SCIENCE REPORTS," IMPERIAL TOHOKU UNIVERSITY

Vol.	No.	Page	Author	Title
1	1	1	K. Honda	Die Thermomagnetischen Eigenschaften der Elemente
1	4	207	K. Honda and H. Takagi	Ueber die Umwandlungen des Eisens und Stahls bei höheren Temperaturen.
1	5	229	K. Honda and H. Takagi	Ueber der Suszeptibilität des Eisens, Stahls, Nickels und Kobalts bei höheren Temperaturen.
2	1	1	K. Honda and T. Soné	Die Magnetische Suszeptibilität der binären Legierungen.
2	1	27	K. Honda and T. Soné	Die Thermomagnetischen Eigenschaften einiger Elemente.
2	2	69	K. Honda	Ueber die Wärmeerscheinungen und Magnetisierungsänderungen ferromagnetischer Körper bei höheren Temperaturen.
2	4	203	K. Honda and H. Takagi	Die Thermomagnetischen Eigenschaften des Eisens und der Stähle.
3	4	165	K. Honda	Ueber die magnetische Umwandlung und ihre Nomenklatur.
4	3	161	K. Honda and H. Takagi	On the Magnetic Transformation of Cementite.
4	3	169	K. Honda	On the Nature of the A_2 Transformation in Iron.
4	3	215	K. Honda and T. Ishiwara	On the Thermomagnetic Properties of Various Compounds and Weiss Theory of Magneton.
4	3	261	K. Honda and H. Takagi	On the Magnetic Study of the A_3 Transformation in Pure Iron.
4	5	313	T. Soné	Magnetic Properties of Iron Electrically Deposited in Magnetic Field.
5	1	53	T. Ishiwara	On the Magnetic Susceptibility of Nitrogenide Manganese.
5	2	121	T. Matsuda	On Some Properties of Annealed Steel.
5	2	135	K. Honda, K. Tawara, and H. Takagi	On the Transformations of Special Steels at High Temperatures.
5	3	153	K. Honda and J. Okubo	Ferromagnetic Substances and Crystals in the Light of Ewing's Theory of Molecular Magnetism
5	5	285	K. Honda	On the Temperature of the Reversible A_1 Transformation in Carbon Steels.
5	5	325	K. Honda and J. Okubo	On the Effect of Temperature on Magnetization Considered From the Standpoint of Ewing's Theory of Magnetism.

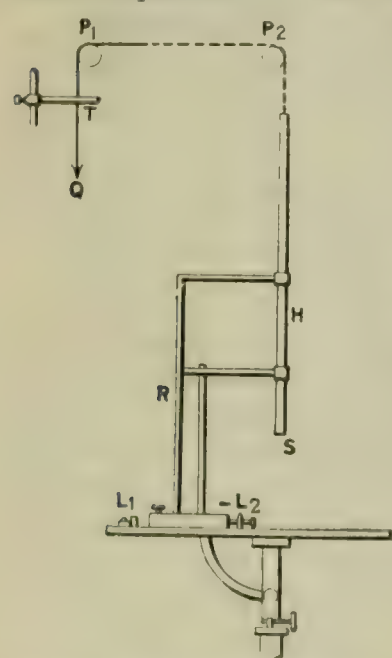


FIG. 4. EXPLORING MECHANISM USED WITH TORSION BALANCE, FIG. 3

²Die thermomagnetischen Eigenschaften der Elemente, K. Honda, *Sci. Reports*, Tohoku University, vol. 1, p. 1.

6	1	23	K. Honda and T. Murakami	On the Thermomagnetic Properties of the Carbides Found in Steels.
6	2	53	K. Honda and T. Murakami	On the Structure of Magnet Steels and Its Change With Heat Treatment.
6	3	133	T. Ishiwara	On the Magnetic Investigation of A_3 and A_4 Transformations in Pure Iron and Steel.
6	3	149	K. Honda	On the Magnetic Investigation of the States of Cementite in Annealed and Quenched Carbon Steels.
6	4	203	K. Honda	On the Thermal Expansion of Different Kinds of Steel at High Temperatures.
6	4	213	K. Honda	A Criterion for Allotropic Transformations of Iron at High Temperatures.
6	4	219	K. Honda and T. Simidu	On the Thermal and Electrical Conductivities of Carbon Steels at High Temperatures.
6	5	235	K. Honda and T. Murakami	On the Structure of Tungsten Steel and Its Change Under Heat Treatment.
6	5	285	T. Ishiwara	On the Magnetic Analysis of Carbides Found in Different Kinds of Steel.
6	5	231	K. Honda and H. Takagi	On the Cause of the Irreversibility of Nickel Steels.
7	1	43	T. Matsushita	On the Slow Contraction of Hardened Carbon Steels.
7	1	59	K. Honda	On the Thermal and Electrical Conductivities of Nickel Steels.
7	2	167	I. Iitaka	A Study of Cementite Transformation and of the Equilibrium Diagram of the System Iron-Carbon by Means of Electric Resistance Measurements.
7	3	217	T. Murakami	On the Structure of Iron-Carbon-Chromium Alloys.
8	1	51	K. Honda and T. Matsushita	Quenching Cracks in Carbon Steels.
8	1	59	K. Honda	On the Moduli of Elasticity and Rigidity of Nickel Steels.
8	2	79	T. Matsushita	On the Influence of Manganese on the Physical Properties of Carbon Steel.
8	2	89	K. Honda and T. Matsushita	On Some Physical Constants of Tungsten Steels.
8	3	181	K. Honda	On the Nature of the A_1 Transformation and a Theory of Quenching.
9	2	143	K. Honda and T. Murakami	On the Structural Constitution of High-Speed Steel Containing Chromium and Tungsten and the Effect of These Elements on Its Hardening and Tempering.
9	3	243	T. Matsushita	On Some Physical Constants of Chromium Steels.
9	5	401	T. Ishiwara	On the Magnetic Determinations of A_0 , A_1 , A_2 and A_3 Points in Steels Containing up to 4.8 per Cent Carbon.
9	5	417	K. Honda and S. Saito	On K. S. Magnet Steel.

Increased Costs in English Pottery Industry

Consul W. F. Doty, of Stoke-on-Trent, reports that manufacturing costs in that center of the English pottery industry have increased enormously over pre-war figures. Labor is 150 to 180 per cent higher than in 1913, fuel 200 to 255 per cent higher, clay 160 to 250 per cent, cobalt 230 to 566 per cent, flint, glaze, etc., 180 to 330 per cent, crates and straw 230 to 425 per cent, cartage 300 to 400 per cent, sagger marl and firebrick 275 to 290 per cent, and plaster 200 per cent higher according to data supplied to the Consul by the Staffordshire Pottery Manufacturers' Association.

Factors Influencing the Viscosity of Glue

BY F. J. CRUPI

AS is well known, the viscosity of glue solutions generally varies with their comparative water content. A glue solution with a high water content produces high dispersion of the molecules, and a consequent low viscosity; whereas a solution of the same glue with a less water content produces less dispersion and a comparatively higher viscosity.

GRADES OF GLUE AND COLLOIDAL PROPERTIES

There are many different grades of glue on the market, and it is noticed that a high-grade glue "B" shows a higher viscosity than an inferior grade "C"—each solution containing glue and water in exactly the same proportion. The cause of this may be explained as follows:

The former glue "B" may consist of colloids which are much larger than the colloids of glue "C"—that is, the colloids of glue "B" may consist of more molecules than the colloids of glue "C"; if so, this would decrease the dispersion of the molecules of glue "B" as compared with the molecules of glue "C." When discharged through a pipette, the more molecules there are in a given volume the more force they will exert on the sides of the vessel and the more resistance they will offer to deformation and flow. The colloids of glue "B," having a greater mass and concentration than "C," will obviously offer more resistance to flow. The glue solution "C," consisting of minor colloids and greater dispersion of the molecules, will flow more readily, since it offers less resistance to deformation—the molecules, having more freedom, will produce more flexibility, thus passing through the opening more readily.

A better conception may be formed when we compare this statement as an analogy with the flow of sand grain instead of glue. If we use a special pipette with a definite opening, and fill it with fine powdered sand, it will be found to flow much sooner than a coarser grade. Let's imagine the grains of sand as the colloids and the analogy is complete. But it does not always follow that the relative size of the colloids determines the viscosity. A glue solution may have colloids containing, for example, ten molecules, and another solution containing colloids made up of half as many (five) molecules and still be of the same size. Since the colloids of both glues are of the same size, we would expect to obtain the same viscosity, but it does not always follow, for the former colloids, containing more molecules, will produce more concentration and will offer more resistance to deformation, etc.; whereas the colloids containing five molecules—the molecules being greatly dispersed—will be more flexible and, therefore, would deform easier and flow more readily. In each of these mentioned factors the mutual attraction between the molecules plays an important part also.

The dispersion and size of molecules and colloids in glue are also influenced by various chemicals.

Some chemicals tend to increase the dispersion, and thereby lower the viscosity; while other chemicals act *vice versa*. Still other chemicals will coagulate a glue solution to a more or less extent, which is really the combining of molecules into large colloidal masses. When certain acids are added to a glue solution, they will produce an increase in dispersion and lower the

viscosity. Formaldehyde and others produce a decrease in dispersion and a higher viscosity.

It is obvious how temperature would affect viscosity, since an increase in temperature will increase the distance between the molecules, causing a lower viscosity, while a decrease in temperature is *vice versa*.

Unless pipettes used are identical in bulk, size, shape and in almost every possible way, it will be found difficult to obtain accurate comparative results. The fact that a pipette will discharge water in a given time does not follow that a different pipette—different size, shape, etc.—which also discharges its contents in that given time will give comparative results with glue. A pipette which is twice as large in bulk as another can be adjusted with an aperture which will discharge its contents in the same time, in the former pipette the aperture being twice as large as the latter. The various effects of these differences can be imagined when we review the colloids, etc.

A stop watch is used and its figures adopted as a means of classification. The length of time a solution of glue remains exposed in the hot water bath, before being actually tested, is found to affect the viscosity, as the water gradually evaporates.

RELATION OF VISCOSITY TO JELLY STRENGTH

Generally the jelly strength of a glue varies with its viscosity. When a finger or rod displaces the colloidal particles of a cold jelly of glue, they act like small solid rubber balls, the hardest rubber balls offering the most resistance to pressure. So in a glue jelly, its strength depends on the concentration of the molecules or the quantity of molecules which make up the colloids. Thus a glue containing colloids made up of ten molecules would offer more resistance than a glue whose colloids are of the same size and consist of only five molecules. The factor of dispersion also affects jelly strength. There are instances where, although the viscosity is lower than a certain standard, the jelly strength is higher. This may be due to the fact that although the molecules which constitute its colloids are less and more highly dispersed, the force of mutual attraction is greater.

Another reason may be that sometimes a glue may form big colloids with a large number of molecules, whereas another glue may form colloids half as big and containing half as many molecules. Of course, the big colloids would take longer to go through the pipette than the small colloids and thereby have a higher viscosity; but it is found that they have quite the same jelly strength, since the force of resistance would be the same in each arrangement of the molecules.

RELATION TO TENSILE STRENGTH, ETC.

Along these principles, then, it should also follow that the tensile strength of the dry glue should vary with the distance and mutual attraction between the molecules. It does not follow that a glue with a strong jelly should always have a strong tensile strength. The relative size of the colloids has very little influence on tensile strength. The characteristic properties of a glue depend on the strength and arrangement of the forces of attraction which hold the molecules together. Hard glues are glues in which the forces that exist between the molecules are very strong and hold them together so that they cannot easily be distorted. An elastic glue is one in which the same forces act to restore its original shape once it has been distorted.

Herman Behr & Co., Inc.,
Brooklyn, N. Y.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Rust-Preventing Mixture.—GEORGE S. MORGAN, of Toledo, Ohio, claims the use of the following mixture for preventing rusting and corrosion of metals: Litharge, 1 part; fatty acids, 2 parts; paraffine oil, 60 to 200 parts. (1,364,134; assigned to Edgar G. Behr, of Detroit, Mich.; Jan. 4, 1921.)

Sulphuric Acid.—If mechanical burners are employed in the chamber process for making sulphuric acid, the quantity of dust carried by the burner gases is large and this dust is not removed in the usual dry dust chambers. Consequently the acid in the Glover tower is made very dirty and when arsenical pyrites are used is highly arsenical. JAMES BROWN, of Manchester, England, modifies the system of dust removal by adding a wet scrubbing system after the usual dust collector. The gases pass first through a coke-filled tower in which H_2SO_4 of sp.gr. 1.5 to 1.7 is circulated, then through two coke filters in series followed by a blower and a small coke filter to remove drops of acid condensed by the fan. By means of heat-interchanger pipes passing through the dry dust chamber, the gases are reheated by the incoming raw gas. In this way it is possible to produce Glover tower acid of high strength which is waterwhite and is dearsenicated down to 5 to 10 parts per million even when using arsenical pyrites. From time to time the acid circulating in the first scrubber is settled in tanks and the clear liquor separated from the sludge. Specially designed distributors are required to prevent clogging. (1,365,964; Jan. 18, 1921.)

Continuous Calcination of Carbon for Electrodes.—High-grade carbon electrodes for certain processes require a carbon of high purity and one as nearly as possible free from contained volatile matter. The principal source of such pure coke is the well-known petroleum coke resulting from the distillation of petroleum. This coke as it comes from the oil stills contains from 6 to 12 per cent, of volatile matter, which must be driven off almost completely (to a small fraction of 1 per cent) before the coke is suitable for the manufacture of high-grade carbon electrodes. This volatile matter is driven off by heating the coke to temperatures in the neighborhood of 1,100 deg. C. and in a manner to prevent contact of the hot coke with the air or other gases which would cause oxidation. Several difficulties have been encountered in attempting to calcine coke by a continuous electrical process. Due to the negative temperature coefficient of resistance, there is a tendency for the current to follow the path first established. This results in overheating a portion of the charge and insufficiently heating the remainder. Furthermore, the raw coke is a poor conductor until the volatile matter has been driven out. WILLIAM HOOPES, of Pittsburgh, Pa., has devised a process which overcomes these difficulties. A furnace of the vertical shaft type is made from three flanged steel sections. The sections are insulated from one another and the upper and lower sections have connections for the heating circuit. These latter sections are lined with carbon so as to provide good electrical contact between the shell and the coke charge. The middle section is provided with an insulating refractory lining. The heated portions of the shell are jacketed for water-cooling. The coke charge is fed continuously through a hopper at the top of the furnace. A portion of the gases escaping during calcination is washed, cooled and circulated counter-currently through the furnace. Cool gas entering at the bottom of the furnace rises through the charge. In this way more even heating is obtained and the charge is conductive by the time it reaches the zone of electric heating. (1,366,457 and 1,366,458, assigned to Aluminum Co. of America; Jan. 25, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Addition to Program Rochester Meeting A.C.S.

The only addition made during the past week to the program for the Rochester meeting of the American Chemical Society was an address by Charles F. Chandler, professor emeritus of Columbia University. He will deliver the principal address at the general meeting the night of April 27.

A cablegram from Mme. Marie Curie to the effect that she regrets that she will not be able to re-arrange her plans so as to arrive in the United States in time to attend the American Chemical Society's meeting was received by Dr. Charles L. Parsons, secretary of the society.

Experimental Lecture on Radium

Interest in the forthcoming visit of Mme. Curie to the United States is reflected in the program of the New York Section of the American Electrochemical Society for April 8. Dr. R. B. Moore, chief chemist for the United States Bureau of Mines, will deliver the address of the evening at the Chemists' Club. Dr. Moore will make his address an experimental lecture on radium. He is well qualified to discuss this subject in an interesting manner, as he had charge for the Government of the plant in Denver which produced about 7 g. of radium salt for the National Radium Institute and the Bureau of Mines.

Recent Advances in Organic Chemistry

Prof. James F. Norris of the Massachusetts Institute of Technology addressed the Philadelphia Section of the American Chemical Society at its regular meeting on March 17, at the Engineers' Club. His subject was "Recent Advances in Organic Chemistry," and with the aid of lantern slides he gave an exceedingly interesting review of the progress in this branch of science during the past ten years.

Many reactions known heretofore only in textbooks have become of great industrial importance. For example, the conversion of ethylene to glycol and of pentane to amyl acetate involve reactions that have been known for years, but it is only recently that anyone thought seriously of operating them on a commercial scale. Propylene is now recovered from oil-cracking stills and is converted into isopropyl alcohol, which shows great promise as a substitute for the ethyl variety. The action of chlorine on acetylene produces dichlorethylene and tetrachlorethane, which are now finding application as solvents.

SYNTHESIS OF NATURAL PRODUCTS

The synthesis of natural products may be called the second chapter in the recent progress of organic chemistry. The structure of turmeric has been shown to be similar to that of acetylacetone. Fischer synthesized tannin from gallic acid and certain glucosides. The speaker paid a tribute to Willstätter for his work on chlorophyll and the coloring matters of flowers.

The rubber molecule is now believed to contain a ring of twenty carbon atoms, formed by the condensation of five isoprene chains. About twenty-five different syntheses of isoprene have been developed. Much of this work was done in Russia, as prior to the war Russia held the leadership in the field of paraffine compounds, just as Germany did in aromatics. Besides this extensive work on isoprene, Russian chemists have studied the polymerization of other hydrocarbons and have prepared many different substances with the physical properties of caoutchouc but differing from it chemically. The German synthesis of rubber during the war started with the hydrogenation of acetone, followed by dehydration to produce methyl-isoprene. After this material had been allowed to polymerize for about four months, a so-called "methyl-rubber" was obtained.

In the realm of sugar chemistry marked progress has been made. The preparation of ethers and esters of the various sugars has been especially valuable in studying the tautomerism and ultimately the constitution of these compounds. The speaker praised the recent excellent work of Hudson in this field.

FERMENTATION AND ENZYME REACTIONS

Fermentation processes and enzyme reactions have come into prominence during the past few years, especially on account of the production of acetone and butyl alcohol in this manner during the war. Fats can now be produced by the fermentation of carbohydrates, the reaction being controlled by the addition of sodium sulphite. Great progress may be expected in the near future through this control of enzyme reactions by the addition of inorganic salts.

CATALYSIS

In discussing the progress in synthetic methods, the importance of catalytic reactions was emphasized. Much has been learned regarding the specific properties of different catalysts. For example, nickel is especially valuable for hydrogenation, copper for dehydrogenation, and the oxides of aluminum or tungsten for dehydration. The development of catalytic promoters shows great promise. The enormous production of acetaldehyde, acetone, acetic acid and alcohol from acetylene was cited as one of the best examples of the commercial application of catalysis in organic chemistry. These processes were operated successfully in Canada during the war, and the yields and efficiencies were extraordinarily high for organic reactions. The production of many other compounds from acetylene is now being studied, such as pyridine, thiophene and acetic anhydride.

Regarding the question of valence, a great deal of evidence has been accumulated in favor of trivalent carbon and univalent and quadrivalent oxygen. Hexaphenyl-ethane and other compounds containing only carbon and hydrogen have been found to ionize and conduct electricity. It may be that the long sought "free radicals" will some day be produced. Electronic conceptions are destined to play an important part in future developments.

APPLICATION OF PHYSICAL CHEMISTRY

The greatest advance in the past ten years, in the opinion of Prof. Norris, has been the growth of the dynamic conception of the organic molecule. We used to think that the carbon and hydrogen atoms "stayed put" just the way we drew the lines in the structural formula, but the present tendency is to think of the molecule as a seething mass of moving atoms. The extensive work on tautomerism and desmotropy has been the chief cause of this dynamic conception. Equilibrium studies of the keto and enol forms in a wide variety of solvents have been especially valuable. Many organic reactions have recently been found to be reversible, thus making it easier to apply the laws of thermodynamics. In conclusion the speaker stated that he believes the application of physical chemistry to organic reactions offers the greatest opportunity for advancement at present and in the immediate future.

To Visit Mining Experiment Stations

Plans for the work at several of the mining experiment stations of the Bureau of Mines during the next fiscal year will be discussed at conferences which will be held at these stations between Director Bain and Dorsey A. Lyon, supervisor of stations, and the local staffs. Messrs. Bain and Lyon will leave Washington April 10 and will visit the stations at Bartlesville, Rolla, Mo., St. Louis, Minneapolis and Birmingham.

Ceramic Appropriation Fails in Ohio

The Ohio Legislature has failed to include in its appropriations the \$15,000 item proposed as the state's part of the co-operative support being given to the Bureau of Mines ceramic station at Columbus. The station soon will have been established four years, but the only appropriation which has been forthcoming is that allowed by the Federal Government.

The failure of Ohio to appropriate for this station probably will be called to the attention of the ceramic industries in that state in order that they may bring home to their legislators the benefits accruing to Ohio by reason of the location of the station within its borders.

Wage Changes at Holyoke Paper Mills

The American Writing Paper Co. after a conference with the leaders of the various local labor unions has announced a cut in wages averaging 15 per cent. The reduction is not horizontal, as recent wage advances in case of certain classes of labor had decreased the differential between skilled and unskilled labor farther than was considered necessary or desirable. This factor was considered in the new rates.

The independent mills of the district have for the most part declared their intention of reducing wages in general accord with the policy of the American Writing Paper Co.

The Crocker McElwain and Chemical Paper companies of Holyoke have reached an agreement with their union help on the individual contract question. Both sides made some concessions. At present the veteran employees are being paid on a salary basis and are reporting for work daily although the mills are operating only two days a week.

There is no question that the laboring men as a whole are well pleased with the arrangement and the company should be able to retain its best men in this way and so reduce its labor turnover.

Water Service and Wood Preservation Discussed By Railway Men

The week ended March 19 marked a time of importance to the railway technical profession assembled in Chicago. The National Railway Appliances Association at the Coliseum presented exhibits of unusual importance in every phase of the railway field, the railway section of the American Association of Engineers discussed education and salaries and the American Railway Engineering Association held technical sessions at the Congress Hotel.

Among the list of papers presented at the latter meetings and of interest to readers of CHEMICAL & METALLURGICAL ENGINEERING were the reports of the committees on water service and wood preservation abstracted in the following paragraphs.

EXPERIMENTAL EFFECT OF INCRUSTATION ON PIPE LINES

A large proportion of stoppages in pipe lines is due to corrosion, or roughening of the interior surface. Where pipe is well coated before laying trouble of this nature is not generally to be expected with ordinary water for a number of years. This corrosion usually forms the foundation for other deposits by roughening the interior of the pipe. The amount of deposit depends entirely on local conditions.

Mud or suspended matter other than found as a result of water treatment seldom forms a deposit in the pipe unless the foundation has been already laid by corrosion. The amount found depends largely upon the nature of the water and the velocity of the flow. Snails and similar growths are frequently found in suction lines, but little information is to be found on the subject.

Iron, manganese or aluminum promotes the growth of various forms of crenothrix in pipes or reservoirs. There is also a large variety of bacteriological growth known more familiarly as pipe moss, pipe sponge, etc. It is claimed that these organisms will not thrive unless the water is acid. Anything tending to make the water alkaline will reduce or cure the trouble. Filtration may or may not assist. To be of value the filter must be of a nature to remove the bacteria or their food, or both. Many filters fail to remove bacteria, although they may lessen the difficulties.

The usual sequence is for the pipe to roughen through corrosion. Then mud or slime is deposited to form a culture bed for a variety of growths. Incrustation due to water treatment is commonly found in treating plants of various types. This deposit is greatest when the water is under-treated or when raw and treated waters are mixed in the pipe lines. There is also difficulty due to water being used before the reactions are complete. There is no evidence that filters will entirely eliminate incrustation, as a reaction frequently takes place after the chemicals pass the filters. This deposit is usually found in annular rings of various degrees of hardness.

The application of heat will deposit a scale largely composed of the combination of lime and magnesia. In treated water the changes in temperature will also cause a deposit. When the temperature rises in passing from the treating tank, any excess of lime or magnesia will deposit. The reverse is true of soda. As any excess is generally carbonate of lime, the latter is usually the main source of deposit.

The methods of cleaning pipe vary from hand and mechanical treatment to chemical methods. Valves, etc., around treating plants or where treated water is used are usually cleaned by use of hydrochloric acid. The pipe lines can be cleaned by the same process, but the cost is often prohibitive unless chemicals are recovered. It is better to prevent these troubles than to encounter them later.

Prevention may be accomplished by flushing; which is entirely mechanical, and may be used if the local conditions are proper. It will seldom prevent the formation of chemical deposits and will often assist them where raw water is used to flush a line. Aeration before pumping will aid when the water contains iron and produces crenothrix.

The prevention of chemical reactions in the pipe line will as a rule stop all incrustation. It may be said, however, that the better and more complete the water treatment the less the trouble will be. No method has been devised which will eliminate temperature changes and their resultant effect. Pipe cleaning will pay if there is a shortage when the cost of cleaning is less than the cost of an additional pipe line needed for adequate service.

SODIUM FLUORIDE AS A PRESERVATIVE FOR CROSSTIES

Sodium fluoride has been used only in small amounts for experimental purposes. Comparatively small amount is available for preservation of ties at this time. Lack of demand and immediate shortage of high-grade fluorspar have deterred manufacturers in increasing their facilities for its preparation. This recovery of a byproduct from the manufacture of phosphate fertilizer is not being carried out because of the high initial outlay in plant construction and the present conditions of labor and material shortages.

Tests on toxicity of sodium fluoride as made at the Forest Products Laboratory indicate it to be about double that of zinc chloride. Service tests on ties treated with this salt have not been carried on over a period sufficiently long to determine that this same ratio holds true in practice. Until this information is at hand no railroad will go into the extensive use of sodium fluoride for the treatment of ties. Under the circumstances, the comparative prices of zinc chloride and sodium fluoride will determine whether or not the former will be supplanted by the latter, wholly or in part. Recent developments indicate that there is a possibility that sodium fluoride will be obtainable at a price very near that of zinc chloride.

PROTECTION OF PILES IN INFESTED WATERS

The committee presented a paper on the protection of piles in water infested by marine borers. The conclusion was that when piles are used in important structures in infested waters where the best protection is desired they should receive in addition to a thorough treatment with creosote oil some form of mechanical protection best adapted to the conditions.

Further, that generally at points on the Gulf and Pacific Coast creosoted piles should have full length mechanical protection to insure protection against *Limnoria* as well as *Teredo*. At Atlantic coast ports creosote treatment will stop the *Teredo*, but mechanical protection is necessary to resist the *Limnoria*.

Forest Products Laboratory Appropriation Increased

The appropriation for carrying on the work of the Forest Products Laboratory at Madison, Wis., for the coming fiscal year was increased by the last Congress to the extent of \$100,000, or approximately 44 per cent. While this is less than the amount asked for by the Secretary of Agriculture, it is nevertheless a substantial and gratifying recognition by Congress of the needs of the laboratory in carrying on the excellent service it is rendering the industries.

Research on Colorado Clay Resources

The board of directors of the Civic and Commercial Association of Denver has passed a resolution urging the Colorado General Assembly to appropriate \$5,000 for the use of the State Geological Survey in making an extensive investigation of the ceramic resources of the state. This action is based on the report of the Industrial Research Committee which is abstracted below. This study sought to determine the character of the technical investigations which must be made in the ceramic resources to get the attention and confidence of men actually engaged in the industry, as well as to determine the broad economic forces upon which the industry had been built in the great Ohio district in so far as these forces might force a way to a parallel development in Colorado.

The work includes interviews with users, manufacturers, dealers, clay brokers, ceramic experts and officials of the U. S. Bureau of Mines and the Bureau of Standards, all of whom testified to the high quality of clay products made in Colorado.

The general economic forces which have elsewhere built up a localized pottery industry are represented in Colorado's conditions—namely, that the product combines high value with small bulk, and will bear transportation charges; that there are large supplies of coal close at hand; that climatic conditions are such as to overcome the industrial disease tuberculosis. Probably no plant in the United States gets so large a proportion of raw materials so close at hand as does the Coors Pottery at Golden. There are in Colorado large supplies of excellent fireclay, needed in making "saggers."

The progress of the existing Colorado plants shows that clay workers can be trained as they have been trained by the Coors Co., at Golden, by the Western Pottery Co., and by the Denver Terra Cotta Co.

Negotiations are going forward with Prof. R. D. George, looking toward an extensive investigation of ceramic resources of the state, including the availability of raw materials for the manufacture of pottery, especially white ware. Preliminary ceramic tests, fusion and color tests will be made.

Industrial Applications of Colloid Chemistry

Dr. Harry N. Holmes addressed the Connecticut Valley Section of the American Chemical Society at the regular March meeting held at the Hotel Bridgway in Springfield, March 18. His subject was "Colloid Chemistry and Some of Its Industrial Applications."

He exhibited a large number of gels and emulsions, some of the former illustrating crystal growth in such media. One in particular, showing crystals of gold in a silica gel, has attracted much interest among geologists because of the plausible explanation of the occurrence of gold in quartz as being the residue from such an original condition in the earth. According to this hypothesis the gold has crystallized in the gel which has subsequently been dehydrated and the resulting silica has crystallized as quartz.

Prominent among the industrial applications of colloidal chemistry that Dr. Holmes described is colloidal silica as prepared by Patrick, originally for an absorbing medium for gas masks. This new material seems to have a wide field of usefulness on account of its high degree of absorption for certain compounds. At present it is being used to clean up the gases from chamber acid plants and recover oxides of nitrogen as well as escaping SO_2 . Its remarkable affinity for water makes it as good as calcium chloride for drying. A large number of important industrial uses have

been suggested for it and some of them are now in the experimental stage. Among these are its use in drying air for blast furnaces and for absorbing gasoline vapors.

The ceramic industry is now being served by studies of colloids. It is possible to work clay with smaller amounts of water if alkali is added. This means a smaller amount of water to be evaporated and less shrinkage of shaped objects. It is also possible to separate iron from clay to a considerable extent by the addition of the proper amount of alkali, for the clay suspension is stabilized by the acid, while the iron, carrying an opposite charge, is readily coagulated in an alkaline solution and settles out. The use of tannins and other extracts is also being studied.

In the preparation of such emulsions as are used in the manufacture of greases there is a great deal of research for the colloid chemist to undertake. The development of colloidal fuel was also touched on as showing an important application.

Among other problems he listed as important the development of a waterproof glue, a product which the Forest Products Laboratory is interested in because of the probability that in the near future there will be no more big timber and it must be replaced by laminated structures.

He also spoke of the degumming of silk and of wool scouring as important industries to which the study of the colloidal state was necessary to work out improved methods.

The proper disposal of mill waste in general, he said, was very apt to be a problem of getting rid of fine suspensions and a study of the specific problem in the light of present-day knowledge of the colloidal state was often the only way to solve the problem.

Institute of Chemistry

The March meeting of the New Jersey Chemical Society on the evening of the 14th was addressed by Dr. E. Newton Harvey, professor of physiology, Princeton University, on animal light and was illustrated by the production of light from the dried remains of a small crustacean which has this remarkable ability.

Dr. Charles Baskerville, of the College of the City of New York, then told the society of the work which had been done in collaboration with Dr. Gwathmey in the production of anaesthesia without the untoward symptoms associated with the inhalation of ether.

The committee on the possible Institute of Chemistry then presented the following report:

REPORT OF THE COMMITTEE OF THE N. J. CHEMICAL SOCIETY ON A POSSIBLE INSTITUTE OF CHEMISTRY

To the Members of the N. J. Chemical Society:

Your committee prepared a tentative scheme and gave it fairly wide publicity, sending it to the journals and prominent chemists and discussing the matter with many. From the printed and written comments and conversations it appears that there are three groups of opinions.

1. That an American Institute of Chemistry is not needed.

2. That an Institute of Chemistry should exist as an adjunct to or function of the American Chemical Society. No one holding this view points out how the American Chemical Society could so function, we are advised to bring the matter to the attention of the officers and Council, as was done about fifteen years ago.

3. That an Institute of Chemistry, to function, in general, as outlined, is needed; that it should be started by the New Jersey Chemical Society, beginning in New Jersey and showing by experience its advantages and developing working plans adapted to the entire country.

Your committee recommends:

A. Anything done should be handled locally, by the N. J. Chemical Society and not by a new organization.

B. That, in view of the fact that even the simplest listing, etc., will require time and money, the entire matter be referred to the board of governors for further action.

The committee extends to all who have answered its questions their hearty thanks for the interest taken in the matter.

GEORGE T. COTTLE,
C. P. TITUS,
F. D. CRANE, Chairman.

Drafting of Tariff Bill Starts

The Ways and Means Committee of the House of Representatives has begun the work of drafting the permanent tariff bill which is to be submitted to Congress at the extra session. The sub-committee charged with the drafting of the chemical schedules is composed of Representatives Longworth, of Ohio; Copley, of Illinois; and Hadley, of Washington. Mr. Longworth has given specialized attention to chemical matters for many years, but the other members of the sub-committee have made no special study of the subject.

The chemical sub-committee is meeting twice a day. At this writing, attention is being concentrated on testimony from representatives of Government departments. The work has not progressed far enough to permit any definite statement as to plans, but Mr. Longworth states that it is evident that the chemical industries must have more protection than is afforded by a tariff. He states that he is not insisting on his licensing plan, but he believes either that or the selective embargo proposed by the Senate must be resorted to. He expressed the opinion that the chemical schedule, above all others, can justify high rates of duty from the fact that it places very little of the burden on the consumer. As an example, he cited the dye in a suit of clothing. The duty paid on that amount of dye would be insignificant even were the schedule very high.

Mr. Longworth commended very highly the work which has been done by the Tariff Commission. This body has been able to furnish the committee, he said, with very pertinent information on every commodity concerning which members of the committee had inquired.

Dust Explosion Wrecks Chicago Elevator

The Chicago & Northwestern Terminal elevator, leased to the Armour Grain Co., at Torrance Ave. and 122d St., South Chicago, Ill., was wrecked by dust explosion on Saturday, March 19. Of the \$4,000,000 worth of grain in the elevator about \$1,000,000 was lost. Six men on duty also lost their lives.

The view is generally held that the explosion was due to spontaneous combustion of grain dusts and it is also believed that a highly explosive mixture of humid air and grain dust was ignited by a spark possibly from a watchman's cigarette. There could have been no sparks from the machinery, because the explosion occurred at night when machinery was idle.

There were two distinct explosions. The first was a small one, evidently in the driers. This merely acted as an igniter, or detonator, of the main explosion, which passed like a wave of fire through the entire structure. It was announced by the Illinois State fire marshal that complete investigation will be made into the cause of this explosion.

Bureau of Mines May Study Black Hills Ores

A study of the complex sulphides, argentiferous galena in quartz and the blue ores containing gold in sulphides, occurring in the Black Hills region, may be undertaken by the Bureau of Mines under a co-operative agreement with the mining and business interests of that section. There is said to be a large tonnage of refractory ores in the Black Hills which could be mined if improved processes were devised.

Colloidal Clay as Paper Filler

A highly colloidal clay, found in the Rocky Mountain region, has been found by the Forest Products Laboratory at Madison, Wis., to be highly valuable as a loading material for paper. This clay when added to English china clay is said to produce a superior finish and a more velvety quality than when the English clay is used alone.

Stolen Platinum Recovered

The police in Washington report the recovery of the platinum stolen from the Bureau of Standards more than a year ago. A former employee of the bureau was arrested on another charge. A subsequent search of his home led to the discovery of the platinum buried in the cellar.

Chemical Warfare Association Proposed

Plans are being made for the formation of an organization which probably will be known as the Chemical Warfare Service Association. The idea is to take organized steps to acquaint the public with the need for continuing active research and development along the line now being followed. The association would use its influence to secure an adequate proportion of the War Department's appropriations for the Chemical Warfare Service. It would endeavor to co-ordinate the experimentation of this character being done by the Army and by the Navy. The broad thought is to work in the interest of this service, which many believe to embody a more efficient and humane method of warfare and one which gives great advantage to an industrial nation.

The final decision in the matter probably will be reached at the third annual dinner of the Chemical Warfare Service, which will be held in Washington the middle of April.

Book Reviews

CHRONOLOGY OF IRON AND STEEL. Compiled by S. L. Goodale, Professor of Metallurgy, University of Pittsburgh, and edited by J. R. Speer, chairman of the Board, Pittsburgh Iron & Steel Foundries Co. Published by the Pittsburgh Iron & Steel Foundries Co., Pittsburgh, Pa. Price, \$5.

This little book of pocket manual size (4 in. x 6½ in.) contains 300 pages of brief notes on the discovery, development, and perfection of iron and steel making and many related occurrences. Starting with the birth of Tubalcain, "the forger of every cutting instrument of brass and iron," and ending with the death of Andrew Carnegie and Henry C. Frick, men of steel and coke, it mentions a great many names of men of various attainments who have lent their aid in perfecting this most useful aid to civilization, as well as many events in the passing years which resulted not so much from one individual's effort as from the march of events.

All the incidents are arranged according to the approximate date of occurrence. Lacking this information as a starting point, one may consult an alphabetical index at the end.

The compilation is evidently very carefully done, and the book contains a great amount of information which will attract those who are interested in knowing something of the "family tree" of familiar articles made of iron and steel.

E. E. THUM.

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CHEMISTRY OF PULP AND PAPER MAKING. By Edwin Sutermeister, chief chemist, S. D. Warren Co. Paper Mills. vii + 479 pp.; 55 figs.; 31 full-page photomicrographs. Price \$6 (33s.). New York: John Wiley & Sons, Inc.; London: Chapman & Hall, Ltd. 1920.

It is over twenty-five years since Griffin and Little published their "Chemistry of Paper Making." During that time there have been very notable advances in both the pulp and paper industries. The paper industry will, therefore, welcome the contributions of 1920, which include Witham's "Modern Pulp and Paper Making," which deals with the technical and mechanical sides of the industry, and Sutermeister's "Chemistry of Pulp and Paper Making," dealing primarily with the chemical aspects of the industry. The material covered by Sutermeister's book is best seen from the following list of chapter titles: Cellulose; fibrous raw materials: rags, esparto, straw, bamboo; the soda process; the sulphate process; the sulphite process; ground wood or mechanical pulp; bleaching, sizing, loading and filling materials; coloring; coated papers; water; testing wood pulps; paper testing; printing. The author has included all details which the chemist should have to enable him to grasp the methods of manufacture, but the book is in no way a treatise on the manufacturing details of the industry. The work is "written chiefly with the idea of

helping the young technical man, whether chemist or engineer, and it has therefore been assumed that the reader has a fair knowledge of the elements of chemistry."

Sutermeister is particularly well qualified to write such a treatise, since he has been engaged in the paper industry for twenty years, and he has combined the experiences of these years with a careful review of the literature. The industry is peculiar in that there are an unusually large number of variable factors which influence any one operation; it is not surprising, therefore, that the literature should be full of conflicting statements and opinions. In some cases an attempt has been made to reconcile these statements; in other cases both sides of the argument have been presented as fairly as possible. The reader will, therefore, find many lines of investigation indicated throughout the book. Thus in the chapter on bleaching the following are some of the problems indicated: "The conclusion that slight washing is not likely to prove injurious to the durability of the paper is counter to the generally accepted theories, but from the above experiment (p. 247) no other conclusion can be reached." "The folding and bursting strength of sulphate is not injured by bleaching . . ." Under the chapter on rosin the question is again raised regarding the use of so-called wood rosin in paper sizing. This apparently is not an entirely reliable method, but more conclusive tests should be carried out. Another question on sizing is the relation between the manner of drying and the sizing of the sheet. These are only a few of the many research problems that the paper maker will find as he carefully reads the book.

The book is well written and illustrated, and is well executed mechanically. The photomicrographs of the typical paper-making fibers and of the loading and filling materials, prepared by the Bureau of Standards, add much to the value and appearance of the work.

The pulp and paper industry is to be congratulated on this addition to an altogether too scanty scientific literature of the art.

CLARENCE JAY WEST.

Personal

Dr. E. Q. ADAMS, of the staff of the Bureau of Chemistry, has tendered his resignation and will take a position in the Nela laboratory of the National Lamp Works at Cleveland.

H. A. BERG, superintendent of blast furnace operations of the Midvale Steel & Ordnance Co. at Johnstown, Pa., has been appointed to succeed W. A. Maxwell, Jr., as assistant general superintendent of the Cambria Steel Co., Johnstown, Pa., the latter having resigned to accept the position of general superintendent of the Inland Steel Co., Indiana Harbor, Ind.

Dr. HENRY C. BOYNTON, metallurgist at the plant of the John A. Roebling's Sons Co., Trenton, N. J., gave an interesting address recently before the members of the local Rotary Club on the subject of the "Evolution of Wire Rope." The talk was illustrated with lantern slides.

R. B. BROWN, superintendent of the Chicago plant of the Sherwin-Williams Co., spoke before the Chicago Chemists Club recently, on the application of chemistry to paint and varnish industries.

A. E. DRUCKER, professor of metallurgical engineering at the Wisconsin School of Mines, went to the University of Illinois Feb. 1 as assistant professor of mining engineering.

Dr. GUSTAV EGLOFF was in New York for a few days last week.

F. C. FAIR has been placed in charge of the new chemical laboratory established by the Railway Signal Co., Hammond, Ind. This company has headquarters at Pittsburgh and manufactures fuses and torpedos for signaling on railroads.

WALTER J. GELDARD recently resigned as chief of the analytical section, Fixed Nitrogen Research Laboratory, and

has accepted a similar position with the International Coal Products Corporation of Newark, N. J.

WALTER F. GRAHAM has resigned as metallurgist with the Spicer Manufacturing Co., Plainfield, N. J., and is now associated with the Henry Souther Engineering Co., Hartford, Conn. Mr. Graham was formerly associated with the late Henry Souther as metallurgist for the Standard Roller Bearing Co., and subsequently with the Ferro Machine & Foundry Co. and the Ingersoll-Rand Co.

CHARLES HORVATH, research chemist for the International Motor Co., New Brunswick, N. J., resigned some months ago to become chief chemist for the National Metal Reduction Co., Newark, N. J., and the Atlantic Smelting & Refining Works of New York City, the plants of which are located in Newark.

J. C. INGRAM, who has for the past four years been chemical engineer in charge of the refinery, oil and soap division for the American Cotton Oil Co., Chicago, has resigned to accept a position as development engineer with Morris & Co. Mr. Ingram's activities will have to do with developing production problems through scientific application at the Chicago packing plant.

H. E. LABOUR, until recently president of the Chemical Equipment Co., has severed his connection, effective March 15, and will remain in Chicago, opening a consulting and sales office.

Major J. C. MILLS has joined the staff of the Chemical Warfare Service as chief chemical adviser to General Fries. During the war Major Mills went to France with the first gas regiment. He was one of the mainstays of the service throughout the struggle. To accept his present position, Major Mills retired from the faculty of the University of North Carolina.

Dr. R. B. MOORE, the chief chemist of the Bureau of Mines, will address the New York Section of the American Electrochemical Society on April 8. In view of the forthcoming visit of Mme. Marie Curie, he has chosen radium as his subject.

A. V. H. MORY, who has recently severed connections with Procter & Gamble Co., Cincinnati, Ohio, is associated with William Hoskins at 111 W. Monroe St., Chicago, on consulting work.

Dr. H. T. NIXON, formerly chief chemist at the Argentine refinery of the Sinclair Refining Co., recently resigned to become chief chemist for the C & C Developing Co., Kansas City, Mo., which concern applied the Cherry process for producing synthetic gasoline.

Dr. ARNOLD H. SMITH resigned his position as research chemist with the Goodyear Tire & Rubber Co., to assume the position of chief chemist with the Thermoid Rubber Co., Trenton, N. J.

Obituary

JAMES B. BROAD, Wilmington, Del., comptroller for E. I. du Pont de Nemours & Co., died March 13, at the Homœopathic Hospital from lung infection, caused by swallowing a tooth during a dental operation. He was forty-three years of age and had been connected with the company in various capacities since 1904. He became comptroller in 1918.

Dr. FRANK W. GUNSAULUS, president of Armour Institute, died March 17 at the age of sixty-five. He was stricken suddenly with heart disease and passed away two hours afterward at his home, 2919 Prairie Ave., Chicago, Ill.

JACOB HASSLACHER, founder of the firm of Roessler & Hasslacher, died on March 15 at his home in New York City. Born at Ems-am-Lahn, Germany, in 1852, he came to New York in 1884, and within five years started a most successful and influential career. Mr. Hasslacher leaves a widow, Mrs. Elizabeth Fleck Hasslacher; two sons, George and Carl, and four daughters, Misses Agnes, Toni, Thea and Emily.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, March 28, 1921.

There was no particularly marked improvement in the demand for chemicals during the past week. Intervals of buying have been followed by periods of extreme dullness; nevertheless, business in general is a shade better compared with the past few weeks. Expansion promises to be slow but steady and there is little in the present situation to inspire any strong optimistic tendencies. Perhaps it is better that it is so as there will be fewer vain regrets arising from the danger of an overextension of trade expansion. There were persistent reports from several directions of curtailed chemical production, while in some cases production has been temporarily suspended, as there is enough stock in second hands to take care of the demand at lower prices than producers can name. This condition is true among leading manufacturers of caustic soda. It is generally agreed that the peak of depression has passed, but how soon business will pick up is a problem only time can solve. Reductions in overhead and operating expenses are being made quite generally and seem to be working temporary hardships in many cases, but in the long run are expected to bring lower prices and normal conditions.

OTHER MARKETS STAGNANT

In trying to analyze the chemical market, it is well to look into other markets, as conditions are practically similar and a great deal rests upon the materialization of developments there. The primary and wholesale markets, which for a time have shown a spotty improvement, have in many cases become dormant again. Railway traffic and earnings are decreasing continually. Steel output has fallen to less than one-half of mill capacity. Production of coal has fallen to the lowest point in the past few years and building operations are lagging far behind the total of new construction known to be in immediate demand. Moderate liquidation from the reserve banks is reflected in the slight improvement in the reserve ratio of the federal reserve system, although a substantial part of this improvement is the result of gold importations which have continued uninterruptedly for the past year. Buyers as a result of existing conditions remain unwilling to contract for other than immediate necessities, which are at an extremely low figure.

The passing of the payment of the income tax for 1920 was a favorable feature. This had an unusually quieting effect on the chemical trade, but business seemed to become brisk again shortly after. The disposition on the part of some interests to sell English soda ash at \$1.90 per 100 lb. ex dock N. Y. is being watched very cautiously. Caustic soda held well owing to the suspension of production and consuming orders came into the market in better volume than in the past month. Business has been placed with a few textile and soap plants.

Reports from various quarters in the New England States show that textile mills are averaging about 70 per cent normal output. Some plants are operating at full capacity, while others have found the road harder to travel on account of the keen competition and have been unable to accomplish much more than one-half their total capacity production. With fall prices completed, the woolen industry seems to have improved and several American Woolen Co. plants have resumed operation on full-time schedule. Reductions in wages and lower prices for finished products are the principal factors responsible for the noticeable improvement among these mills. Reports from leading Western chemical producers were more optimistic than from local points.

Standard brands of *caustic soda* appear to be well held at the present time. Buyers demanding special makes are finding a stiff market. The general range was from \$3.70 @ \$3.80 per 100 lb. ex-warehouse and \$3.80 @ \$3.85 f.a.s.

Occasionally arrivals from interior points go at a slight concession, while outside makes can be purchased in the neighborhood of 3½c. per lb. Resale light *soda ash* is generally quoted at \$1.95 @ \$2.05 per lb. in single bags. Offerings of English material have left the market in a somewhat unsettled condition. The feeling is prevalent in the trade that producers will be forced to meet foreign competition, but as yet they have failed to do so. Barrels are quoted from \$2.10 @ \$2.25 per 100 lb., according to quantity. Contract prices remain unchanged at \$1.72½ per 100 lb., basis 48 per cent, in carlots f.o.b. works.

Imported 88-92 per cent *caustic potash* is offered at 10c. per lb. with odd lot sales noted down to 9½c. per lb. A peculiar position exists in this market due to the fact that the 70-75 per cent KOH is selling at a higher figure than the stronger variety. Exporters bought the 88-92 per cent almost exclusively during the past year and with the recent slump in the foreign markets all this material was reshipped to American ports and dumped into the market. Leading factors in *chlorate of potash* are asking 10 @ 12c. per lb. for prime American material. It is stated that a cheap lot of imported stock has been taken off the market. There are enough stray lots, however, that still can be purchased all the way down to 8c. per lb. The better grades of imported material are offered at 9 @ 10c. per lb. Small quantities of *yellow prussiate of potash* are being offered by dealers at 25 @ 27c. per lb. The red variety is in small supply, with the market quoted around 50c. per lb. Fused 60-62 per cent *sodium sulphide* is quoted at 5¼ @ 5½c. per lb. by second hands. The crystals, 30 per cent, are very scarce at present and buyers are finding difficulty in covering requirements of spot material. Spot *citric acid* is quoted firm, with sales at 47c. per lb. and sellers asking up to 48c. Continued strength prevails in the foreign market and 42c. per lb. for shipment from abroad is considered a very close figure. Some real business has recently been placed at these levels and the market for the coming season looks exceptionally favorable for early buying at the low prices.

A continued quiet inquiry for *bichromate of soda* has had a depressing influence on spot quotations during the past week and the market closed easy with a moderate amount of resale material of standard quality offered at 7½c. per lb. The range was from 7½ @ 7¾c. per lb., according to quantity. While resale stocks are not described as heavy, it is asserted that unless the demand improves a lower trading is likely to be established. Prices on *ammonium chloride* continued rather uncertain in the absence of any noted demand. Imported material is still to be had in good volume at prices well below those named by domestic producers. White granulated *sal ammoniac*, imported, is offered at 7½ @ 8c. per lb., with domestic prices around 10c. The gray variety is to be had at 8 @ 9c. per lb. A continued lack of interest has forced further recessions on *ammonium sulphate* and offers are now heard at \$2.75 @ \$2.85 per 100 lb. in single bags. Double bags for export are quoted down to 3c. per lb. Leading makers of *calcium acetate* are quoting on the former basis of \$2 per 100 lb., but there are offers in the market from outside manufacturers as low as \$1.50 per 100 lb. The weakness of acetic acid has prevented strength in this item.

According to figures on foreign trade recently issued by the Department of Commerce, increased imports and decreased exports in February as compared with January are shown in the following table:

	February, 1921	January, 1921
Exports	\$489,000,000	\$655,000,000
Imports	215,000,000	209,000,000
Totals	\$274,000,000	\$446,000,000
	February, 1920	January, 1920
Exports	\$5,127,000,000	\$5,230,000,000
Imports	2,757,000,000	3,235,000,000
Totals	\$2,370,000,000	\$1,995,000,000

COAL-TAR PRODUCTS

Although there was a difference of opinion expressed in various quarters on the action of the coal-tar products market, there surely was an expansion noted on the part of consumers and also on the volume of trading. Sales were confined to limited quantities, as the future needs are not being anticipated.

Intermediates have shown very little change during the week and while most producers have held quite close to last week's prices, there has been a tendency toward shading on firm business. There still seems to be quite a few resale lots of intermediates offered on the market, but the prices at which they were quoted did not reveal any marked concessions under prevailing levels. A fair volume of inquiries was noted, on the other hand, and in view of the fact that plants are producing on a smaller scale a scarcity of some commodities will eventually show on the market.

The crude market held steady and prices have practically shown no noticeable change, except in naphthalene flakes and balls, which are a trifle firmer in view of the more active demand at this time of the year.

Supplies of *diethylaniline* are available in fair volume in some directions. There has been very little interest shown by consumers, other than a quiet routine movement of small quantities. Prices ranged from \$1.25@1.30 per lb. The demand for *alpha naphthol* during the week has been very light and while the level of prices holds fairly steady for the crude at \$1.20 per lb, shading is possible in second hands at \$1.10@1.15. The position of *beta naphthol* seemed to be a trifle weaker, although quite a few factors claimed a better demand. First hands are firm in their views and quote the market at 40@43c. per lb. Resale material is available in fair volume down to 33c. per lb. Resale offerings of *paranitraniline* continue around 85c. per lb., but producers are still unwilling to sell below 95c.@\$1.05 per lb. for spot or prompt shipment. Makers are rather inclined to doubt the quality of resale material which has been out of their hands for some time. Contracts are offered by manufacturers at \$1.15 per lb., although shading is quite possible on firm business.

The Chicago Market

CHICAGO, March 25, 1921.

Quiet conditions still prevail in the market for industrial chemicals. Reports from some quarters indicate that a fair volume of business is being done, although only in small packages. Consumers are still adverse to anticipate and are buying only for their immediate requirements.

Soda ash, 58 per cent, continues to be firm and is quoted in barrels at \$3.10 per 100 lb. for small quantities. *Caustic soda*, 76 per cent, is quoted as high as \$4.25 per 100 lb. in ton lots. *Salsoda* is moving in a small way at 2½c. per lb. *Bleaching powder* is very dull, and is quoted at 3½c. in 700-lb. drums.

Producers' agents are offering *formaldehyde* at 16½c. and are doing considerable business at this figure. Most of the resale material is now out of the market and the first hands are again able to compete. Spot *potassium chlorate* crystals are available at 13c., but most factors report little business. *Caustic potash*, 88-92 per cent, is quoted in 700-lb. drums at 11½c., but with actual business in sight this could probably be bettered. *Potassium carbonate*, 80-85 per cent, is offered at 15½c. in casks. *Glycerine*, c.p., is lower and refiners now quote 18c. per lb. in drums. The new level for non-beverage *ethyl alcohol* is \$4.85 per gal. in single drums, and is moving in a fair way. The continued mild winter has had its effect on the *denatured alcohol* market, distillers quoting 40c. per gal. in five-drum lots on the 188 deg. proof completely denatured, while a wide range of prices can be obtained from resellers. *Wood alcohol*, 95 per cent, continues weak, and is quoted at 85c. in barrels, or 77c. in drums.

Quicksilver is very quiet and is quoted from \$48@\$52 per flask. *Ammonia*, 26 deg., is available at 7½c. in drums. White granular *ammonium chloride* is offered at 11½c. in single barrels, but very little is moving. Imported *barium chloride* is offered at \$80 per ton in cask lots. Some interests report a fair volume of small business in *lead acetate*, white crystal, at 15c. per lb. Spot *sodium dichromate* can be had at 9½c., with somewhat better prices on material for prompt shipment from the works. *Potassium dichromate* is offered to arrive at 16c., but it is doubtful if much business could be done at this figure.

The general list of acids is firm and quiet, with the exception of *acetic acid*. The *glacial* is now offered by makers at \$11.25 per 100 lb. in lots of fifteen to twenty barrels.

The 28 per cent is moving in a very fair way at 2½c. in barrels and 3½c. in carboys. *Muriatic acid*, 18 deg., is offered at from 1½@2½c., depending upon the quantity. *Sulphuric acid*, 66 deg., is quoted around \$20 per ton, but, like the rest of the list, is very quiet. *Oleum* can be had for \$3.10 per 100 lb. in drums. Imported *oxalic acid* is offered on spot at 19½c. in single casks, while producers continue to quote 25c. for the domestic.

VEGETABLE OILS

The vegetable oil market is extremely quiet and business in most of the oils is confined to unusually small parcels. The trade appears to have adopted a waiting policy and buyers are holding off pending developments in the general situation. *Coconut oil* is quoted at 10½c., but very little is moving. *Linseed oil* is offered at 69c. in single barrels, but, owing to the quietness in the paint trade, very little is being sold.

NAVAL STORES

Conditions in the local naval stores trade have undergone little change and a quiet tone was reported in all quarters. *Turpentine* is quoted at 58c. in drums, the demand being light. *Rosin* is offered at \$7.35 for the WG with corresponding prices for the other grades.

COAL-TAR PRODUCTS

Business in coal-tar products is still very dull, although encouraging reports are heard in some quarters. There is an ample supply of *benzene* available at 31c. per gal. for the 90 per cent and 33c. for the 100 per cent in lots of one to ten drums. Refined *toluol* can be obtained for 33c. per gal. There is little demand for *naphthalene flakes*, which are being held on spot for 10½c. in small lots.

The Iron and Steel Market

PITTSBURGH, March 25, 1921.

The slight improvement in demand for steel products noted a week ago has grown. There is distinctly noticeable a greater call for steel products, particularly for merchant bars, standard steel pipe and sheets. The week's news of structural work shows a larger tonnage, but this may prove ephemeral. In the other products mentioned the call is widespread, there being numerous small lots.

Careful scrutiny does not indicate that the increased call for steel is a seasonal affair, due to the arrival of spring. Rather it is due to the technical condition of the trade, there having been for weeks a particularly rigid curtailment by all buyers, while they reduced inventories. Such an extreme lightness of demand could not continue indefinitely, as it was far below the rate of actual consumption.

The total of demand now, however, is still small. There is merely improvement in the rate. Absolutely fresh buying remains very light, the improvement in the call for material being chiefly by way of releases on orders, shipment against which had been held up. The rate of production of steel continues to decline, shipments having been in excess of specifications and orders, and a further decline in production is to be expected in the next few weeks, until demand increases sufficiently to effect a turn.

The United States Steel Corporation's production last week, measured by ingots, was about 49 per cent of capacity. This week production is slightly less, probably about 45 per cent. The common estimate now is that the independents are operating at 20 per cent or less. These percentages would make rates of production of 10,000,000 tons of ingots a year by the Steel Corporation and 6,000,000 tons by the independents, the 16,000,000 tons being 30 per cent of the present estimate of capacity or 53 per cent of the average rate in 1912 and 1913, the two best tonnage years before the war, when there appeared to be a widespread demand for steel products for practically all employments. Now there appears to be scarcely any consumption, and from this viewpoint the actual production is high rather than low.

PRICES

On carload lots with fairly desirable specifications bars are still quotable at 2c. and shapes and plates at 2.10c. Concessions possible from these figures for really large lots

are if anything smaller than obtainable a month ago. Black sheets remain at 3.85c. for carload lots with desirable specifications. Galvanized sheets in carload lots may be quoted at 4.90c., or \$2 a ton less than a week ago. The spread of 1.05c. between black and galvanized is equal to the average spread in the ten years before the war. Zinc is considerably lower, while wages are higher.

STANDARD STEEL PIPE LOWER

Standard steel pipe has now joined the list of steel products on which Industrial Board or Steel Corporation prices are shaded. Several independent mills now quote an extra 2½ per cent in addition to the customary trimmings from the published list, which has a basing discount of 57½ per cent. It is reported that in some cases an extra 5 per cent is given, the extra discounts representing approximately \$2 and \$4 a ton respectively from the prices hitherto held. It is reported that several mills have put out a price guarantee.

Tin plate is now the only important steel product in the independent market remaining at the Steel Corporation or Industrial Board price. Tin plate is held at the \$7 price chiefly perhaps because mills recognize that if cutting once began it could not be stopped.

STEEL CORPORATION POSITION

The wisdom of the Steel Corporation's continued policy of maintaining its prices is being more generally commended. It is plainly seen that price reductions do not bring out additional business, that consumers do not wish to make commitments at this time, and that indeed many buyers prefer to see prices maintained, as facilitating their disposal of material already on hand. That the Steel Corporation will eventually reduce its prices, and will reduce them quite sharply, is commonly believed. Opinion differs as to whether the corporation will reduce prices first and wages afterward or will act on both subjects at the same time. It seems improbable that the corporation will maintain present prices and wages longer than until May 1.

PIG IRON

Sufficient movement of basic pig iron out of stocks of steel interests has occurred to force recognition of the steel works as making the pig iron market. Steel interests have sold basic at \$23 valley, and are willing, even anxious, to sell more at the same price. The merchant furnaces continue to quote their former price of \$25, which is below their recent or even present cost of production, including overhead, but the steel interests can probably figure that iron sold at \$23 can later be replaced at a lower cost, without allowance for overhead. Bessemer remains quotable nominally at \$27 valley, but it is understood that it has been offered in limited quantities by dealers at \$25. Foundry iron, recently quotable at \$26 valley, can now be had at \$25.

SEMI-FINISHED STEEL

There are dilettante negotiations between sheet mills and steel mills on sheet bars. The sheet mills do not make bids, and do not close when offered sheet bars at \$38. Standard billets are nominally at the same price as sheet bars. Small billets have been quoted at \$40.

STEEL PROSPECTS

The volume of demand for steel in the next few months is regarded as hingeing chiefly upon two factors, the matter of German reparations and the attitude of labor in the building trades. Settlement of the reparations question would greatly improve general sentiment and would probably stimulate business to an extent. Reductions in the wage scales of the building trades would in all probability materially stimulate building, which is now at a low ebb. That any very large tonnage demand for steel would be created by a wave of dwelling house construction is obviously improbable. The large consumption of steel lies rather in hotel and skyscraper buildings and in power development. The oil country demand for tubular goods may easily revive. Oil prices are down, but if the cost of drilling is correspondingly reduced the oil industry will be more promising than in 1920.

General Chemicals CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	—	\$0.40 - \$0.45
Acetone.....lb.	\$0.13 - \$0.13½	.13½ - .14
Acid, acetic, 28 per cent.....100 lbs.	2.50 - 2.75	3.00 - 3.25
Acetic, 56 per cent.....100 lbs.	4.00 - 4.25	4.50 - 5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	9.00 - 9.50	10.00 - 10.50
Boric, crystals.....lb.	.14½ - .15	.15½ - .16
Boric, powder.....lb.	.15½ - .16½	.17 - .18
Citric.....lb.	—	.47 - .50
Hydrochloric.....100 lb.	1.75 - 2.00	2.10 - 2.25
Hydrofluoric, 52 per cent.....lb.	.13 - .13½	.14 - .14½
Lactic, 44 per cent tech.....lb.	.10 - .11	.11½ - .12
Lactic, 22 per cent tech.....lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.	—	—
Nitric, 40 deg.....lb.	.06½ - .07	.07½ - .07¾
Nitric, 42 deg.....lb.	.07½ - .08	.08½ - .08¾
Oxalic, crystals.....lb.	.16½ - .17	.17½ - .18
Phosphoric, Ortho, 50 per cent solution.....lb.	.15 - .15½	.16 - .16½
Picric.....lb.	.30 - .32	.35 - .40
Pyrogallol, resublimed.....lb.	—	1.90 - 2.15
Sulphuric, 60 deg., tank cars.....ton	—	15.00 - 16.00
Sulphuric, 60 deg., drums.....ton	—	—
Sulphuric, 66 deg., tank cars.....ton	19.00 - 20.00	—
Sulphuric, 66 deg., drums.....ton	22.00 - 22.50	23.00 - 23.50
Sulphuric, 66 deg., carboys.....ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 - 24.00	—
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 - 35.00	40.00 - —
Tannic, U. S. P.....lb.	—	1.15 - 1.25
Tannic (tech.).....lb.	.45 - .47	.48 - .50
Tartaric, crystals.....lb.	—	.36 - .40
Tungstic, per lb. of WO.....lb.	—	1.30 - 1.40
Alcohol, Ethyl.....gal.	—	4.90 - 5.25
Alcohol, Methyl (see methanol).....gal.	—	—
Alcohol, denatured, 188 proof.....gal.	—	.40 - .45
Alcohol, denatured, 190 proof.....gal.	—	.50 - .54
Alum, ammonia lump.....lb.	.04½ - .04½	.04½ - .05
Alum, potash lump.....lb.	.05½ - .06	.06½ - .07
Alum, chrome lump.....lb.	.13 - .13½	.14 - .14½
Aluminum sulphate, commercial.....lb.	.02½ - .02½	.02½ - .03
Aluminum sulphate, iron free.....lb.	.03 - .03½	.03½ - .03¾
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07 - .07½	.07½ - .08
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 - .32	.33 - .35
Ammonium carbonate, powder.....lb.	.10 - .11	.11½ - .12
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	.07½ - .07¾	.08 - .08½
Ammonium chloride, granular (gray salamoniac).....lb.	.08 - .08½	.09 - .09½
Ammonium nitrate.....lb.	.08 - .08½	.09 - .10
Ammonium sulphate.....100 lb.	2.90 - 3.00	3.10 - 3.20
Amylacetate.....gal.	—	4.00 - 4.25
Amylacetate tech.....gal.	—	3.25 - 3.50
Arsenic oxide, (white arsenic) powdered lb.	.08 - .08½	.09 - .10
Arsenic, sulphide, powdered (red arsenic) lb.	.12 - .12½	.13 - .14
Barium chloride.....ton	65.00 - 70.00	75.00 - 80.00
Barium dioxide (peroxide).....lb.	.19 - .20	.21 - .22
Barium nitrate.....lb.	.10 - .10½	.10½ - .11
Barium sulphate (precip.) (blanc fixe).....lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calc. hypochlorite).....lb.	—	—
Blue vitriol (see copper sulphate).....lb.	—	—
Borax (see sodium borate).....lb.	—	—
Brimstone (see sulphur, roll).....lb.	—	—
Bromine.....lb.	.40 - .41	.42 - .45
Calcium acetate.....100 lbs.	1.60 - 2.00	—
Calcium carbide.....lb.	.04 - .04½	.04½ - .05
Calcium chloride, fused, lump.....ton	27.00 - 29.00	30.00 - 32.00
Calcium chloride, granulated.....lb.	.01½ - .01½	.02 - .02½
Calcium hypochlorite (bleach'g powder) lb.	.02½ - .02½	.03 - .03½
Calcium peroxide.....lb.	—	1.25 - 1.50
Calcium phosphate, tribasic.....lb.	—	.15 - .16
Camphor.....lb.	—	.70 - .75
Carbon bisulphide.....lb.	.08 - .08½	.09 - .09½
Carbon tetrachloride, drums.....lb.	.10 - .10½	.11 - .12
Carbonyl chloride (phosgene).....lb.	—	.75 - 1.00
Caustic potash (see potassium hydroxide).....lb.	—	—
Caustic soda (see sodium hydroxide).....lb.	—	—
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08 - .09	.09½ - .10
Chloroform.....lb.	—	.38 - .40
Cobalt oxide.....lb.	—	3.00 - 3.10
Copperas (see iron sulphate).....lb.	—	—
Copper carbonate, green precipitate.....lb.	.22 - .23	.24 - .25
Copper cyanide.....lb.	—	.55 - .63
Copper sulphate, crystals.....lb.	.05½ - .05½	.05½ - .06½
Cream of tartar (see potassium bitartrate).....lb.	—	—
Epsom salt (see magnesium sulphate).....lb.	—	—
Ethyl Acetate Com. 85%.....gal.	—	.90 - 1.00
Ethyl Acetate pure (acetic ether 98% to 100%).....gal.	—	—
Formaldehyde, 40 per cent.....lb.	.15½ - .16	.16 - .16½
Fusel oil, ref.....gal.	—	3.50 - 3.75
Fusel oil, crude.....gal.	—	2.00 - 2.25
Glauber's salt (see sodium sulphate).....lb.	—	—
Glycerine, C. P. drums extra.....lb.	—	.18 - .19
Iodine, resublimed.....lb.	—	3.75 - 3.85
Iron oxide, red.....lb.	—	.10 - .20
Iron sulphate (copperas).....100 lb.	1.05 - 1.10	1.20 - 1.40
Lead acetate.....lb.	—	.13½ - .14½
Lead arsenate.....lb.	.11 - .12	.12½ - .13
Lead nitrate.....lb.	—	.15 - .20
Litharge.....lb.	.08½ - .09	.09½ - .10
Lithium carbonate.....lb.	—	1.25 - —
Magnesium carbonate, technical.....lb.	.10½ - .11	.11½ - .12
Magnesium sulphate, U. S. P.....100 lb.	2.75 - 3.00	—
Magnesium sulphate, commercial.....100 lb.	—	2.25 - 2.50
Methanol, 95%.....gal.	—	.75 - .77
Methanol, 97%.....gal.	—	.78 - .82
Nickel salt, double.....lb.	—	.12 - .12½
Nickel salt, single.....lb.	—	.13 - .13½
Phosgene (see carbonyl chloride).....lb.	—	—
Phosphorus, red.....lb.	.45 - .46	.47 - .50
Phosphorus, yellow.....lb.	—	.35 - .37
Potassium bichromate.....lb.	.12 - .13	.13½ - .14

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar).... lb.	\$.35 — .40	\$0.30 — \$0.35
Potassium bromide, granular..... lb.	.35 — .40	.20 — .40
Potassium carbonate, U. S. P..... lb.	.08 — .08½	.45 — .50
Potassium carbonate, crude..... lb.	.08 — .10	.09 — .10
Potassium chlorate, crystals..... lb.	.08 — .10	.11 — .15
Potassium cyanide..... lb.	.09½ — .10	.40 — .45
Potassium hydroxide (caustic potash).... lb.	.09½ — .10	.10½ — .11½
Potassium muriate..... ton	60.00 — 70.00	
Potassium iodide..... lb.	.09½ — .09½	2.75 — 3.00
Potassium nitrate..... lb.	.09½ — .09½	.10 — .12½
Potassium permanganate..... lb.	.45 — .46	.48 — .50
Potassium prussiate, red..... lb.	.50 — .52	.53 — .55
Potassium prussiate, yellow..... lb.	.25 — .26	.27 — .28
Potassium sulphate (powdered)..... per unit		2.15 — 2.25
Rochelle salts (see sodium potas. tartrate).....		
Sal ammoniac (see ammonium chloride).....		
Sal soda (see sodium carbonate).....		
Salt cake..... ton		32.00 — 34.00
Silver cyanide..... oz.		1.30 — 1.35
Silver nitrate..... oz.		.38 — .40
Soda ash, light..... 100 lb.	1.95 — 2.10	2.15 — 2.40
Soda ash, dense..... 100 lb.	2.20 — 2.30	2.40 — 2.60
Sodium acetate..... lb.	.05½ — .05½	.06 — .06½
Sodium bicarbonate..... 100 lb.	2.60 — 2.75	3.00 — 3.25
Sodium bichromate..... lb.	.07½ — .07½	.07½ — .08
Sodium bisulphate (nitre cake)..... ton	6.00 — 6.25	7.00 — 8.00
Sodium bisulphite powdered, U.S.P..... lb.	.05½ — .05½	.06 — .06½
Sodium borate (borax)..... lb.	.07½ — .08	.08½ — .08½
Sodium carbonate (sal soda)..... 100 lb.	1.90 — 2.00	2.25 — 2.50
Sodium chlorate..... lb.	.10 — .10½	.10½ — .11
Sodium cyanide, 96-98 per cent..... lb.	.18 — .20	.22 — .30
Sodium fluoride..... lb.	.12 — .12½	.13 — .14
Sodium hydroxide (caustic soda)..... 100 lb.	3.60 — 3.70	3.80 — 4.00
Sodium hyposulphite..... lb.		.03½ — .04
Sodium nitrate..... 100 lb.	2.75 —	2.85 —
Sodium nitrite..... lb.	.06 — .06½	.06½ — .07
Sodium peroxide, powdered..... lb.	.30 — .31	.32 — .34
Sodium phosphate, dibasic..... lb.	.04½ — .04½	.05 — .05½
Sodium potassium tartrate (Rochelle salts) lb.		.27 — .28
Sodium prussiate, yellow..... lb.	.13 — .13½	.13½ — .14
Sodium silicate, solution (40 deg.)..... lb.	1.25 — 1.35	1.40 — 1.50
Sodium silicate, solution (60 deg.)..... lb.	.03 — .03½	.03½ — .03½
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.75 — 2.00	2.25 — 2.50
Sodium sulphide, crystal, 60-62 per cent (conc.) lb.	.05½ — .05½	.05½ — .06
Sodium sulphite, crystals..... lb.	.04 — .04½	.04½ — .05
Strontium nitrate, powdered..... lb.	.15 — .15½	.16 — .17
Sulphur chloride, red..... lb.	.07 — .07½	.07½ — .08
Sulphur, crude..... ton	18.00 — 20.00	
Sulphur dioxide, liquid, cylinders..... lb.	.08 — .08½	.09 — .10
Sulphur (sublimed), flour..... 100 lb.		2.25 — 3.10
Sulphur, roll (brimstone)..... 100 lb.		2.00 — 2.75
Tin bichloride, 50 per cent..... lb.	.18 — .19	
Tin oxide..... lb.		.40 — .42
Zinc carbonate, precipitate..... lb.	.16 — .18	.19 — .20
Zinc chloride, gran..... lb.	.11 — .11½	.11½ — .12
Zinc cyanide..... lb.	.45 — .49	.50 — .60
Zinc dust..... lb.	.12 — .13	.13½ — .14
Zinc oxide, XX..... lb.	.08½ — .09	.09½ — .10
Zinc sulphate..... lb.	.03½ — .03½	.04 — .05

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.15 — \$1.25
Alpha-naphthol, refined..... lb.	1.45 — 1.50
Alpha-naphthylamine..... lb.	.38 — .40
Aniline oil, drums extra..... lb.	.20 — .26
Aniline salts..... lb.	.26 — .29
Anthracene, 80% in drums (100 lb.)..... lb.	.75 — 1.00
Benzaldehyde U.S.P..... lb.	1.00 — 1.50
Benzidine, base..... lb.	.90 — 1.00
Benzidine sulphate..... lb.	.75 — .80
Benzoic acid, U.S.P..... lb.	.65 — .70
Benzoate of soda, U.S.P..... lb.	.65 — .70
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.30 — .35
Benzene, 90%, in drums (100 gal.)..... gal.	.28 — .32
Benzyl chloride, 95-97%, refined..... lb.	.28 — .30
Benzyl chloride, tech..... lb.	.25 — .27
Beta-naphthol benzoate..... lb.	3.50 — 4.00
Beta-naphthol, sublimed..... lb.	.70 — .75
Beta-naphthol, tech..... lb.	.33 — .45
Beta-naphthylamine, sublimed..... lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)..... lb.	.23 — .25
Cresylic acid, 97-99%, straw color, in drums..... gal.	.90 — .95
Cresylic acid, 95-97%, dark, in drums..... gal.	.85 — .90
Cresylic acid, 50%, first quality, drums..... gal.	.55 — .60
Dichlorobenzene..... lb.	.06 — .09
Diethylaniline..... lb.	1.25 — 1.30
Dimethylaniline..... lb.	.50 — .60
Dinitrobenzene..... lb.	.30 — .32
Dinitrochlorobenzene..... lb.	.25 — .30
Dinitronaphthalene..... lb.	.33 — .35
Dinitrophenol..... lb.	.40 — .45
Dinitrotoluene..... lb.	.25 — .27
Dip oil, 25%, tar acids, car lots, in drums..... gal.	.38 — .40
Diphenylamine..... lb.	.60 — .70
H-acid..... lb.	1.30 — 1.50
Meta-phenylenediamine..... lb.	1.20 — 1.25
Monochlorobenzene..... lb.	.14 — .16
Monoethylaniline..... lb.	1.90 — 2.00
Naphthalene crushed, in bbls. (250 lb.)..... lb.	.08 — .08½
Naphthalene, flake..... lb.	.08 — .08½
Naphthalene, balls..... lb.	.09½ — .10½
Naphthionic acid, crude..... lb.	.70 — .75
Nitrobenzene..... lb.	.12 — .15
Nitro-naphthalene..... lb.	.30 — .35
Nitro-toluene..... lb.	.16 — .18
Ortho-amidophenol..... lb.	3.20 — 3.75
Ortho-dichlor-benzene..... lb.	.15 — .20
Ortho-nitro-phenol..... lb.	.75 — .80
Ortho-nitro-toluene..... lb.	.17 — .20
Ortho-toluidine..... lb.	.25 — .30
Para-amidophenol, base..... lb.	1.90 — 2.00
Para-amidophenol, HCl..... lb.	2.10 — 2.20

Para-dichlorobenzene..... lb.	.15 — .20
Paranitroaniline..... lb.	.85 — .90
Para-nitrotoluene..... lb.	.90 — 1.05
Para-phenylenediamine..... lb.	1.90 — 2.00
Para-toluidine..... lb.	1.25 — 1.60
Phthalic anhydride..... lb.	.50 — .60
Phenol, U. S. P., drums (dest.), (240 lb.)..... lb.	.12 — .14
Pyridine..... gal.	2.00 — 3.50
Resorcinol, technical..... lb.	1.85 — 2.00
Resorcinol, pure..... lb.	2.30 — 2.50
Salicylic acid, tech., in bbls. (110 lb.)..... lb.	.22 — .23
Salicylic acid, U. S. P..... lb.	.25 — .27
Salol..... lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.28 — .32
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.16 — .18
Sulphanilic acid, crude..... lb.	.30 — .35
Tolidine..... lb.	1.35 — 1.45
Toluidine, mixed..... lb.	.40 — .45
Toluene, in tank cars..... gal.	.28 — .32
Toluene, in drums..... gal.	.30 — .35
Xylidines, drums, 100 gal..... lb.	.40 — .45
Xylene, pure, in drums..... gal.	.42 — .45
Xylene, pure, in tank cars..... gal.	.45 — .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 — .35
Xylene, commercial, in tank cars..... gal.	.30 — .35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.24 — \$0.26
Beeswax, refined, light..... lb.	.27 — .28
Beeswax, white pure..... lb.	.40 — .45
Carnauba, Florida..... lb.	.68 — .70
Carnauba, No. 2, North Country..... lb.	.30 — .32
Carnauba, No. 3, North Country..... lb.	.18 — .19
Japan..... lb.	.19½ — .20
Montan, crude..... lb.	.07 — .08
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03½ — .03½
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.02½ — .03
Paraffine waxes, refined, 118-120 m.p..... lb.	.04 — .04½
Paraffine waxes, refined, 125 m.p..... lb.	.04½ — .05
Paraffine waxes, refined, 128-130 m.p..... lb.	.05 — .06
Paraffine waxes, refined, 133-135 m.p..... lb.	.06 — .06½
Paraffine waxes, refined, 135-137 m.p..... lb.	.06½ — .06½
Stearic acid, single pressed..... lb.	.11 — .11
Stearic acid, double pressed..... lb.	.11½ — .11½
Stearic acid, triple pressed..... lb.	.12 — .12½

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.70
Pine oil, pure, dest. dist..... gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.36
Turpentine, crude, sp. gr. 0.900-0.970..... gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.37
Pinewood creosote, ref..... gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl..... 280 lb.	\$5.50 —
Rosin E-I..... 280 lb.	5.75 —
Rosin K-N..... 280 lb.	6.00 —
Rosin W. G.-W. W..... 280 lb.	6.25 —
Wood rosin, bbl..... 280 lb.	6.75 —
Spirits of turpentine..... gal.	.57 —
Wood turpentine, steam dist..... gal.	.56 —
Wood turpentine, dest. dist..... gal.	.55 —
Pine tar pitch, bbl..... 200 lb.	7.00 —
Tar, kiln burned, bbl. (500 lb.)..... bbl.	14.50 —
Retort tar, bbl..... 500 lb.	15.00 — 14.75
Rosin oil, first run..... gal.	.45 —
Rosin oil, second run..... gal.	.48 —
Rosin oil, third run..... gal.	.60 —

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41
70-72 deg., steel bbls. (85 lb.)..... gal.	.39
68-70 deg., steel bbls. (85 lb.)..... gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30

Crude Rubber

Para-Upriver fine..... lb.	\$0.17 — \$0.18
Upriver coarse..... lb.	.13 — .14
Upriver caucho ball..... lb.	.19 — .14½
Plantation—First latex crepe..... lb.	.17½ —
Ribbed smoked sheets..... lb.	.18 —
Brown crepe, thin, clean..... lb.	.20 —
Amber crepe No. 1..... lb.	.20 —

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.08½ — \$0.08½
Castor oil, AA, in bbls..... lb.	.09½ — .10
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.07½ — .08
Cocoonut oil, Ceylon grade, in bbls..... lb.	.09½ — .09½
Cocoonut oil, Cochín grade, in bbls..... lb.	.09½ — .10
Corn oil, crude, in bbls..... lb.	.08 — .08½
Cottonseed oil, crude (f. o. b. mill)..... lb.	.04½ —
Cottonseed oil, summer yellow..... lb.	.06½ —
Cottonseed oil, winter yellow..... lb.	.07 — .07½
Linseed oil, raw, car lots (domestic)..... gal.	.65 —
Linseed oil, raw, tank cars (domestic)..... gal.	.58 —
Linseed oil, in 5-bbl lots (domestic)..... gal.	.68 — .70

Olive oil, commercial.....	gal.	\$2.00	—	\$2.50
Palm, Lagos.....	lb.	.07	—	.07½
Palm, Niger.....	lb.	.06½	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.05½	—	.05
Peanut oil, refined, in bbls.....	lb.	.11	—	.11
Rapeseed oil, refined in bbls.....	gal.	1.05	—	1.10
Rapeseed oil, blown, in bbls.....	gal.	1.15	—	1.20
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07	—	.07½
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.04½	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.45	—	\$0.47
Yellow bleached menhaden.....	gal.	.47	—	.....
White bleached menhaden.....	gal.	.49	—	.....
Blown menhaden.....	gal.	.84	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	.....
Blanc fixe, dry.....	lb.	.05	—	.05½
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.16
Chalk, domestic, extra light.....	lb.	.05	—	.05½
Chalk, domestic, light.....	lb.	.04½	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04½	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mires.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Fla.....	net ton	25.00	—	.....
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	30.00	—	35.00
Graphite, Ceylon lump, first quality.....	lb.	.08	—	.09
Graphite, Ceylon chip.....	lb.	.07	—	.08
Graphite, higher lubricating grades.....	lb.	.11	—	.40
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.57	—	.....
Shellac, orange superfine.....	lb.	.60	—	.....
Shellac, A. C. garnet.....	lb.	.45	—	.....
Shellac, T. N.....	lb.	.45	—	.....
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	14.00	—	15.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	40.00	—	50.00
Talc, California talcum powder grade.....	ton	20.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	.....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	80-100	.....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	45-50	.....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	.....	55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	.....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	.....
Magnesite brick, 9-in. straight.....	net ton	100	.....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105	.....
Magnesite brick, soaps and splits.....	net ton	120	.....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	65-70	.....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	56-61	.....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	50-60	.....

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.15	—	.....
Ferrochrome per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.15	—	.16
Ferromanganese, 76-80% Mn, domestic.....	gross ton	90.00	—	95.00
Ferromanganese, 76-80% Mn, English.....	gross ton	90.00	—	95.00
Spiegelisen, 18-22% Mn.....	gross ton	30.00	—	35.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50	—	.....
Ferrosilicon, 10-15%.....	gross ton	50.00	—	55.00
Ferrosilicon, 50%.....	gross ton	85.00	—	90.00
Ferrosilicon, 75%.....	gross ton	145.00	—	150.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.50	—	.55
Ferroureanum, 35-50% of U, per lb. of U content.....	lb.	6.00	—	.....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00	—	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.45	—	.50
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.45	—	.50
Coke, foundry, f.o.b. ovens.....	net ton	5.50	—	6.00
Coke, furnace, f.o.b. ovens.....	net ton	4.50	—	5.00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00	—	16.00
Fluorspar, lump, f.o.b. Heathden, New Mexico.....	net ton	17.50	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	—	25.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.35	—	.40
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.16	—	.....
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.16½	—	.....
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	—	3.25
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	.....
Zircon, washed, iron free.....	lb.	.03	—	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.00
Aluminum, 98 to 99 per cent.....	28.3 @ 28.5
Antimony, wholesale lots, Chinese and Japanese.....	5½ @ 5½
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	.35
Monel metal ingots.....	.38
Monel metal, sheet bars.....	.40
Tin, 5-ton lots.....	28.50
Lead, New York, spot.....	4.00 @ 4.20
Lead, E. St. Louis, spot.....	4.00
Zinc, spot, New York.....	7.00
Zinc, spot, E. St. Louis.....	4.70

OTHER METALS

Silver (commercial).....	oz.	\$0.56½
Cadmium.....	lb.	1.10
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.65
Cobalt.....	lb.	4.50
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00-75.00
Iridium.....	oz.	250.00 @ 300.00
Palladium.....	oz.	65.00 @ 70.00
Mercury.....	75 lb.	46.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per Lb.

Copper sheets, hot rolled.....	20.50
Copper bottoms.....	28.00
Copper rods.....	18.75
High brass wire.....	18.25
High brass rods.....	15.25
Low brass wire.....	20.25
Low brass rods.....	20.25
Brazed brass tubing.....	29.50
Brazed bronze tubing.....	34.25
Seamless copper tubing.....	22.00
Seamless high brass tubing.....	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York				
	Current	One Year Ago	Cleveland	Chicago	
Copper, heavy and crucible....	8.50@ 9.00	18.50	10.00	10.50	
Copper, heavy and wire.....	8.00@ 8.25	16.50	9.50	9.50	
Copper, light and bottoms.....	7.00@ 7.50	14.50	9.00	8.50	
Lead, heavy.....	3.00@ 3.50	7.25	4.00	4.00	
Lead, tea.....	2.00@ 2.12½	5.25	3.00	3.00	
Brass, heavy.....	4.25@ 4.50	9.50	7.00	10.00	
Brass, light.....	3.00@ 3.25	8.00	5.00	5.50	
No. 1 yellow brass turnings....	4.00@ 4.25	9.50	5.50	6.00	
Zinc.....	2.00@ 2.50	5.00	3.00	3.50	

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	*Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes.....	\$3.60	\$3.80	\$3.47	\$3.58	\$3.37	\$3.58	\$3.47
Soft steel bars.....	3.80	3.70	3.52	3.34	3.27	3.48	3.52
Soft steel bar shapes.....	3.80	3.70	3.52	3.48	3.27	3.48	3.52
Soft steel bands.....	4.20	4.65	4.22	6.25	.....	.....	.....
Plates, ½ to 1 in. thick.....	3.80	4.00	3.67	3.78	3.57	3.78	3.67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

GOLDEN—The Colorado Feldspar, Flint & Mica Co., Denver, Col., has preliminary plans under way for the construction of a new plant at Golden, to comprise a complete crushing and grinding mill.

Connecticut

BRIDGEPORT—The American Tube & Stamping Co., Stratford Ave., has filed plans for the erection of a new 2-story laboratory building, 30 x 40 ft. It will be used for chemical, physical and other experimental work, divided into seven departments.

Georgia

SAVANNAH—The Atlantic Turpentine & Pine Tar Co., Central Junction, near Savannah, is planning for the rebuilding of its plant recently destroyed by fire. The loss is estimated at \$150,000, instead of \$75,000, as previously announced. D. S. Owen is manager.

Idaho

WEISER—The Idaho Clay Products Co. is planning for the early erection of its proposed new local branch plant, to be located at clay properties near the city.

Indiana

HARTFORD CITY—The Fort Wayne Corrugated Paper Co. is making a number of improvements in its local plant during a curtailment period, and plans for the resumption of operations at an early date.

WINAMAC—The Winamac Cement Product & Construction Co. has been organized to take over the cement tile manufacturing plant of the Winamac Tile Co. The new company is said to be planning for a number of improvements in the plant. It is headed by Christopher Hanson, George and John Kenzick.

SUMMITVILLE—The Crystal Glass Co. has awarded a contract to the L. J. Drummond Co., Elwood, Ind., for extensions and improvements in its plant. A number of new gas producers, tanks and other equipment will be installed.

Kentucky

LOUISVILLE—The Magic Soap Co., recently organized, has acquired the property of the Magic Soap Products Co. at a receiver's sale for a consideration of \$160,000. The new company will continue the operation of the plant and is said to be planning for a number of improvements. M. O. Curd is president and L. L. Daugherty treasurer.

Louisiana

SHREVEPORT—The United States Window Glass Co., Morgantown, W. Va., will increase the size of its proposed new plant at Jewella, near Shreveport, with total investment of over \$2,000,000 instead of about \$1,000,000 as previously arranged. Plans are under way for the plant and it is expected to inaugurate operations at an early date. Walter A. Jones is president.

NEW IBERIA—The Charles Boldt Pulp Co., has awarded a contract to the Mac-Cabe Construction Co., Cincinnati, Ohio, for extensions in its plant to cost about \$40,000.

Maryland

FAIRFIELD—The Prudential Oil Co. has acquired about 30 acres of property at Fairfield, in the vicinity of its present works, known as the Bowles property, for the erection of a number of extensions. Plans for the work are under way.

BALTIMORE—The United States Industrial Chemical Co., Curtis Bay, is completing plans for the proposed extension to its plant at Stonehouse Cove, consisting of a building 60 x 130 ft.

Massachusetts

HOLYOKE—The Paper City Mfg. Co., Rackliffe Bldg., has acquired the building of the Ferguson Laundry Co. at a public sale, and will utilize the structure for proposed extensions. It was secured for a consideration said to be \$16,000.

New Jersey

NEWARK—The Franklin Baker Oil Co., Diremus Ave., is said to be planning for the early rebuilding of the portion of its plant, destroyed by fire March 10, with loss estimated at about \$100,000. The company specializes in the manufacture of coconut oils.

TRENTON—The American Rotex Mfg. Co., Cleveland, O., manufacturer of imitation leather products, has acquired the plant of the Trenton Lamp, Brass & Copper Works, New York Ave. and Mulberry St., more recently occupied by the Cosmic Chemical Co., for a consideration said to be about \$100,000. The plant consists of a group of six large buildings with power plant, and the different structures will be remodeled at a cost of about \$30,000 to accommodate the new industry. Machinery and equipment estimated to cost about \$100,000 will be ordered and installed at an early date. Offices will be established at the plant site at once. A. M. Mander is president; P. F. Wills is representative of the company in charge.

CLAYVILLE—The L. G. Nester Co., recently incorporated with a capital of \$50,000 to manufacture glassware, has plans under way for its proposed new plant on local site. Lyman G. Nester is head.

TRENTON—Fire, March 16, destroyed a portion of the plant of the Ewing Rubber Co., Homan and Hilton Aves., with loss estimated at about \$15,000. It is said that the plant will be rebuilt. George H. Royle is head.

NEWARK—The Celluloid Co., 290 Ferry St., will use a considerable portion of the proceeds of its recent capital increase of \$4,000,000 for plant extensions and improvements. During the year just past the company expended a total of \$1,300,000 for work of this character and it is proposed to continue this expansion program. Marshall C. Lefferts is president.

CAMDEN—The Russell Products Co., Sixth and Jackson Sts., manufacturer of paper specialties, is arranging for the rebuilding of the portion of its plant recently destroyed by fire with loss of about \$15,000.

JERSEY CITY—James H. Rhodes & Co., South Albany Ave., Chicago, Ill., manufacturer of industrial chemicals, has purchased the 2-story factory, 100 x 200 ft., at 34-40 Liberty St., for use as a branch works. The structure heretofore has been held by the Foot Mfg. Co., manufacturer of polishing buffs, felts, etc.

New York

BUFFALO—The Dunlop Rubber Co., River Rd., is planning to inaugurate operations at its new local plant for the manufacture of tires and other rubber goods on April 15, giving employment to about 1,000 operatives. This number will be increased until the working force totals about 5,000 persons before the close of the year. The plant when entirely complete will represent an investment of about \$20,000,000.

MALONE—The Northern Process Co. has awarded a contract to Henry I. Jones, Grove St., for the erection of a new 2-story and basement plant, 35 x 140 ft., to cost about \$60,000, forming an addition to its present works.

North Carolina

CHARLOTTE—The American Progressive Sales Co., Asheville, N. C., is planning for the erection of a plant at Charlotte for the manufacture of cement and clay building products. S. F. Roberts is manager.

GREENSBORO—The Armour Fertilizer Works, Chicago, Ill., is planning for the early operation of its new acid works now nearing completion, representing a cost of about \$250,000. The plant will be operated

for the production of sulphuric acid for use at the company's fertilizer works at this same place.

Ohio

DEFIANCE—The Farmers' Sugar Co. is having plans prepared for the construction of a new sugar mill on local site, to consist of a number of 1-, 2- and 3-story buildings, estimated to cost about \$1,000,000 with machinery. A. H. Smith, 215 Nasby Bldg., Toledo, O., is engineer. Charles H. Allen is president.

WILLIARD—The Pioneer Rubber Co. has completed plans for the erection of the proposed new 2-story addition to its plant, 63 x 160 ft., and will soon call for bids. It is estimated to cost about \$50,000. A number of homes for employees will also be constructed. Granville E. Scott, Norwalk, Ohio, is architect. B. O. Smith is president.

Oklahoma

MUSKOGEE—The Muskogee Cotton Oil Co., 724 Mill St., is planning for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at about \$15,000. George H. Walker is president.

TULSA—The Phanotax Chemical Co., recently removed to Tulsa from Memphis, Tenn., has acquired a half block of property on Fourth St., between Frankfort and Elgin Sts., 150 x 300 ft., for the erection of a new 7-story and basement building, a large portion of which will be given over to chemical and chemical byproduct manufacture. The new plant is estimated to cost about \$400,000 with equipment.

LAWTON—The Damascus Refining Co., Cleveland, O., is perfecting plans for the erection of its proposed new plant at Lawton for the manufacture of waxes to be used for lubricating oil production. W. G. Black is president.

Ontario

TRENTON—The Chemical Products Co. is having plans prepared for the erection of a new plant for the manufacture of fertilizer products, to consist of three buildings, each 1 story, 80 x 220 ft., 60 x 120 ft. and 50 x 50 ft., estimated to cost about \$500,000 with machinery. The Austin Co., 16122 Euclid Ave., Cleveland, O., is in charge. A. H. C. Hartman is head.

Oregon

PORTLAND—The Portland Vegetable Oil Mills has inaugurated preliminary work on its proposed new local plant, to be located on a portion of the site previously used by the Foundation Co. as shipyard property. Actual construction of the new mills will be started early in April. The plant is estimated to cost about \$450,000 with machinery.

OREGON CITY—T. B. McBain and associates, Oregon City, are perfecting plans for the construction of a new local paper mill.

Pennsylvania

PHILADELPHIA—The Rinold Brothers Paint Works, Inc., has taken title to the 2-story brick factory on Grove St., near Wharton St., 50 x 314 ft., for a local plant. The site was secured for a consideration said to be \$43,000.

KANE—The Interstate Glass Co., Bradford, Pa., has plans under way for extensions and improvements at its plant at Kane, to cost about \$70,000. H. J. Walters is head.

Texas

BRECKENRIDGE—The Shamrock Oil Corp. has plans under way for the erection of the initial unit of its proposed new casinghead gasoline plant. Construction will be inaugurated at an early date.

West Virginia

HUNTINGTON—The West Virginia Glass Mfg. Co. is planning for the erection of a number of additions to its plant to double, approximately, the present output. New automatic blowing machines and auxiliary operating equipment will be installed. The plant specializes in the manufacture of glass jars and has a present capacity of from two to three cars a day. The expansion is estimated to cost about \$75,000. B. G. Landau is general manager.

Wisconsin

MILWAUKEE—The building occupied by the Frazer Paper Co., National Belting & Salvage Co. and kindred industrial interests was destroyed by fire March 17, with total loss of about \$130,000, distributed among the companies.

New Companies

THE WEST CHEMICAL CO., 313 South Clinton St., Chicago, Ill., has been incorporated with a capital of \$30,000 to manufacture chemicals and chemical byproducts. The incorporators are A. B. Rosenfeld, Abraham Jacobson and Abraham M. Gordon.

THE WINOIL SUPPLY CO., Passaic, N. J., has been incorporated with a capital of \$100,000 to manufacture refined oils and affiliated products. The incorporators are John Hanley, Thomas E. Duffy and Peter J. Wynne, 185 Jefferson St.

THE IDOLA CHEMICAL MFG. CO., New York, has been incorporated with a capital of \$100,000 to manufacture chemicals and chemical byproducts. The incorporators are T. J. O'Hanlon, J. Reusch and C. Massingill, 152 Madison Ave.

LEVEISEUR, HAROTH & CO., INC., Boston, Mass., has been incorporated with a capital of \$100,000 to manufacture leather products; the company will operate a tannery. The incorporators are Frederick J. Leviser, A. W. Hull and Alfred W. Haroth, 8 Stratford Rd., Melrose, Mass.

THE CERAMIC PRODUCTS CO., 175 West Jackson Blvd., Chicago, Ill., has been incorporated with a capital of 75,000 to manufacture pottery and other fine ceramics. The incorporators are William C. Danms, Walter W. Weiss and E. S. Radcliffe.

THE AMERICAN LABORATORY PRODUCTS CO., Cleveland, O., has been incorporated with a capital of \$2,000,000 under Delaware laws, to manufacture chemicals and chemical byproducts. The incorporators are H. Linsdale Smith, W. C. Husted and G. S. Patterson, Cleveland.

THE RAVENSWOOD PORCELAIN CO., Ravenswood, W. Va., has been incorporated with a capital of \$50,000, to manufacture porcelain products. The incorporators are Charles W. Turnbull, New Haven, W. Va.; J. H. Camp and J. W. Hall, Ravenswood.

THE HIMMER BROS. CO., INC., 1221 East Monument St., Baltimore, Md., has been incorporated with a capital of \$20,000 to manufacture paper products. The incorporators are John C. and Charles Himmer and John H. Renner.

THE AMPROCO CO., New York, has been incorporated with a capital of \$10,000 to manufacture chemicals and chemical byproducts. The incorporators are S. R. Barrett, and C. F. and L. T. Glendhill, 684 East 19th St., Brooklyn.

THE MARVELLUM CO., Holyoke, Mass., has been incorporated with a capital of \$15,000, to manufacture paper products. The incorporators are R. S. Bracewell, George E. Senseney and Francis C. Heywood, Holyoke.

THE SANITARY CHEMICAL SPECIALTIES CO., 208 North Wells St., Chicago, Ill., has been incorporated with a capital of \$15,000, to manufacture chemicals. The incorporators are Walter H. Shryock and J. W. and Arthur C. Tretow.

THE WESTERN NEW YORK PAPER CO., Rochester, N. Y., has been incorporated with a capital of \$15,000, to manufacture paper specialties. The incorporators are C. H. Mason and G. and J. Doyle, Rochester.

THE HIGH GRADE LARD & COMPOUND CO., INC., 2600 Hafer St., Baltimore, Md., has been incorporated with a capital of \$25,000, to manufacture lards and compounds. The incorporators are Max Baker, Robert Plein and William E. Bragg.

THE TEXTILE LEATHER & METAL PRESERVER CO., Kalamazoo, Mich., has been incorporated with a capital of \$100,000, to manufacture compounds and chemical preservatives for textiles, leather and metal products. The incorporators are Clarence D. Shaffer, and Willard R. Sparks, Kalamazoo; and Elbert W. Sweet, Benton Harbor, Mich.

THE SIGNAL MOUNTAIN PORTLAND CEMENT CO., Atlanta, Ga., has been incorporated with a capital of \$3,000,000, to manufacture cement, lime and affiliated products. The incorporators are R. C. Lubien, St. Angar, Ia.; and Ralph A. Law, Mason City, Ia.

THE CLENSOL CHEMICAL CO., INC., Salem, N. J., has been incorporated with a capital of \$100,000, to manufacture chemicals and chemical byproducts. The incorporators are I. Castelli, Louis O. Bergh and E. E. Cushing, Salem.

THE CALABRA CHEMICAL CO., Boston, Mass., has filed notice of organization to manufacture chemical products. The company is headed by Abraham M. Berman and Harry Chaimken, 8 Crawford St., Roxbury, Mass.

THE MUNN LABORATORIES, 518 Main St., East Orange, N. J., has filed notice of organization to manufacture chemical products. The company is headed by Robert Loder, 60 Walnut St., East Orange.

THE ONTARIO-CORONA OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$5,000,000 to manufacture petroleum products. The incorporators are F. A. Welshans, Alhambra, Cal.; L. R. Kennedy and C. E. White, Ontario, Cal.; and P. W. Lacy, Los Angeles.

THE VICTOR INK CO., Jersey City, N. J., has been incorporated with a capital of \$350,000, to manufacture inks. The incorporators are E. Burke Tinnerty, G. M. Jones and Isador Halprin, Jersey City.

THE DOOLEY MFG. CO., Philmont (Columbia Co.), N. Y., has been incorporated with a capital of \$50,000, to manufacture glue, chemical products, etc. The incorporators are J. E. Clune, E. L. and C. E. Dooley, Philmont.

THE R. R. GLASS WORKS, INC., Providence, R. I., has been incorporated with a capital of \$50,000, to manufacture glass products. The incorporators are Hiram G. Hall, 372 Benefit St.; Peter Perrotta and Ralph Kakusian.

THE PLANTERS' LIME, PHOSPHATE & FERTILIZER CO., Penters Bluff, Ark., has been incorporated with a capital of \$1,500,000, to manufacture fertilizers, lime and affiliated products. The incorporators are J. R. Alexander, Scotts, Ark.; R. R. Ramey, Kensett, Ark.; and J. W. Williamson, Batesville, Ark.

THE ALL-KLEAN MFG. CO., New York, has been incorporated with a capital of \$10,000, to manufacture valve grinding compounds, chemical specialties, etc. The incorporators are C. and C. Cunningham, Jr., and R. Lee, 111 Young St., Brooklyn.

THE TUDOR PRODUCTS CO., New York, has been incorporated with a capital of \$55,000, to manufacture chemicals and chemical byproducts. The incorporators are E. Levy, J. J. Fischer and R. E. Tinsley, 299 Bway.

THE ELK HILLS CRUDE OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$350,000, to manufacture petroleum products. The incorporators are William O. Maxwell, Fred V. Gordon and R. E. Kline, all of Los Angeles. Andrews Toland & Andrews, 916-24 Union Oil Bldg., head the company.

THE CLIMAX SPECIALTIES CO., Jersey City, N. J., has been incorporated with a capital of \$25,000, to manufacture chemicals and chemical byproducts. The incorporators are W. B. Madden, Fred Bebbler and Samuel H. Neve, 1035 Summit Ave.

THE AJAX RUBBER CO., Dallas, Tex., has been incorporated with a capital of \$25,000, to manufacture rubber products. The incorporators are L. D. Ormsby, F. C. Burnett and W. J. Jackson, Dallas.

THE GENESSEE POTTERY CO., Chittenango (Madison Co.), N. Y., has been incorporated with a capital of \$5,000, to manufacture pottery and other ceramic products. The incorporators are A. W. Surles, J. H. Thompson and J. M. Moir, Marcellus, N. Y.

THE DIRECT RUBBER CO., 46 Paterson St., New Brunswick, N. J., has been incorporated with a capital of \$500,000, to manufacture rubber goods. The incorporators are Samuel C. Clark, Willett S. Chinery and John J. Moriarty, New Brunswick.

THE KENNEBEC PULPWOOD CO., Augusta Me., has been incorporated with a capital of \$100,000, to manufacture pulpwood and paper products. Blaine S. Viles is president and W. R. Pattangall treasurer.

THE APEX OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$1,000,000, to manufacture petroleum products. The incorporators are Arthur C. Gage, Leslie C. Monks and M. L. Jenks, Los Angeles. Adams, Adams & Binford, 716 Van Nuys Bldg., represent the company.

THE BOYSTON PAPER CO., Boston, Mass., has been incorporated with a capital of \$500,000, to manufacture paper products. The incorporators are T. Mercer Atkinson, M. MacGill, Cambridge, Mass.; and Ralph F. Alvord, Auburndale, Mass.

THE HUDSON VALLEY OIL CO., Kingston, N. Y., has been incorporated with a capital of \$30,000, to manufacture petroleum products. The incorporators are C. Wilson, A. R. Newcomb and W. G. Maus, Kingston.

THE NORTHERN REFRACTORIES CO., Ridgway, Pa., has been organized to manufacture firebrick, furnace linings and other refractory products. The company is headed by Ives J. Harvey, Bellefonte, Pa.; M. P. Shanley, Ridgway; and E. J. Burke, Rochester, N. Y.

Capital Increases, Etc.

THE ROESCH ENAMEL RANGE CO., Belleville, Ill., has filed notice of increase in capital from \$15,000 to \$75,000.

THE FALL CITIES HYDRAULIC BRICK CO., Jeffersonville, Ind., has filed notice of increase in capital from \$50,000 to \$100,000.

THE ACME SANITARY POTTERY CO., May St., Trenton, N. J., manufacturer of sanitary earthenware, has filed notice of increase in capital from \$50,000 to \$200,000.

THE ESCANABA PAPER CO., Escanaba, Mich., has filed notice of increase in capital from \$2,800,000 to \$3,000,000.

THE LOCKWAY, STOUCK PAPER CO., Benton Harbor, Mich., has filed notice of increase in capital from \$50,000 to \$100,000.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29. Headquarters will be at the Hotel Rochester.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17. Headquarters will be at the Congress Hotel.

AMERICAN PAPER & PULP ASSOCIATION will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

AMERICAN ZINC INSTITUTE will hold its annual meeting in St. Louis May 9 and 10.

BRITISH IRON AND STEEL INSTITUTE will hold its spring meeting May 5 and 6, at the Institution of Civil Engineers, Great George St., S. W. 1, London, England.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

HARVARD ALUMNI CHEMISTS' ASSOCIATION will meet Tuesday noon April 26 at Rochester, N. Y., for luncheon.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27 to 29.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, N. Y., April 11 to 14.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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CHARLES N. HULBERT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

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Consolidation of Research

By Electro Carbon Group

THE Union Carbide & Carbon Corporation is consolidating its principal research laboratories into a single organization in Long Island City. For this purpose it has leased for a minimum period of five years the entire second floor of a great building, covering a ground area 200 x 600 ft.; the net space available for laboratory activities will be in excess of 100,000 sq.ft.

The principal research laboratories which it is intended to consolidate at the present time are those of the Union Carbide Co. and the Electro Metallurgical Co. at Niagara Falls; the Cleveland and Fremont laboratories of the National Carbon Co., and certain of the laboratory activities of the Linde Air Products Co. at Buffalo, the Prest-O-Lite Company at Indianapolis and the American Ever Ready Works at Long Island City. Only such activities will be transferred as can advantageously be carried on at a point remote from the several factories, and include chemical, electrical, mechanical and physical research. Professional and social organizations of men of science in New York may well congratulate themselves on the advent of the distinguished men of research who will continue their labors as members of the staff of this metropolitan institution.

We have heard complaints of late in regard to over-consolidation of research, but these scarcely apply in the present instance. The corporation has a great purpose in mind; it has on its staff a considerable number of men of signal ability in research, and it is believed that, in bringing together these many minds as to the solution of more pressing problems, earlier and better results not only may be but will be attained. Instead of overspecializing, as is occasionally the case when research is centralized, it is believed that the same men will have the advantage of familiarity with a greater variety of problems, and that a far greater opportunity for convenient consultation, interchange of ideas and team work will be afforded.

The moving force back of this consolidation of research activities is of course the conviction in the minds of the officers that thereby even more rapid progress may be made along those industrial and scientific lines for which the corporation stands. These comprise such varied subjects as the application of the electric furnace to the manufacture of carbide of calcium and other carbides and to the preparation of a wide variety of metals, alloys, refractories, etc.; the manufacture of carbon electrodes for electric furnaces, arc lights, projectors, welding equipment and the like; the production, storage, distribution and utilization of acetylene; the application of acetylene to the welding and cutting of metals and other purposes, and the manufacture of welding and cutting equipment; the

manufacture of carbon and metal-carbon brushes for electric generators and motors and of miscellaneous carbon articles for a wide variety of purposes; the manufacture of storage batteries, of dry cells and of flashlight apparatus and batteries; the liquefaction and fractionation of gas mixtures; the industrial utilization of oxygen; the production of synthetic organic chemicals from acetylene and other hydrocarbons. A mere catalog of the manufactured products would form a small volume, and with the assembling of the majority of the research men from the several plant laboratories it is confidently expected that each will find a wider horizon for his thought and for the application of his work, and that thereby the organization will become a more effective tool for the advancement both of industry and of science.

The new laboratory will have a fascination due to the variety of its problems, and a further interest due to the inherent industrial and scientific significance of its activities. Consider, for example, the single instance of the industrial application of carbon for purposes other than fuel. It is confidently believed that carbon in its multifarious forms has a great and growing future as an industrial raw material, though many such uses have already been widely developed. For example, carbon enters into electrodes for every purpose of heating or illumination; it is a primary component of the familiar dry cell and flashlight battery; it is molded into motor and dynamo brushes; in the form of lampblack it enters largely into such diverse industries as the manufacture of automobile tires and printing inks; in its so-called "activated" form it is a gas mask absorbent, a sugar decolorizer, a collecting agent for gasoline and other condensable vapors, and a powerful catalyst for chemical reactions; in the form of graphite it enters largely into the field of lubrication and is the cornerstone of the electrolytic alkali industry.

In these and many other applications carbon remains in those familiar physical forms which we identify with the name. When we extend our consideration to the chemical aspects we open the door wide into the field of organic chemistry—"the chemistry of the carbon compounds." As to this we cannot do better than to repeat Dr. WHITNEY'S fine statement from his recent Perkin Medal address.

Referring to the great development of coal tar chemistry he said: "New fields are greater in number because the territory of chemical knowledge is so greatly broadened, and new tools are so numerous. The results will depend solely on mentality—not tar. Is it not within reason that another field as great as dyes will be developed directly from carbon itself? The entering gates of organic chemistry reached by the shortest road were apparently opened when calcium carbide was first made. Thus starting with two of our

most abundant mineral products, coal and limestone, and adding water alone, we are supplied with the endothermic gas, acetylene. From this point almost anything seems possible. When we realize that the manufacture of acetone, alcohol, etc., has thus been made possible, from the inorganic raw materials, we might as well expect, by the same road, useful food as certainly as medicaments."

Wanted—

A Nitrogen Industry

WITH fertilizers, explosives, dyestuffs and other chemical products demanding nitrates, ammonia and many other nitrogen compounds, America cannot get along without a nitrogen industry. In this respect every chemist and every chemical establishment can join the Chief of Ordnance in his urgent demand that some provision be made for the stimulation of nitrogen fixation in the United States.

The main question which has been debated during the past year with respect to the nitrogen industry has been whether it should be a Government industry or a matter of private development and control. But that question is now beside the point, because Congress has defeated not only the legislation intended to provide for a nitrogen corporation but also the power development at the Wilson Dam, Muscle Shoals, Ala. However, with the defeat of that legislation the whole question is not closed. There remains the important matter of determining the status and future development of the Government research on various nitrogen-fixing processes. This is at the present stage almost as important a matter as the plant development itself, for today the success of plant operation either private or public will depend more upon well-planned successful research than upon the appropriation of the requisite millions or the satisfaction of political requirements.

The Fixed Nitrogen Research Laboratory at American University has already contributed materially to our knowledge of this basic chemical industry. Approximately a dozen important published contributions from the laboratory staff are on record to demonstrate the important advancement of science in the nitrogen industry which can be expected from this organization. In addition there are more than sixty confidential reports not yet released bearing upon various phases of this question, and in due time and under proper conditions they will become general property for the development of all branches of industry affected. The means to this end are worthy of immediate consideration.

The emergency funds allotted by President WILSON to nitrogen-fixation investigations are still available in adequate amount for the continuation of the fixed nitrogen laboratory for a year or perhaps two years in the future. This laboratory organization is a going concern, working effectively and efficiently on many of the basic problems which can be solved nowhere else as quickly and as cheaply. The question is, Are we to stand by and allow this organization to be disrupted or disbanded altogether? On the part of the chemical industry it would seem that the answer should be emphatically "No."

Some might say that this laboratory organization should be transferred to private hands by allowing the staff to resign and take up employment elsewhere as

private industry saw fit to employ the personnel. A similar suggestion might follow as a natural corollary that the equipment of the laboratory should be sold or placed "in reserve for use in case of emergency," that familiar phrase which means "allowed to rust itself to pieces." On the other hand, a far more sensible plan will be to continue the work of this laboratory on a basis comparable with the work of the Bureau of Chemistry in the food and drug business, the Bureau of Mines in the fields of mining engineering and metallurgy, and the Bureau of Standards in the field of physical science and technology. Not to continue it for the period for which funds are available would be the grossest waste. And such waste at a time like the present is even more unjustifiable than usual.

The Chief of Ordnance has received a recommendation from the director of this laboratory urging the continuance of the work for industrial, agricultural and military purposes, and it seems certain that he must concur therein. If so it then becomes in turn the responsibility of the Secretary of War and the President to approve or amend this program. To these responsible officers and officials the chemical industry can well express its opinion on three matters: (1) Keep this laboratory as a going concern working upon the proper basis for the service of the industry, private and public alike. (2) Decide the matter favorably at once so that the organization can be insured a sufficient permanence to prevent early resignation of the important, and almost irreplaceable, members of the staff. (3) In view of the congressional decision not to advance the nitrogen industry as a publicly owned affair, make available by publication at the earliest proper date all of the results of this important laboratory organization so that the explosives, the dyestuff and the agricultural industries may at the earliest possible time take advantage of them for the general public welfare.

If these three things are done the Government will have contributed materially to the advancement of an adequate nitrogen industry, an industry in which it is as much interested as anyone else can possibly be.

Metallurgy and Civilization

MAN'S progress—the history of civilization—is vitally influenced and even given great impetus at many times by improvements in metallurgy. Still the most ardent enthusiast would not wish to infer that the advancement of our material well-being has been due solely to the efforts of metal workers, for doubtless all living men have had their own influence. But like all other branches of knowledge, metallurgy has been advancing at a rapidly increasing rate; compared to the two thousand years which elapsed between the invention of a bellows for blowing a forge and its equipment with a simple flap valve, announcements of successive discoveries today are made at a perfectly startling rate.

In view of this history of metallurgy, a history of peculiar dignity, the individual now engaged in the art may often wonder what part he may have in its future development. What can one man do with rather limited experimental equipment? The most-talked-of researches now are the co-operative researches planned on a large scale and requiring the labor of many investigators, or the systematic investigations supported by our large manufacturing concerns.

One may fairly point out, however, that research cannot be planned, any more than an expedition can be outfitted to locate a new gold lode. A true discoverer sets sail boldly into the unknown; his followers, traveling in companies, are mere map-makers; collectors of needed and precise information, truly, but of value to further research mostly as a new expeditionary base.

Again, is it not most curious that fundamental discoveries are made with absurdly meager equipment, not at all in keeping with the magnitude of the subject? The CURIES did not need to finger an electron to discover radioactivity—indeed no man or woman ever will. Nor did NEWTON weigh a planet before announcing the law of gravitation—in fact it is rumored that all he needed was to see an apple fall. FARADAY discovered electric induction—the foundation principle of all we know as electrical engineering today—with a magnet and a loop of wire. More recently, BENEDICKS proved the highly controversial and baffling question of thermo-electric currents in a homogeneous metal by merely cutting a wire in the center and crossing the ends.

Metallurgists may thus well derive inspiration and courage in reflecting on the important work which is possible even with a moderate amount of instrumental equipment, when reinforced with a large amount of intellectual resource.

German Chemists in American Employ

APPARENTLY the emigration to the United States of a few German dye chemists has created more disturbance in the Vaterland than in this country, and official steps are being taken to discourage further exodus of German scientists and technologists. It is reported that one of the Bayer chemists was under detention at Rotterdam on demand of the German Government on a charge of theft of documents containing technical and commercial information. Incidentally a lot of noisy talk has emanated from the German side to the effect that the emigrants violated terms of an agreement under which they were employed and that they brought with them to the United States trunks and other receptacles full of voluminous manuscripts and data representing the innermost secrets of German dye establishments. It is also alleged in German quarters that the du Pont company cunningly enticed the Germans to forsake their country and default in their agreements with employers. Personal information from Berlin, however, reassures us on these points, and advises us that no great inducement or artfulness is necessary to attract Germans into American service. In fact, our correspondent says that numerous German engineers would gladly respond to offers of foreign employment. As for the imputation of a breach of contract on the part of the chemists who have already come to the United States, we are advised that the German law does not recognize as binding contracts which bar employees from accepting positions in competing establishments. However all this may be, we have previously expressed our attitude on the question and refer to it again merely to affirm our belief that American manufacturers can be trusted to use good judgment in any decision to obtain the technical services of Germans and others who can furnish information that will advance our industries. Voluntary employment of German brains may prove more acceptable than forced purchase of German dyes.

U. S. Steel Corporation Twenty Years Old

IN SOME industries twenty years is not a long time. In the steel industry it is a very long time. Two decades ago the steel industry was a full-fledged industry. Three decades ago steel was just coming into its own. Long previously it had supplanted wrought iron in rails, but only then was it becoming the dominant material for other rolled products in general.

It is an event that at the end of last month the United States Steel Corporation completed its twentieth year, for it was on April 1, 1901, that the Steel Corporation came into business existence, a consolidation of two concerns, the Carnegie Steel Company and the Federal Steel Company.

Interesting as is the history of the steel industry as an industry in the past twenty years, the history of the United States Steel Corporation as an institution is much more interesting in its relations to society. The corporation as formed was what was known in the parlance of that day as "a trust," a term that cared not for details and simply connoted monopoly or a desire to monopolize. Now "trusts" had been interdicted by the Sherman law, an act of a little less than a thousand words, dated July 2, 1890, but the Supreme Court decision of 1894 in the Knight "sugar trust" case seemed to remove actual consolidations of property from the scope of the act. The view of the man in the street twenty years ago was that trusts were wrong, but certain descriptions of "trusts" the public would have to put up with.

The friends of the Steel Corporation insisted that no "trust" was contemplated. They wished to avoid "cut-throat competition" and the unnecessary duplication of plants, introduce economies in manufacture and build up a sound export trade, to replace the "dumping" process that had sometimes been indulged in.

Whatever were the motives and aspirations, the interesting and important thing today is that the United States Steel Corporation has "made good" on all points. One reason is ex-Judge ELBERT H. GARY. Many men might have done what he has done, though that is very doubtful. The fact is that this man, chairman for twenty long, eventful and exciting years in steel, has done the work. He has had very good advisers, but so have other men, who failed. His chief characteristic is balance, poise. He cannot be stampeded. He never "gets rattled," whether as in 1920 the "independents" advance their prices far above the prices he thinks should be charged or, as in the past two months, when they cut his prices.

The corporation is strong and stable today, sound and safe. Yet it is by no means a monopoly or partial monopoly as at first it was expected to be, for it has only about 43 per cent of the steel ingot-producing capacity of the country. When it became clear that it was not and would not approach monopoly in point of percentage of capacity the corporation was charged by those who feared for results with being a "dominant interest" or a "leader." That the corporation is not such now is shown by the fact that it neither held the prices of independent steel producers down in 1920 nor held them up in recent months.

The United States Steel Corporation has "made good" to its stockholders, its employees and the public by being merely a great manufacturing organization, very wisely and safely managed.

Readers' Views and Comments

Comparison of Various Methods of Water Purification

To the Editor of Chemical & Metallurgical Engineering

SIR:—Mr. Taylor's article on this subject in the Jan. 19 number of CHEMICAL & METALLURGICAL ENGINEERING very correctly and clearly describes the chemistry involved and relative advantages of the zeolite water softener as compared with the cold process lime-and-soda water softener, but is incomplete for the reason that it makes no reference to the hot process lime-and-soda water softener.

This omission is particularly noticeable for the reason that much of his article pertains to softening water for boiler feed purposes, whereas the hot process water softener has been developed primarily to meet the need of a hot soft water for boilers. Its development has been based on the fact that it is economical and otherwise advantageous to heat boiler feed water to approximately 210 deg. F. before feeding to the boilers and the well-known fact that heat generally aids chemical reactions, particularly those involved in softening water with lime and soda ash.

The accompanying curves show the value of heat in softening water. The practical value of heat in softening water is also well illustrated by the following analyses representing Delaware River water before and after treatment in a Sorge-Cochrane hot process water softener at a large chemical manufacturing plant near Philadelphia.

	Grains per U. S. Gal. Before Treatment	Grains per U. S. Gal. After Treatment
Calcium carbonate.....	0.70	1.23
Calcium sulphate.....	1.40	....
Magnesium carbonate.....	.64	.18
Silica	.35	.35
Iron oxide and alumina	.06	...
Sodium sulphate.....	2.39	2.62
Sodium chloride.....	.766	1.28
Sodium carbonate.....	....	2.04
Volatile and organic.....	.58	.58
Total solids by evaporation.....	6.88	8.17
Suspended matter	5.01	none

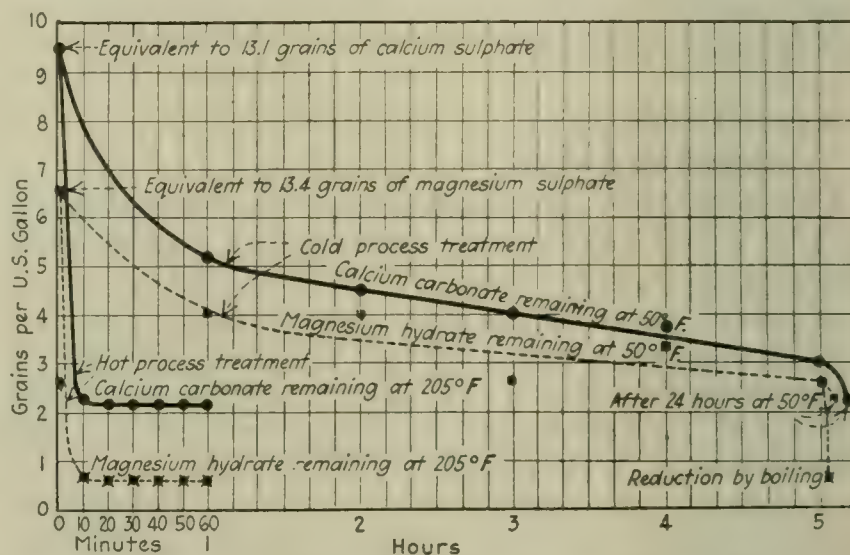
You will observe the sum of the calcium and magnesium carbonates in the Delaware River water treated by the hot process softener is only 1.41 grains per gallon, as compared with 2.99 grains per gallon reported by Mr. Taylor as being representative of the best results to be obtained by the cold process lime-and-soda treatment. Furthermore, the excess sodium carbonate, 2.04 grains per gallon, is slightly less than the excess sodium carbonate which he reported, 2.33 grains per gallon; the significance of the excess sodium carbonate being that the greater the excess chemical fed the lower is it possible to reduce the calcium and magnesium salts. By feeding 3 to 4 grains per gallon excess sodium carbonate with the hot process lime-and-soda treatment the calcium and magnesium carbonates are reduced to approximately $\frac{1}{2}$ grain per gallon. Again, the calcium and magnesium carbonate in the treated water, as above reported, is only very slightly greater than that reported by Mr. Taylor as being most representative of waters treated by zeolite softeners, his analysis showing

a total of 1.13 grains per gallon. His analysis also shows an excess of 17.44 grains per gallon sodium carbonate, which he correctly stated as being highly objectionable for boiler feed.

The analysis of treated water above given by no means represents exceptional treatment, for it is representative of a large number of analyses called to my attention of samples of water treated by the hot process lime-and-soda softener.

The small amount of calcium and magnesium salts remaining in solution after the hot process treatment, for a correspondingly small excess sodium carbonate, makes this method of water treatment highly desirable for boiler feed, which in addition to being soft should also be hot.

Mr. Taylor's article also refers to boiler compounds generally being more satisfactory than water softeners



CURVE SHOWING THE VALUE OF HEAT IN SOFTENING WATER

Solid curves show calcium carbonate remaining in solution after treating calcium sulphate with sodium carbonate (soda ash). Dotted curves show magnesium hydrate remaining in solution after treating magnesium sulphate with calcium hydrate (lime). In all tests the theoretical quantity of softening chemicals was used to combine with the scale-forming solids.

for water-tubular boilers. This statement is not in accord with present-day experience, when water-tubular boilers are generally overloaded, particularly on peak loads. Many boilers fed with waters having less than 8 grains per gallon of encrusting solids (suggested by Mr. Taylor as the minimum hardness requiring water softeners) have developed very serious troubles with scale and priming since carrying high overloads, whereas before operating the boiler at overload apparently satisfactory results had been obtained by the use of boiler compounds.

The chemical plant above referred to, of which water analyses are given before and after treatment, is one such. For many years this plant had been operated without serious tube troubles, but when forcing the boilers, as became possible when installing oil burners, very serious tube troubles resulted, which were corrected by the installation of a hot process water softener for treatment of the boiler feed.

While a satisfactory theoretical explanation may not easily be given for the cause of priming and foaming of boilers, it is well established that large amounts of suspended solids as well as high concentration of sodium

salts within the boiler will cause priming and the more common cause for foaming is suspended matter. It is therefore obviously advantageous to give the boiler feed such treatment as to reduce to the minimum solids to be suspended in the boiler and at the same time keep the concentration of sodium salts as low as possible. This demands that the solids originally suspended in the water be completely removed and that, further, those solids made insoluble by boiler evaporation, as calcium and magnesium salts, should be reduced to the minimum while feeding the smallest permissible excess sodium carbonate. The analysis of treated water above reported is a good representation of what may be expected in this regard if the water is given a hot process lime-and-soda treatment.

If it is desired to feed some anti-foaming compound, this may equally as well be done after the water is softened as before, although experience generally shows that where the water is properly softened anti-foaming compounds can give no further improvement and are accordingly not required.

J. D. YODER.

Philadelphia, Pa.

Porcelain Enameling Furnaces

To the Editor of Chemical & Metallurgical Engineering

SIR:—In the interesting paper on "Porcelain Enameling Furnaces" by C. G. Armstrong published in your issue of March 16 the author says:

"The electric furnace has not entered the commercial field as yet, *due to great heat losses entailed.*" The italics are mine.

Now unless the design of an electric furnace of this kind is very bad it is impossible that its failure should be "due to great heat losses entailed," because one of the great advantages of electric heating in such a furnace is the possibility of reducing heat losses to a minimum. On the other hand, in the fuel-fired furnace heat losses are bound to be high, particularly if no recuperative device is employed.

Several years ago at the FitzGerald Laboratories experiments were made on a furnace used both for baking porcelain and also glazing biscuit ware. The longest continuous run of the furnace lasted fifty-four days and during that time experiments were tried at various temperatures from 1,000 to 1,500 deg. C. (about 1,800 to 2,700 deg. F.). The results were very satisfactory and the indications at that time were that electric energy could be used with such high efficiency that even though the cost of electrically-generated heat was much higher than fuel-generated heat, yet because of the more efficient way in which the former could be used it would actually be more economical. With the relatively great increase in the cost of fuel-generated heat which we now have it is probable that electrically-heated porcelain and enameling furnaces would compete successfully with fuel-fired furnaces in localities where reasonably low-priced electric energy is available.

The only real difficulty in the way of the electric furnace for this purpose is the discovery of some one with sufficient courage to spend the money necessary for development. The preliminary work has been done already so that we now know how such a furnace should be designed; but to go further it is necessary to construct a commercial apparatus.

FRANCIS A. J. FITZGERALD.

FitzGerald Laboratories, Inc.,
Niagara Falls, N. Y.

Library and Research Work

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your issue of March 2 is a communication from "Librarian" in which attention is called to an article in the editorial section of the *New York Times* entitled "Engineers Join in Research Work." He further suggests in this connection a "library link" that might serve in two ways; first, by the publishing of a weekly index of abstracts of articles in current technical papers and second, in "the founding of a large central card catalog of all technical books, pamphlets, trade catalogs, translations, carefully analyzed for every article of value in them."

He also calls to mind some of the large technical libraries of this country and mentions that "this proposed library has its prototype in the International Institute of Bibliography at Brussels, which fortunately escaped the ruthlessness of the Germans and recently filed its twelve-millionth card. The fact that the International Institute of Bibliography has existed even through war-ridden days of Belgium long enough to file its twelve-millionth card is indicative of the commercial possibilities of a similar scheme in this country where the machinery for its accomplishment is greater."

In this connection it would be interesting to inquire whether "Librarian" knows to what extent practical use is made of the twelve million cards of the International Institute. Are distance and time a barrier to the use of this index outside of the city of Brussels? How much is it used by means of communication through the mail and do people actually make journeys to Brussels to use it? How much is it used by the residents of Brussels? Do those who actually use it find it difficult to find the few references wanted in a catalog of twelve million cards? In other words, does its great size defeat the purpose for which this elaborate card index system was devised?

If such a large catalog is of value to those who happen to be in its vicinity, would it not be worth while to incur the somewhat larger expense of printing and making it available to all corners of the earth? In comparing these two methods it is perhaps not unfair to say that the card catalog should be compared to a reservoir of static information and that the printed catalog available at moderate cost anywhere might be compared to a central power station with lines of distribution.

New York City.

H. W. WILSON.

Who Is a Chemist?

To the Editor of Chemical & Metallurgical Engineering

SIR:—In connection with the discussions which have appeared recently in your columns as to what constitutes a chemist I am inclosing the following want advertisement clipped from the *New York Herald* of March 13:

CHEMIST FOR LABORATORY; NO SPECIAL EXPERIENCE NECESSARY, BUT MUST PROVE TO BE ABSOLUTELY RELIABLE, CONSCIENTIOUS AND OF GOOD CHARACTER; ONLY APPLICATIONS GIVING DETAILED INFORMATION AND SUPPLYING BUSINESS AND FAMILY REFERENCES WILL BE CONSIDERED. Y 752 HERALD, HERALD SQ.

Their description of "chemist for laboratory; no special experience necessary" is another example of the altogether too prevalent conception of the chemical profession.

What these people apparently want, without knowing it, is probably a beaker boy who can "do" chemistry on the side.

CHEMICALLY TRAINED WORKER.

Massena, N. Y.

British Chemical Industry

(FROM OUR LONDON CORRESPONDENT)

LONDON, March 14, 1921.

THE political situation is expected to benefit chemical markets materially. Before the breakdown of the negotiations of the London Conference a little improvement was noticeable, though buying was still on a hand-to-mouth basis. In the heavy chemical trade prices have been well maintained in spite of foreign competition and in some cases makers have announced their intention of closing down rather than sell at unremunerative prices.

STAGNATION IN GERMAN IMPORTS EXPECTED

The proposal to make importers pay half of the value of German goods to the British Treasury is likely to stifle the influx of German chemicals for some time and to give a much needed breathing spell to manufacturers. Grave doubts are expressed as to the effectiveness of the measures to be adopted, particularly in regard to payments made by bills of exchange and in regard to the liability of importers under running contracts for goods sold forward in this country. Apparently goods for re-exportation will be exempted, and this may prove a welcome, if temporary, loophole in addition to that provided by shipment to or through neutral countries. Meanwhile there remains the possibility of German producers refusing to supply at all under the conditions to be imposed or of demanding deposits or enhanced prices. On the other hand, it is considered that the expected reduction of German imports of chemicals will be of immediate benefit to American producers, and considerable business is stated to have passed already in anticipation of rising prices for certain commodities. The fertilizer trade is better, particularly as regards nitrate of soda and sulphate of ammonia and increased activity is expected. Basic slag is an exception, particularly as regards export, trade with Australia being almost impossible on account of credit restrictions in that country.

TRADERS DEMAND SECRECY IN REGARD TO PURCHASERS

The arbitrary attitude of certain manufacturers in refusing supplies to merchants (see previous article in *CHEM. & MET.*, March 9, p. 418) for markets in which the manufacturers have their own agent has, it is understood, been definitely challenged in one specific case, where refusal led to the order being placed abroad. The matter has apparently been referred to the Board of Trade, but it is likely that the cause of friction will be removed without action by the government. In this connection it is interesting to note that a conditional promise has been given that the advisory committee on dyestuffs appointed by the Board of Trade will not be given the names of purchasers of dyestuffs imported under license except in special circumstances, the information remaining normally in the confidential hands of the Secretariat. The constitution of the advisory committee is now known and the promise given was obviously necessary on account of the consumers' and manufacturers' representatives. Dr. M. O. Forster and W. J. U. Woolcock, M. P., were obvious selections for this committee and E. V. Evans, chief chemist of the South Metropolitan Gas Co. is also of the number, being officially and perhaps with unconscious humor described as the "treasurer of the Society of Chemical Industry." The names of the members of the develop-

ment committee to be set up under the dyestuffs restriction act have not yet been announced.

The key industries bill, under which it was hoped that the fine chemical industry would receive a measure of protection similar to that given under the dyestuffs act, will not be introduced until after Easter, owing to pressure of political and financial business in the houses of Parliament. It is understood that the bill will be very hotly contested and it is by no means unlikely that it will fail to be carried into effect, at any rate on the comprehensive scale originally proposed. Official support, while outwardly enthusiastic, is actually believed to be very lukewarm and the propaganda and press campaign in connection with the fine chemical industry seems to have been overdone.

MR. KESTNER READS IMPORTANT PAPER BEFORE THE SOCIETY OF CHEMICAL INDUSTRY

Mr. Kestner's paper last week on the "Degassing and Purification of Boiler Feed Water" at the Institution of Mechanical Engineers attracted considerable attention and set a very welcome precedent for future joint meetings between chemists and engineers; it also tends to show that the society is increasingly appreciating its responsibility in the furtherance of chemical engineering knowledge. The paper dealt in detail with the process of continuous blowing down used in conjunction with hot purification, whereby a thermal saving is effected and the gases dissolved in the feed water are eliminated. Agitation and heat increase the speed of reaction and the settlement of the precipitate and the apparatus proposed consists of a steam separator, a central reservoir and heater, a re-heater and a precipitation chamber, soda being used as the reagent. The discussion brought out the fact that other workers have been proceeding on similar lines in the past, but the paper and discussion will do much to clarify the knowledge at present available on this important subject.

Details have now been given of the annual meeting of the society to be held in Canada at the end of August. The trip is likely to prove sufficiently expensive to prevent a large and representative attendance, though it is hoped that the larger firms will, as a matter of policy, defray the expenses of special representatives, particularly as an extension of the tour to New York will enable them to visit the National Exposition of Chemical Industries. It is felt that a larger attendance at what is, after all, a function of international importance could be secured by arrangements for cheaper travel and accommodation and no doubt the proverbial hospitality of America will solve the difficulty for the one hundred-odd delegates who are expected to make the trip.

PERSONAL NOTES

In Lord Moulton British chemical industry has lost a personality and a leader whose place it will be extraordinarily difficult to fill. Those who were associated with him during the war learned to appreciate not only his legal and mathematical ability, but also his uncanny aptitude for sizing up an individual correctly and placing him in his proper niche in a harmonious whole. He had hoped to save the fine chemical industry as well as that of dyestuffs, and the propaganda campaign in regard to the former will suffer from the loss of his leadership at a critical time unless another man can be found to take his place. Other losses to science have been occasioned by the deaths of Prof. Odling, F.R.S., and Prof. Miall, F.R.S.



GENERAL VIEW FIXED NITROGEN RESEARCH LABORATORY

Government Fixed Nitrogen Research

The Present Status and Recommendations for the Future of the Investigations of the Fixed Nitrogen Research Laboratory, American University, Washington, D. C., as Reported to the Chief of the Nitrate Division by the Directors of the Laboratory, March 15, 1921

BY R. C. TOLMAN

IN ORDER that a wise decision may be made as to the future of the Fixed Nitrogen Research Laboratory, the following brief statement as to its present activities and tentative future plans is made:

The Fixed Nitrogen Research Laboratory was founded by an order of the Secretary of War dated March 29, 1919, and has been operated, with a budget of \$300,000 a year, from funds which were made available to the President of the United States by the national defense act of June 3, 1916, specifically authorizing him to "cause to be made such investigations as in his judgment are necessary to determine the best, cheapest and most available means for the production of nitrates and other products for munitions of war and useful in the manufacture of fertilizers and other useful products, by water power or any other power, as in his judgment is the best and cheapest to use." The laboratory is engaged in carrying out these provisions of this act, and there are still funds available from the original appropriation which will make it possible to continue the work for two years longer, provided such continuation seems wise to the Secretary of War and the President of the United States.

PERSONNEL CAREFULLY SELECTED

The laboratory is located at the American University, Washington, D. C., making use of buildings and equipment formerly used by the Research Division of the Chemical Warfare Service. It has a total personnel of between 110 and 120 persons, 50 of whom are chemists. This personnel has been very carefully selected for the work in hand, many of the men having had experience along similar lines in the Research Division, Chemical Warfare Service. The total equipment of the laboratory for purposes of chemical researches has a value of approximately \$399,000, much of which has been specially designed and constructed for the

difficult researches in progress. The largest building in use by the laboratory is loaned by the American University and a duplication of the entire plant is roughly estimated to cost in the neighborhood of a million dollars.

THE ACTIVITIES OF THE LABORATORY

The main work of the laboratory has been to study the fixation of nitrogen by the cyanamide process, by the Haber process and by the arc process, and to study the methods of transforming the various forms of nitrogen-containing products so as to make them most available for military, agricultural or industrial uses.

The work of the laboratory has been carried out with particular reference to the changes in equipment and methods of operation that would be necessary in order that the Muscle Shoals (cyanamide) plant might be operated in peacetime to produce fertilizer material instead of explosives, and with reference to the changes that must be made in the smaller Sheffield (Haber) plant in order to make its operation successful.

The results of these investigations have been presented to the Chief of the Nitrate Division in a series of sixty-one confidential reports.

Summaries of the results of this work will be found in the Reports of the Director, Aug. 20, 1920, and Jan. 20, 1921. These reports have been held confidential in order that the material contained therein should be available to the Government, in case Congress should decide to operate the two existing nitrate plants as a governmental activity. It is the plan of the laboratory, however, to publish a large portion of this material for the general use of the nitrogen industry in case Congress should decide that the serious national problem of nitrogen fixation can safely be left to development by private capital.

Besides the confidential reports which the laboratory has made to the Chief of the Nitrate Division, the laboratory has also published in the *Journal* of the American Chemical Society and elsewhere ten purely scientific articles.¹

The laboratory plans in the future to publish a very considerable number of further purely scientific articles, and also to publish such technical material now contained in the confidential reports as will be of general advantage to the nitrogen industry without jeopardizing the special interests of the Government.

THE FUTURE POLICY OF THE LABORATORY

Owing to the potential seriousness of the nitrogen problem from a national point of view, it is the belief of the writer that the Fixed Nitrogen Research Laboratory should be continued on its present basis, in order that the specially trained personnel of the laboratory and its special equipment for experimental work may be utilized for the maximum public benefit. The question as to whether the Muscle Shoals plant is to be operated by the Government or the development of the nitrogen industry is to be left to private capital has no *direct* bearing on the desirability of continuing the activities of the laboratory. In case the Muscle Shoals and Sheffield plants are operated by the Government, the information collected by the laboratory will be available for the Government, while in case the plants are dismantled, there will be an even greater national need for the kind of information that can be obtained by the laboratory in order that the nitrogen industry may be scientifically developed by private capital.

THE CYANAMIDE AND HABER PROBLEMS

As to the cyanamide problem, it is believed that eight or ten months' more work will be sufficient for rounding out a great portion of the work planned, although a certain amount of attention must always be paid to the cyanamide process, so long as that is the only one by which nitrogen can actually be fixed in America.

The work on cyanamide was originally undertaken at the specific direction of the Fixed Nitrogen Administrator, Arthur Graham Glasgow, because of the Government's ownership of the great Muscle Shoals plant, which will produce 220,000 tons of cyanamide per annum. The main purpose of this work has been to study cyanamide and its various possible transformation products from the point of view of their utility in agriculture, explosives and the arts. The laboratory has already collected an enormous amount of information as to the various compounds which can be

prepared from this material, as will be seen from the reports to the Chief of the Nitrate Division. A large amount of further information is now coming through in the form of additional reports, and a number of important experimental investigations are being brought to a close. The writing up of this material alone will be a task of several months' duration, and all of this material should be made available for the Government in the form of confidential reports if the Muscle Shoals plant is to be operated by the Government, and should be made available to the general public in the form of publications if the Government is not to operate the Muscle Shoals plant.

Although the cyanamide process is one of the best known and best established methods of fixing nitrogen and although the laboratory has completed more work in connection with the cyanamide process than in connection with the other methods of nitrogen fixation, it is not believed that an entire abandonment of the work on the cyanamide process should be contemplated. The cyanamide process is at the present time the only process by which nitrogen can be fixed in America in case of emergency. The Haber process, which under certain industrial conditions can certainly displace the cyanamide process, has never been commercially operated outside of Germany and has very great inherent difficulties connected with handling large quantities of flammable gas at high pressures and high temperatures. This laboratory believes that the cyanamide process will remain an important method of fixing nitrogen for many years to come. It is susceptible of considerable improvement and can furnish a great variety of nitrogen products. In this connection particular attention should be called to the fact that nitroguanidine is almost



MAIN BUILDING OF THE FIXED NITROGEN RESEARCH LABORATORY LOANED BY THE AMERICAN UNIVERSITY, WASHINGTON, D. C.

certain to be an important constituent in new smokeless powders. The Ammunition Division of the Ordnance Department and this laboratory are working on the production of dicyandiamide, guanidine and nitroguanidine from cyanamide. Except for the Muscle Shoals plant, the only source of dicyandiamide, guanidine and the end product nitroguanidine in this hemisphere would be the plant of the American Cyanamid Co. which is located in Canada.

The work of the laboratory on the Haber problem

¹These are:

"Pressure Measurements of Corrosive Gases. The Vapor Pressure of Nitrogen Pentoxide," *J. Am. Chem. Soc.*, vol. 42, No. 6, p. 1132 (1920); by Farrington Daniels and Arthur C. Bright.

"The Heat of Absorption of Vapors on Charcoal," *J. Am. Chem. Soc.*, vol. 42, No. 6, p. 1146 (1920); by Arthur B. Lamb and A. Sprague Coolidge.

"The Entropy of Gases," *J. Am. Chem. Soc.*, vol. 42, No. 6, p. 1186 (1920); by Richard C. Tolman.

"Motion of Droplets and Particles in the Field of the Corona Discharge," *CHEM. & MET. ENG.*, vol. 22, No. 26, June 30, 1920; by Richard C. Tolman and Sebastian Karrer.

"Statistical Mechanics Applied to Chemical Kinetics," *J. Am. Chem. Soc.*, vol. 42, No. 12, p. 2506 (1920); by Richard C. Tolman.

"The Thermal Decomposition of Gaseous Nitrogen Pentoxide. A Monomolecular Reaction," *J. Am. Chem. Soc.*, vol. 43, No. 1, p. 54 (1920); by Farrington Daniels and Elmer H. Johnston.

"The Photochemical Decomposition of Nitrogen Pentoxide," *J. Am. Chem. Soc.*, vol. 43, No. 1, p. 72 (1921); by Farrington Daniels and Elmer H. Johnston.

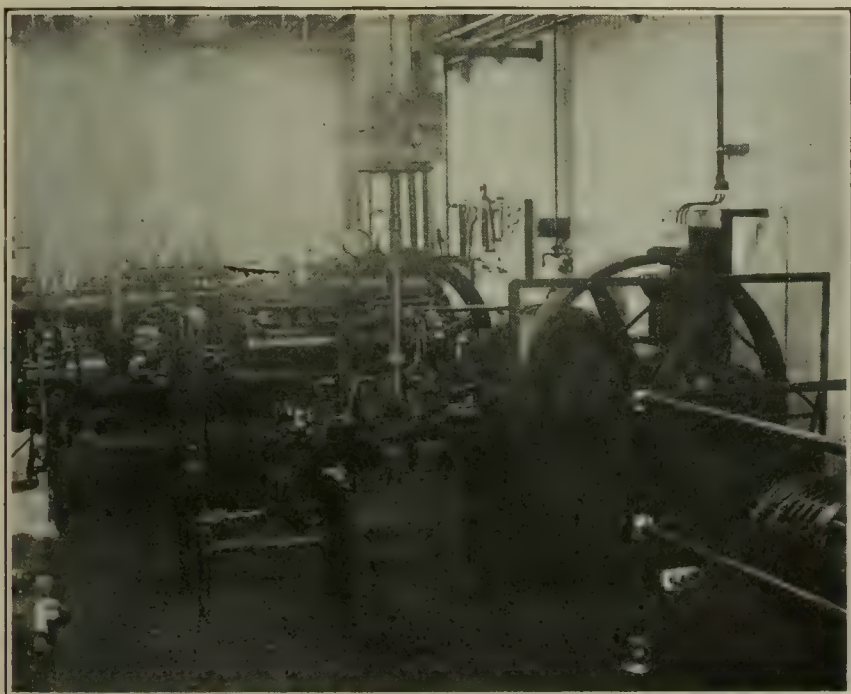
"Note on the Theory of Monomolecular Reactions," *J. Am. Chem. Soc.*, vol. 43, No. 2, p. 269 (1921); by Richard C. Tolman.

"Relativity Theories in Physics," *General Electric Review*, vol. 23, No. 6, p. 486 (1920); by Richard C. Tolman.

"Gas Analysis by Absorption and Titration," *CHEM. & MET. ENG.*, vol. 23, Dec. 8, 1920; by R. S. Tour.

was undertaken primarily because of the partly developed Sheffield plant which was designed for the Government to operate in accordance with the Haber process. This plant failed to operate successfully because of incorrect engineering design, because a satisfactory catalyst for the synthesis of ammonia had not been developed, and because of the great difficulties connected with the solution of such a complicated process in a limited time under war conditions.

In connection with this problem the laboratory is still in the midst of most important and difficult investigations. We have obtained a catalyst for the reaction between nitrogen and hydrogen to form ammonia which is, we believe, equal if not superior to the catalyst which the Germans had obtained up to the time of the armistice when the Oppau plant was made available for Allied inspection. Our catalyst is satisfactory, both from the point of view of stability and from the point of view of the large yield of ammonia which it gives.



CATALYST-TESTING PLANT. COMPRESSORS

We believe, however, that much superior catalysts can be made, and that the theory of catalytic action can be so elucidated with further work as to put the whole art of catalyst manufacture on a firm scientific basis.

For the purpose of catalyst testing we have developed a high-pressure catalyst-testing plant at a cost of between \$90,000 and \$100,000, which has now been in successful and continuous operation for nearly a year and which is, as far as we know, the only catalyst-testing plant outside of Germany which has ever been operated continuously for more than a week at a time. This plant is operated on a shift basis twenty-four hours per day with a specially trained personnel, and we have only begun to realize on the cost of the investment involved. The testing of catalysts for ammonia synthesis will certainly be an important need of the nitrogen industry in America for many years to come, and the unusual equipment at the Fixed Nitrogen Research Laboratory should certainly be maintained available for testing catalysts whether developed in the future by the Government or by the industries.

For testing catalysts at lower pressures, for studying the theory of catalytic action and for carrying out other chemical researches incidental to the development of the Haber process, we have installed special apparatus at a cost of about \$20,000. The disorganization

of the work being carried on with this apparatus would be a very serious loss to the country.

Among other contributions to the Haber problem, we have started an elaborate set of tests on the ability of different alloy steels to withstand the action of nitrogen, hydrogen and ammonia at high temperatures and pressures. This is a very important problem, since ordinary steel forms nitride of iron under these conditions and bombs constructed from ordinary steel for the catalyst chamber will disintegrate and finally explode. The preliminary work for this test has been carried out in co-operation with the Technical Staff of the Ordnance Department and partly at their expense, and has already cost in the neighborhood of \$16,000 to \$20,000. This money has been expended in the purchase of the twenty-four different kinds of material to be tested, in the construction of the test bombs and test specimens, in carrying out the initial tensile, compression and shearing tests, in making the initial micrographic examination of the steels, and in building the heaters and auxiliary furnaces for carrying the specimens under test. This apparatus is now ready to be assembled and it is planned to maintain the specimens under the conditions of high temperature, pressure and gas concentrations for a period of a year, when the specimens will be removed for their final test and micrographic examination. This work will give most important information in connection with the construction of Haber plants. It will cost us approximately \$10,000 to complete the test if it is run in connection with our catalyst-testing plant, where it can be controlled by our regular operators and where the supply of gas is continuously available. If all the apparatus and specimens already constructed were turned over to be operated independently of our catalyst-testing plant, it might cost from \$40,000 to \$50,000 to complete the work.

THE ARC PROBLEM

As to the arc problem, the laboratory has installed special equipment for this study, having a value of about \$14,000. From a military point of view this is one of the most important methods of nitrogen fixation, since it can be most rapidly installed in case of war and since it provides nitrogen at once in the nitrate form without the necessity of any oxidation from the ammonia form. Since the Government owns no arc plants, we have, for the time being, given less attention to this process than to the others and have confined ourselves to studying the fundamental theory of chemical reactions in the path of the electric discharges. Owing to the great difficulty of the problems involved, we have only begun to realize on the time and investment which we have put into this work. At the present time very important information is coming through as to the maximum yield of ozone which can be obtained by an electric discharge under the most favorable conditions. It is believed that the work on the arc process should be extended and vigorously pushed, since it is by no means out of the question that very fundamental improvements in this process can be achieved.

OTHER METHODS OF NITROGEN FIXATION

Attention must be called to the fact that the laboratory has up to the present time made no serious investigation of other methods of nitrogen fixation than the three mentioned above. The laboratory strongly

believes that various modifications of the cyanide process such as that proposed by Bucher and partially developed at the Government Saltville plant, and such as the Mehner process, which is being developed in Germany, should be given a thorough study. Plans for this work are already under way, and it is believed that the laboratory should divert personnel from the cyanamide section to work on the cyanide process and to prosecute more vigorously the work on the arc process as soon as this becomes possible.

AGRICULTURAL WORK

Special attention should be called to the agricultural work of the laboratory. This has been carried out partly by means of pot and field tests made in co-operation with the Bureau of Plant Industry of the Department of Agriculture, and partly by our own experimental work at the two Alabama plants, where twenty acres was given over to agricultural tests last year. It might seem that the carrying out of such tests was hardly the function of the War Department. The work, however, is a direct consequence of the very peculiar chemical nature of cyanamide which makes its utilization in agriculture a matter that needs further investigation, and the work has been carried out in the closest co-operation with the Department of Agriculture.

The samples of fertilizer material for next year's tests at the plants are now being prepared by the laboratory. It is very important that this work should continue for at least another year, owing to the great variability in the results obtained in field tests. The laboratory has already collected very important information as to the behavior of about ten nitrogen-containing substances in these field tests, but the value of the work will be greatly increased if the conclusions are made more certain by further tests using as far as possible the same fertilizer materials on the same plots. This is customary in ordinary agricultural experiments where the continuation of the tests often runs through a series of years in order to eliminate the variable climatic and other factors.

VITAL IMPORTANCE OF THE NITROGEN FIXATION PROBLEM

The problem of nitrogen fixation is one of vital importance to this country both in war and in peace. The element forms an essential constituent of explosives, of fertilizers, of dyestuffs and many other substances used in the arts. In time of war the necessity of importing Chilean saltpeter, with its attendant uncertainties and tie-up of carrying capacity, is very serious. In time of peace the use of nitrogen in fertilizers is only limited by the supply and, if available, larger quantities would be used for increasing the food and other crops necessary for the country's welfare.

As Prof. Shimer of the Massachusetts Institute of Technology has put it, man has passed through the stone age, the bronze age and the iron age and now is in the nitrogen age. Although nitrogen is one of the most abundant chemical elements, forming four-fifths of the earth's atmosphere, it is one of the most difficult to capture in useful chemical combination. The main function of the Fixed Nitrogen Research Laboratory is to show America how to carry out this capture and how to transform the different nitrogen compounds one into another.

The nitrogen-containing explosives necessary to keep fifty divisions in the field for one year have a value of approximately \$500,000,000. Prof. Jacob G. Lipman estimates that the total loss of nitrogen from the arable land under cultivation in the United States is equivalent to 15,000,000 to 20,000,000 tons of ammonium sulphate per annum, and although it would be impractical at the present time to replace all of this nitrogen, it represents a loss of material worth in the neighborhood of \$1,000,000,000 a year. Surely the expenditure of \$300,000 a year at the Fixed Nitrogen Research Laboratory to keep abreast with the work of other nations on nitrogen fixation is small insurance.

VALUE OF RESEARCH IN NITROGEN FIXATION

Germany spent about ten years in perfecting the Haber process before going into the late war and after she was cut off from the importation of Chilean saltpeter she was still able to continue the war for four years. It is believed that during the last three years of the war she obtained her nitrogen for explosives



CATALYST-TESTING PLANT. REACTION BOMBS

and for food production almost exclusively from the cyanamide and the Haber processes, with perhaps a little importation from Norway of nitrogen fixed by the arc process. This German development meant far more research than is even contemplated at the Fixed Nitrogen Research Laboratory. At the Oppau plant alone there was a research laboratory costing \$1,000,000 and employing 200 research chemists, quite independent of the chemists doing routine work.

BODY OF EXPERTS HERE SECOND TO NONE OUTSIDE OF GERMANY

At the time of our entrance into the war, America had no method of fixing nitrogen within her own borders and had only a few men in the Government service who were even at all familiar with methods of nitrogen fixation. There is now a body of experts at the Fixed Nitrogen Research Laboratory and connected with the Nitrate Division as a whole, whose information concerning nitrogen fixation could hardly be duplicated outside of Germany. If such a body of Government experts had been available at the time of our entrance into the war, it would certainly have been appreciated that the Haber process had not been sufficiently developed in America to warrant the con-

struction of the Sheffield plant, while the construction of the great Muscle Shoals plant, which was built and in operation in less than a year and had already produced 1,700 tons of ammonium nitrate before being shut down, might have been started a year earlier.

ADVANTAGES OF A PERMANENT GOVERNMENT AGENCY TO STUDY NITROGEN FIXATION PROBLEMS

It is our belief that a laboratory for studying the fixation of nitrogen should be a permanent agency of the Government, and that the present laboratory should certainly be continued as long as the funds which Congress wisely appropriated for the specific study of nitrogen fixation are still available.

In this connection it should be specially pointed out that although research on the nitrogen problem has been carried on, particularly in Germany, for many years and will always continue, the work differs from other scientific work in that the results are kept secret to an unusual extent. We can get no reliable information concerning ammonia catalysts, for example, from the German literature. Attention should also be called to the fact that the personnel of the Fixed Nitrogen Research Laboratory are all civilians. If the laboratory is disbanded it will be very difficult to get them together again.

Although the laboratory is working under great disadvantages owing to the present uncertainty as to its future and has already begun to lose personnel because of this uncertainty, it is realized that a wise decision of this question is a very complex matter. This is specially true since it is difficult to obtain any clear picture of the activities of the laboratory without a careful study made at the laboratory itself. Before any decision is made as to the future, it is believed that the work of the laboratory should be studied by some body of technical experts who can estimate the importance of its researches to the Government, to the nitrogen industry and to the country as a whole.

Recovery of the Beet Sugar Industry in France

A forecast by the Ministry of Agriculture indicates that the French beet sugar production from the crop of 1924-25 will probably reach 590,000 metric tons (metric ton = 2,204 lb.), or 68 per cent of its normal pre-war output.

During 1913-14, the last crop year before the war, there were in France 213 mills operating, producing 864,814 metric tons of 100 deg. sugar, at an average of 16.95 per cent extraction, from 6,674,022 tons of beets grown on 566,309 acres of land.

During the war there were destroyed completely 135 sugar mills, located in the ravaged areas of the northern departments. There remained intact seventy-eight mills, but with heavy plant deterioration due to enforced idleness, a deterioration necessitating repairs or replacement of the most expensive equipment, such as slicing machinery, pumping systems, triple and quadruple effects, vacuum pans, crystallizers and centrifugal machines.

In 1918-19, the first crop year after the war, French mills produced 107,841 tons of beet sugar. In 1919-20 the sugar output rose to 152,332 tons from 163,496 acres of beets, at an average extraction of 17.57 per cent of the weight of beets sliced. The average extraction of 100 deg. sugar for ten years prior to 1914 was about 16 per cent. For the present crop of 1920-21 there was

sown in beets 202,230 acres, the average extraction to date is 17.69 per cent and the estimated sugar production will be 350,000 tons at 100 deg. polarization, thus exceeding an earlier estimate of 250,000 tons. The increased sugar extraction, it should be observed, is due to deep plowing of land which had lain fallow for four years, more thorough cultivation, and heavier fertilization with potash now available at reduced cost from the Alsace-Lorraine deposits. The daily slicing capacity of mills now in operation is 2,375 tons of beets, and mills about to resume grinding will have an additional beet capacity of about 3,000 tons per day.

Future sugar production per crop is estimated as follows: 1922-23 crop, 460,000 tons; 1923-24 crop, 550,000 tons; 1924-25 crop, 590,000 tons.

It is estimated that to complete the rehabilitation of the French beet sugar industry there will be required an additional expenditure of about \$4,825,000 (with the franc at 19.3c.).

Canada's Coal Trade for 1920

The output of Canadian coal mines in 1920, according to figures compiled by the Dominion Bureau of Statistics, was 16,968,568 short tons, as against 13,919,096 short tons in 1919, being an increase of 21.9 per cent and a record in the history of coal mines in Canada since the previous high mark was set in 1913 at 15,532,878 short tons. Exports increased to 2,558,223 tons, as compared with 2,070,050 tons in 1919, and imports from the United States were 20,815,596 tons, against 16,982,773 tons in 1919.

Except in Saskatchewan, the output of coal in 1920 in the Canadian provinces was everywhere in excess of that mined in the previous year. Alberta led in output, with 41 per cent of the year's total production. Nova Scotia produced 37.86 per cent of the total, British Columbia 18.3 per cent, Saskatchewan 1.9 per cent and New Brunswick 1 per cent.

By kinds of coal the increases in output for Canada amounted to 0.3 per cent for anthracite, 16 per cent for bituminous and 5.6 per cent for lignite.

An analysis of the exports of Canadian coal during the year shows Nova Scotia as the principal coal-exporting province, with shipments out of the province for foreign destinations amounting to 1,245,673 short tons, as against 994,107 tons in 1919. British Columbia comes a close second with 1,191,103 short tons in 1920 and 1,014,201 tons in 1919.

Ontario leads in the amount of coal imported, central Ontario receiving 2,945,082 short tons of anthracite last year and 2,978,472 tons the year before. More bituminous coal was brought into Ontario in 1920 than in the previous year, the quantities for the two years being 10,374,324 short tons in 1920 and 7,700,935 tons in 1919.

Importations of bituminous coal from the United States into the Province of Quebec fell off very markedly during 1920, as compared with 1919, the total figures being 2,073,813 short tons in 1920 and 3,503,410 tons in 1919. As regards anthracite, the totals for the two years were 1,544,456 tons in 1920 and 1,378,460 tons in 1919.

Bituminous-coal imports into the whole of Canada amounted to 15,902,632 tons in 1920, compared with 12,010,490 tons in 1919. Anthracite imports were slightly lower at 4,912,964 tons in 1920 and 4,972,283 tons in 1919.

Gasification of Powdered Coal*

A Consideration of the Velocity With Which Reaction Takes Place Between Producer Gas and Suspended Carbon, Using the Results for Estimating a Proposal for Gasifying Powdered Coal or Oil

By A. E. BOURCOUD

SINCE the first practical application of burning powdered coal many attempts and processes have been put forward in order to use the same fuel for generation of industrial or producer gas. However, at the present moment, so far as the knowledge of the writer is concerned, none of the trials made has given enough satisfaction to justify its adoption. To cite only those receiving more or less public report, Gobbe, in Belgium; De Laval, in Sweden; Junquera, in Spain; Marconnet, in France, and Allis-Chalmers (Hirt producer), in United States, have shown that the resulting gases had approximately the heating value of blast-furnace top-gas, containing a high percentage of CO_2 and partially decomposed hydrocarbons, having a relatively low calorific value when cooled, and keeping a great part of the original powdered coal in suspension as powdered coke.

CLASSIFICATION OF PROCESSES

The methods or processes put forward can be divided into two groups, namely: (a) One-step processes and (b) two-step processes.

The one-step process consists in introducing a current of air into a chamber with the theoretical quantity of powdered coal to form producer gas by incomplete combustion. Thus all the fuel is first subjected to a rapid distillation; the air introduced for the incomplete combustion of the whole fuel is generally more than that necessary for the complete combustion of the contained volatile matter, with the result that these volatiles are the very first to burn. A small amount of the fixed carbon also is consumed, a high temperature is quickly produced, and the remainder of the fixed carbon, remaining as powdered coke, reacts with the products of combustion of the volatile matters, decomposing the CO_2 and H_2O into CO and H_2 respectively.

The two-step process divides the operation into two stages; the first introduces air with the theoretical quantity of powdered coal for perfect combustion, and then introduces by a second injection the theoretical quantity of powdered coal to transform the products of combustion into fuel gases. Practical inconveniences prevent the two-step process from being carried out in its theoretical entirety, as will be seen afterward.

Theoretically the same amount of thermic work has to be done in both processes to treat the same kind of coal and to arrive at the same end. Only slight differences in temperatures will result, these due to the way in which operations are carried out.

In both processes the reactions are the same as those in ordinary gas producers, with the difference that partial distillation of the coal is effected in the cool or top zone of a common gas producer, while in gasifying

powdered coal this distillation takes place in zones of high temperature. Thus dissociation of the hydrocarbons is more complete. Provision evidently must be made for this important difference.

As a first impression, it seems that neither the one-step nor the two-step process is distinctly more advantageous with the exception perhaps that the two-step process, although with the slight complication of a second fuel injection and control, makes possible the employment of different kind of fuels for the first injection and the second. A second injection of anthracite, coke or charcoal may be made, which so far have presented great difficulties in the one-step gasification.

Both processes are so simple as to be considered much more handy, compact and controllable than any of the ordinary producers of standard type.

Considering the great advantage to be gained by treating raw materials with such a considerable surface action, it seems curious enough that no better results have been obtained. This in turn suggests that some theoretical reasons underlying practical requirements probably not accounted for have been standing in the way of commercial success. The very presence of large quantities of carbon suspended in the partly decomposed products of combustion making up the final gas evidently shows that complete reaction between carbon and CO_2 and H_2O has not taken place, either due to faulty conditions of temperature or pressure or a lack in time.

To arrive at a more definite conclusion it is convenient to review the causes modifying the velocity of such reactions.

RATE OF REDUCTION

The rate of reduction of CO_2 by carbon has been dealt with exhaustively by several well-known experimenters since Boudouard; later on, among others, by Clements, Adams and Hisking,¹ and by Rhead and Wheeler.² These experiments not only show the reaction as a function of temperature and concentration, but also confirm the general fact in like actions that the rate of reduction is affected by the facility with which the exhausted gaseous compounds are replaced by fresh ones to continue the work.

The above-mentioned researches passed a current of CO_2 through charcoal at different speeds and temperatures; that is to say, giving the molecules of gas every chance to be removed from the surface of the pieces of carbon. On the other hand, if the particles of carbon are maintained in suspension in the very same medium with which they have to react, there is less chance of removal of the exhausted or connected molecules of gas from the zone of influence of the particles of carbon. The rate of reaction must then diminish in

*Excerpts from a communication to the U. S. Bureau of Mines in 1918 on the Possibilities of Oil and Other Fuels Than Coking Coals for the Manufacture of Steel Direct From Iron Ores.

¹Bureau of Mines Bull. 7, 1911.

²Trans. Chem. Soc., 1912.

some appreciable degree, compared to the case of stationary carbon at the same range of temperature.

The writer is not aware of any special experiments carried out on the above lines. However, some interesting information can be deduced from other experiments upon the behavior of coke-oven gas containing an appreciable quantity of CO_2 and suspended carbon, the latter due to the decomposition of the hydrocarbon gases. Simmersbach³ heated such coke-oven gas for different periods, and published the resulting analysis of the transformed gas, showing an increasing amount of CO until the whole of the original CO_2 was reduced. The range of temperatures used was between 800 and 1,200 deg. C., and the time of reaction between eleven and twenty-two seconds.

Lacking more complete information, these data will serve for a preliminary survey of the reasons for the failure of attempts to gasify pulverized fuel.

With these views, Fig. 1 has been prepared, showing

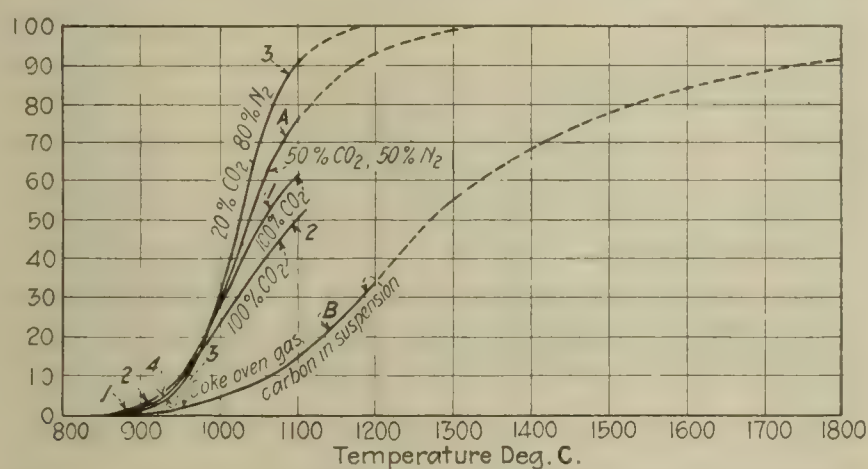


FIG. 1. RATE OF REDUCTION PER SECOND OF CO_2 TO CO

the percentage of CO_2 reduced by carbon per second and at different temperatures:

Curve 1 shows Rhead and Wheeler's series I and II, using pure CO_2 .

Curve 2 shows the results found by Clements, Adams and Hisking under the same conditions, calculated for a time of contact of one second, from their original curve for five seconds.

Curve 3, according to Rhead and Wheeler, for a mixture of 20 per cent of CO_2 and 80 per cent N_2 .

Curve A is the corresponding calculated value, for a mixture of 45 to 50 per cent N_2 , the average final gas made when gasifying bituminous coal or oil, deduced from the average of curves 1 and 2, and curve 3.

Curve B shows the rate of reduction per second with carbon in suspension, calculated from the experiments of Simmersbach. The greater part of curve B has been determined by extrapolation, and although methods of this kind are many times branded as dangerous, in the case under consideration the similarity of all the reactions makes all the curves of the same class, with the sole difference of their respective parameters.

It now remains to compute from these graphical data a curve which will show the rate at which the gas made when gasifying pulverized fuel may be expected to react with the carbon it carries in suspension. Various fuels may be used either in the one-step or the two-step process, and air for combustion may be either cold or preheated. However, the method of computation is in all cases quite similar, and the following solution is given for a dried bituminous coal, gasified in one step with dry cold air.

³Stahl und Eisen, Feb. 6, 1913.

TABLE I. GASIFICATION OF POWERED COAL IN ONE-STEP

Air at 0 Deg. C.

Zone Temperatures, Deg. C.	Cu.M. of Mixture Reduced in Zone	Cu.M. of Unre- duced Mixture at the End of Zone	Percentage Re- duced in Each Zone (100 %)	Per Cent Rate of Reduction per Second (100 r)	Time in Seconds —		
					Partial, Log (1-r)	Total	Cumulative Reduc- tion, per Cent
1545 to 1500	16	249	6.5	80.0	0.042	0.042	6.5
1500 to 1400	38	195	16.4	73.5	0.135	0.177	21.0
1400 to 1300	38	157	19.5	62.5	0.221	0.398	36.5
1300 to 1200	37	120	23.5	45.5	0.445	0.843	51.5
1200 to 1100	37	83	31.0	25.0	1.295	2.138	66.5
1100 to 1000	37	46	44.6	10.0	5.620	7.758	81.5
1000 to 900*	37	9	80.0	3.0	53.100	60.858	96.5
900 to 875	8	1	89.0	0.5	435.000	495.838	99.6

* Reactions would stop before this temperature is reached, due to equilibrium.

Composition of Dried Coal Proximate

	Per Cent		Per Cent		Per Cent
C.....	75	Fixed carbon...	56	C.....	19
H.....	5	Vol. matter. ...	34	H.....	5
O.....	10	Ash.....	10	O.....	10
Ash.....	10				

Heat produced = 7,089 calories per gram.

Combustion of carbon in 255.3 kg. coal⁴ to CO

$$75\% \text{ carbon} \times 255.3 \text{ kg.} \times \frac{16}{12} = 255.3 \text{ kg. O}_2 \text{ required}$$

$$10\% \text{ oxygen} \times 255.3 \text{ kg.} = 25.5 \text{ kg. O}_2 \text{ from coal}$$

$$229.8 \text{ kg. O}_2 \text{ supplied from air}$$

$$229.8 \text{ kg. O}_2 \times \frac{1}{1.43} = 160.0 \text{ cu.m. O}_2 \text{ (standard conditions)}$$

$$\text{corresponding to } 610.0 \text{ cu.m. N}_2 \text{ (765 kg.)}$$

$$\text{A total of } 770.0 \text{ cu.m. air (995 kg.)}$$

In other words, 255.3 kg. coal is injected with 770 cu.m. air (standard conditions) in unit time.

Assume that the volatile matter first burns to CO_2 and H_2O , and any excess oxygen converts some fixed carbon to CO_2 .

	Products—	
	CO_2 Cu.M.	H_2O Cu.M.
19% C $\times$ 255.3 kg. $\times$ $\frac{32}{12}$ = 129.7 kg. O_2 to CO_2	90.5	.....
5% H $\times$ 255.3 kg. $\times$ $\frac{16}{2}$ = 102.1 kg. O_2 to H_2O}....	.....	142.0
Balance of oxygen = 23.5 kg.		
Will burn 9.0 kg. carbon forming.....	16.5	.....
Total.....	107.0	142.0

The products of this partial combustion are now as follows:

CO_2	107.0 cu.m.
H_2O	142.0 cu.m.
N_2	610.0 cu.m.
C.....	133.5 kg.
Ash.....	25.5 kg.

The next step is to determine the final temperature of this mixture produced by the combustion of the volatile matter plus 9 kg. of fixed carbon. First the heat of combustion of the volatile matter is figured:

$$\text{Heat liberated by total combustion of 100 g. in calorimeter} = 708,900 \text{ Cal.}$$

$$\text{Heat due to combustion of carbon } 56 \times \frac{97,200}{12} = 453,000$$

$$\text{Balance due to volatile matter} = 255,900$$

$$\text{Heat of combustion of volatile matter} = \frac{255,900}{34} = 7,500 \text{ cal. per kg.}$$

⁴255.3 kg. coal is used in the calculation of the one-step process so that the results may be compared with those for the two-step, calculated for a primary injection of 100 kg. of coal and a subsequent addition of another 155 kg. to transform the product of combustion into combustible gases.

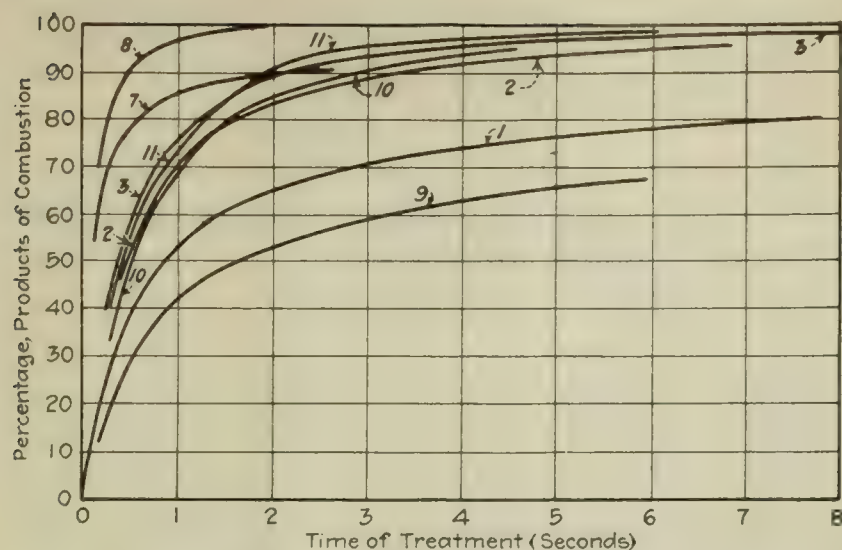


FIG. 2. PROGRESS OF RELATION BETWEEN PRODUCTS OF COMBUSTION AND SUSPENDED CARBON

Then determine the heat liberated by assumed partial combustion of 255.3 kg. coal:

By volatile matter 34% × 255.3 kg. × 7,500 cal./kg. =	Cal. 655,000
By 9 kg. carbon 9 × $\frac{97,200}{12}$ =	73,000
	728,000
Less 5% radiation.	36,000
	692,000

This heat is absorbed by the products of partial combustion, bringing their temperature to t .

In CO ₂	107 cu. m. @ (0.37 <i>t</i> + 0.00022 <i>t</i> ²) =	39.5 <i>t</i> + 0.0235 <i>t</i> ²
In H ₂ O	142 cu. m. @ (0.34 <i>t</i> + 0.00015 <i>t</i> ²) =	48.1 <i>t</i> + 0.0213 <i>t</i> ²
In N ₂	610 cu. m. @ (0.303 <i>t</i> + 0.000027 <i>t</i> ²) =	184.0 <i>t</i> + 0.0164 <i>t</i> ²
Carbon	133.5 kg. @ 0.5 <i>t</i>	
Ash	25.5 kg. @ 0.5 <i>t</i>	
		= 79.5 <i>t</i>

Total.....351.1*t* + 0.0612*t*²

But 351.1*t* + 0.0612*t*² = 692,000
whence $t = 1545^\circ \text{C.}$ (incoming air and coal at 0°C.)

We have therefore 107.0 cu.m. CO₂ and 142.0 cu.m. H₂O (measured at standard conditions) entering the reduction chamber in the producer at a high temperature and with sufficient finely divided carbon to effect their complete reduction. Chemical reaction, absorbing heat, will then occur at a continually decreasing rate determined by curve *B* in Fig. 1. It has been supposed that the rate of reduction of a mixture comprising x parts of CO₂ and y parts of H₂O acts with the same velocity as a volume of CO₂ equal to $x + y$ and that the time of treatment is too short to feel the influence of the reversible reaction $\text{CO}_2 + \text{H}_2 \rightleftharpoons \text{CO} + \text{H}_2\text{O}$ in the presence of carbon. For purposes of computation it is handy to divide the reaction chamber into zones, limited by certain temperatures.

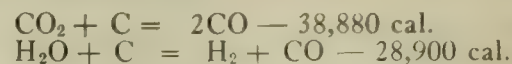
The time in the first zone (assumed to be from 1,545 deg. C. to 1,500 deg. C.) may be calculated by the formula

$$t = \frac{\log(1 - k)}{\log(1 - r)}$$

where r is the decimal fraction giving the amount of mate-

rial reduced per second at the average temperature of the zone (scaled as 0.80 from curve *B*, Fig. 1).

In cooling from 1,545 to 1,500 deg. C. the gas loses a certain amount of heat, all of which (barring radiation) is absorbed in the endothermic reactions



The volume of gas so reduced divided by the total amount which may be reduced equals the factor k . The composition of the gas and its sensible heat at 1,500 deg. C. can be calculated by successive approximations, but a simplifying assumption will be made, thus: Figure the temperature of the gas at the end of the reaction and assume that the volume of gases reduced is proportional to the temperature drop. The figured total time for the reaction will then be greater than that derived by more precise computations—an error on the side of conservatism.

Final products of combustion:

CO	75% × 255.3 kg. × $\frac{28}{12} \times \frac{1}{1.25} =$	356 cu. m.
H ₂	5% × 255.3 kg. × $\frac{1}{0.09} =$	142 cu. m.
N ₂		610 cu. m.
Ash		25.5 kg.
Sensible heat in this mixture at t deg. C.:		
CO	356 (0.303 <i>t</i> + 0.000027 <i>t</i> ²)	} = 336 <i>t</i> + 0.0299 <i>t</i> ²
H ₂	142 (0.303 <i>t</i> + 0.000027 <i>t</i> ²)	
N ₂	610 (0.303 <i>t</i> + 0.000027 <i>t</i> ²)	
Ash	25.5 kg. @ 0.5 <i>t</i>	= 13 <i>t</i>

Total sensible heat = 349*t* + 0.0299*t*²

Heat produced by reaction equals that from original combustion less that absorbed by reduction of CO₂ and H₂O by equations noted above.

Absorbed by CO₂ = 107.0 cu. m. × $\frac{1.98}{44} \times 38,800 = 187,000 \text{ cal.}$

Absorbed by H₂O = 142.0 cu. m. × $\frac{0.81}{18} \times 28,900 = 185,000 \text{ cal.}$

Total absorbed..... 372,000 cal.
Original quantity..... 692,000 cal.

Balance at end point⁵ 320,000 cal.
Equate:

$$349t + 0.0299t^2 = 320,000$$

whence $t = 875 \text{ deg. C.}$, the temperature of the gases at the end.

Reverting to the assumption of proportionality between sensible heat and temperature, Column 2 of Table I can be readily calculated.

The rest of the data contained in the table can be readily calculated in a manner obvious from the definitions noted at the top of each column. The last column is then plotted as curve 1 on Fig. 2, which shows immediately the time of reaction necessary to convert any portion of the CO₂ plus H₂O into CO and H₂. Eleven cases in all were computed and plotted in Fig. 2, as in Table II.

Temperatures of the various zones plotted against the time consumed in reaching that degree are plotted in the curves of Fig. 3.

Complete reduction and an ideal gas cannot be obtained unless the last traces of the first products of combustion react with the last traces of carbon in suspension at a temperature well above equilibrium, in general 1,100 deg. C. or 1,150 deg. C.

With the exception of coke or anthracite, the curves show therefore that ordinary coals and oil cannot be completely converted into an ideal gas without the addition of external help in the form of preheated primary air. Its temperature varies from the semi-bituminous coals up to oils, the latter requiring a very high tem-

⁵An amount less than that liberated by the CO existing, by the heat absorbed in decomposing volatile matter and heat radiated.

TABLE II. PRINCIPAL DATA FOR FIGS. 2 AND 3

Curve No.	Operation	Fuel	Temperature of Air, Deg. C.	Temperature at Beginning of Reduction	Temperature on 100 per Cent Reduction
1	One-step	Carbon in suspension	0	1,545	875
2	One-step	Carbon in suspension	400	1,725	1,115
3	One-step	Carbon in suspension	560	1,800	1,200
4	Two-step	Carbon in suspension	0	1,510	875
5	Two-step	Carbon in suspension	400	1,700	1,115
6	Two-step	Carbon in suspension	560	.....	.....
7	Two-step	Stationary carbon	0	1,545	875
8	Two-step	Stationary carbon	400	1,725	1,115
9	One-step	Oil	0	1,374	900
10	One-step	Oil	800	1,654	1,285
11	One-step	Oil	1,000	1,712	1,280

perature for gasification into permanent gases. These high temperatures are necessary not only to keep the reactions well above equilibrium, but still more in order to operate in zones where the reactions can take place within a reasonable and practicable time.

To diminish the time taken by the reaction of a given portion of the gas [i.e., for a constant value of $\log(1 - k)$] it is necessary to increase the value of $\log(1 - r)$ as much as possible. That is the same as saying increase the value of r , which in turn is a function of the increase in temperature. The best way therefore to speed up the process is to translate the whole system to a higher temperature zone by increasing the temperature of the primary air.

This influence in the partial and total time taken is clearly evident when comparing the curves 1, 2 and 3

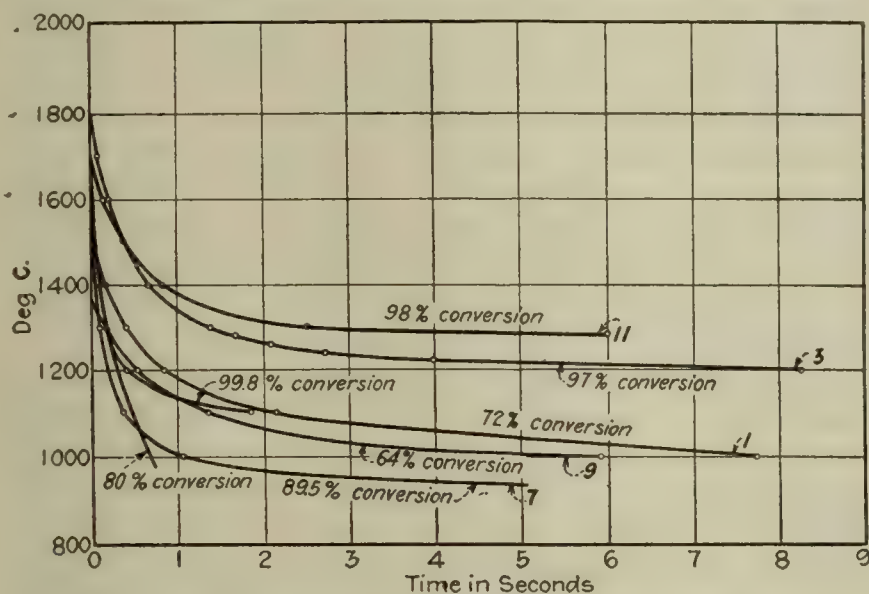


FIG. 3. FALL OF TEMPERATURE DURING REDUCTION OF CO_2 AND H_2O INTO CO AND H_2

for powdered coal with primary air at 0 deg. C., 400 deg. C. and 560 deg. C. respectively and the curves 9, 10 and 11 with primary air at 0 deg. C., 800 deg. C. and 1,000 deg. C. respectively when gasifying oil.

Curves 4, 5 and 6, which have been calculated, are not shown in Fig. 3, as they follow curves 1, 2 and 3 so closely that they can be considered as the same.

The curves 7 and 8 have been calculated with values of r from curve A in Fig. 1 only to show the difference when working with stationary carbon, as in our ordinary gas producer, with gas mixtures containing 45 to 50 per cent N_2 .

Gas from coke gas producers, working along the same lines as a blast furnace, has 80 per cent N_2 at the beginning of CO_2 reduction. It acts still more rapidly, being governed by curve 3 in Fig. 1, which has higher value of r at each temperature than curve A, for ordinary gas producers.

The theoretical temperature of the products of combustion (with the coal used in the other examples), at the beginning of the second stage in the two-step process is about 1,900 deg. C. with air at 0 deg. C., and 2,065 deg. C. with air at 400 deg. C. This would require an excess of coal mixed with the first injection in order not to transgress the practical limits of available refractory materials. A two-step process with excess coal thus reverts to a one-step operation.

REASON FOR FORMER FAILURES

In those examples representing the best results a temperature of 1,700 to 1,800 deg. C. has been reached in the combustion chamber, which is the maximum admissible for the best refractory material to withstand

in daily routine. Even in that extreme case the total time taken for generating a nearly ideal gas for a reducing agent or combustible is between five and six seconds, in addition to the time taken by the first combustion of the fuel in the combustion chamber (about one second), meaning a total of six to seven seconds.

It seems that previous trials in gasifying oil or pulverized fuel have paid too little attention to the time necessary for the reaction and the temperature which must be maintained for its completion. In published drawings and descriptions the path of the gases through the producer is clearly too short to hold them the required time. The resulting gas, moreover, is that which would be delivered by a perfect producer if it were tapped too near the combustion chamber. When utilizing cold air and powdered coal, it is evidently hopeless (from a consideration of Fig. 2) to produce a gas 50 per cent better than ordinary blast-furnace top-gas within a total period of five seconds. ($\text{CO}_2 + \text{H}_2\text{O} = 6$ per cent by volume. $\text{CO} + \text{H}_2 = 35$ per cent.)

PROPOSED PRODUCER FOR POWDERED FUEL

A producer of considerable capacity being desired, let us fix upon one which should gasify about 150 tons of coal (or 600 bbl. of oil) in twenty-four hours.

Two different types of producers are immediately suggested: First, with horizontal combustion chamber, which should have special advantages in the two-step method where different kind of fuels are used for each injection. Second, a producer with vertical combustion chamber, working preferably with the one-step method of gasifying, and in general outlines similar to blast-furnace hot-blast stoves. Only the latter will be discussed in detail.

Fig. 4 shows in schematic lines the general arrangement. Injection of powdered coal and preheated air occurs at I' ; A is the combustion chamber; the path

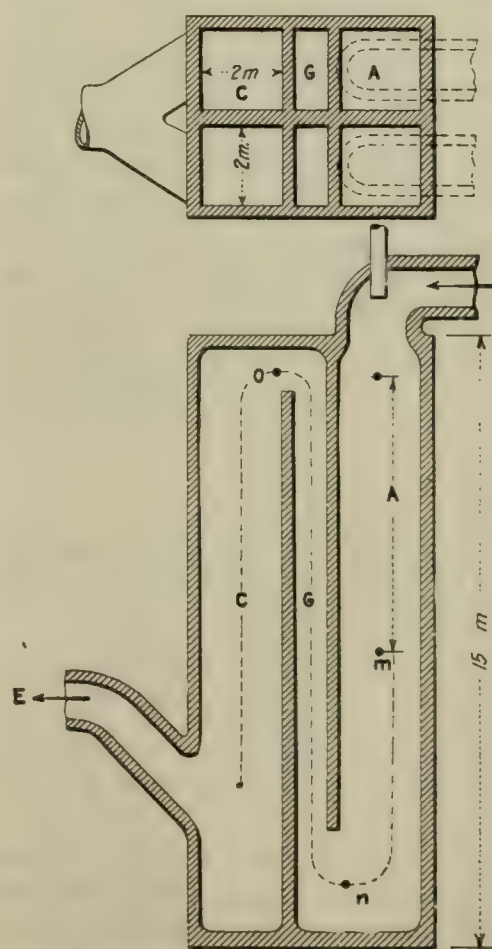


FIG. 4. SKETCH OF VERTICAL PRODUCER

of the gas follows the dotted line. At the bottom of chamber C most of the ashes can be withdrawn, part of them possibly at the bottom of A, especially if a coal with very fusible ash is utilized. The central passage G has much smaller area than A and C, with the object of accelerating the velocity of the gases, so that the matter in suspension—carbon and ashes—may be better carried up to the top of chamber C. During the whole passage the suspended coal and the gases will have every chance for mutual displacement. Going down, the material in suspension will travel quicker than the sur-

rounding gases; in the up direction, slower. The gases pass finally through *E*, most likely with a small amount of ashes still in suspension. If desired they can be completely cleaned by passing them through a coke scrubber, or any other dry-cleaning system.

It is obvious that in practical operations it would be necessary to use a small amount of fuel in excess of the theoretical and also to provide the bottom of chamber *A* with a well-designed siphon for slagging off the melted ashes.

TABLE III. PRODUCER COMPUTATIONS

Time of treatment in seconds, after combustion.....	0	1	2	3	4
Temperature, deg. C.....	1,800	1,350	1,260	1,235	1,220
Per cent of products of combustion reduced in total time.....	0	77	89	96	97
Fall in temperature.....	0	450	90	25	15
Volume of gases (standard conditions) from 255.3 kg. coal, at end of zone:					
CO.....		274.0	316.0	341.0	346.0
H ₂		109.0	126.0	136.0	138.0
CO ₂	107.0	25.0	12.0	4.0	3.0
H ₂ O.....	142.0	33.0	16.0	6.0	4.0
Active elements.....	249.0	441.0	470.0	488.0	491.0
N ₂	610.0	610.0	610.0	610.0	610.0
Total volume.....	859.0	1,051.0	1,080.0	1,098.0	1,101.0
Carbon in suspension, kg.....	133.5	30.6	14.7	5.4	4.0
Decimal composition:					
CO.....		26.0	29.3	31.0	31.5
H ₂		10.4	11.7	12.6	12.8
CO ₂	12.5	2.4	1.1	0.4	0.2
H ₂ O.....	16.6	3.1	1.5	0.5	0.3
N ₂	70.9	58.1	56.3	55.5	55.2
Degree of saturation*.....	100.0	100.0	100.0	100.0	100.0
Volumes at actual temperature in cu.m.....	6,900.0	6,300.0	6,050.0	5,709.0	5,500.0
Volumes per ton coal gasified, at actual temp.....	27,500	25,000	24,000	22,800	22,000
Volumes passing cu.m. per second.....		43.5	42.0	39.6	38.0
Length of zone, speed of gas 8 m. per sec.....		5.5	5.25	5.0	4.8

* Quotient of oxidizing gases by oxidizing plus reducing.

Table III contains the results of a number of simple computations, taking data from curve 3 of Figs. 2 and 3, corresponding to the gasification of bituminous coal by the one-step process, using primary air preheated to 560 deg. C. All volumes have been reduced to 0 deg. C. and 760 mm.

The maximum velocity of the gases during the highest temperature zone at *A* has been limited to 6 m. per second (or about 20 ft.) when expanded at the correct temperature. For facility of construction, the section should be kept constant in area all the way through, with the exception of uptake *G*, where the velocity has been increased to 18 m. per second (60 ft.). The temperature of the gases at the entrance of *G* should be about 1,300 deg. C. maximum, and at this temperature there is no danger of eroding the refractory lining.

Dimensions of Producer

Combustion chamber:

150 tons coal per 24 hr., each making 27,500 cu.m. gas at 1,800 deg. C., produces 47.7 cu.m. per second.
At a maximum gas velocity of 6 m. per sec., this requires *A* to have a cross-section of 8 sq.m.
Its length, assuming 1½ seconds for combustion, is 9 m.
From Table III lengths of zones 1, 2, 3 and 4 total 20.55 m.
Total length 29.55 m. (95 ft.)
Disregarding volume of passage *G*, the volume of reacting chamber = 29.55 × 8 = 236.4 cu.m., or 38 cu.m. per ton of coal gasified per hour.

The required structure with thick heat-insulating walls could doubtless be contained in a steel shell 20 ft. in diameter by 60 ft. high and a 300-ton-per-day producer would have to be 25 ft. in diameter and 70 ft. in height.

General Factors in Belgian Metallurgy, 1920

Out of the fifty-four blast furnaces existing in Belgium in 1913 only ten were in operation on Jan. 1, 1920. On Jan. 1, 1921, among the fifty-two blast furnaces now in existence, twenty-seven were in operation, of which, in twenty-four hours, twenty-three produce 3,748 tons of steel, two produce 277 tons of ordinary pig, and the two others 235 tons of refined pig iron. In 1914 forty-nine blast furnaces were operating, of which forty-four produced 6,615 tons of steel, four produced 280 tons of ordinary pig, and one furnace 85 tons of refined pig iron per twenty-four hours.

In Belgian metallurgy the year 1920 showed, during the first six months, a period of unprecedented prosperity, during which abundant orders at abnormally high prices gave added impetus to reconstruction work, so that by July the general metallurgical production in Belgium had reached 60 per cent of its pre-war record. The month of June saw rails at 1,600 f. a ton, but the price decline of the second half of 1920 and the gradual decrease in demand, together with foreign competition, particularly from German sources, has removed the stimulus for increased production, and while reconstruction work is still vigorously pursued, the production figures for December, 1920, exhibit relatively little variation above those of the preceding July.

It is hoped in Belgian industrial circles that a diminution of production costs by wage readjustments, lowering of coal prices and the restoration of the former preferential freight tariffs for ore transport by rail will have a favorable effect on Belgian offers in foreign markets. The introduction of the 8-hour day, necessitating additional working shifts, has added another important item of wage expenditure. For the purpose of export expansion, large Belgian banking interests with important metallurgical affiliations are recommending a policy of combining for the purpose of specialized production and for the establishment of technical sales organizations in foreign markets. The traditional tendency of Belgian industrial life has, however, been so intensely individualistic and competitive that, despite the necessity of some such innovation, its introduction can result only from the further education of the Belgian producer.

Italian Sumac Production

Sicily is the largest producer of sumac in the world, followed by the United States. The annual output in recent years is estimated at 15,000 tons, a decrease of 50 per cent, compared with pre-war production, due to the lack of cultivation brought about by war conditions. However, it is believed that this is only temporary.

Sumac is of two kinds—male and female. The male species, which is found in the Provinces of Palermo and Girgenti, contains 28 per cent or more of tannin, and is therefore the better of the two. The female leaf averages about 24 per cent tannin and is generally found in the Provinces of Catania and Girgenti. Both species thrive throughout the island at any elevation up to 2,000 feet.

At present there is a slump in the sumac market, owing to the prevalent opinion that prices in the foreign markets will fall. Stocks are now available in Palermo at the following prices: Ground ventilated, 28 per cent, 73.60 lire; leaf, 28 per cent, 71.05 lire; and leaf, 30 per cent, 76.15 lire. The prices quoted are f.o.b. Palermo, per hundredweight Yocum's test.

Recovery of Sugar From Beet Molasses

Description of the Steffens and Strontia Processes Using Alkaline Earth Saccharate Precipitate Methods of Recovering Sugar From Non-Edible Beet Molasses—Specification of Materials—Status of Processes

BY WALLACE MONTGOMERY

THE solubility of sugar is affected very much by the presence of foreign organic and inorganic substances. These impurities limit its recovery from the sirups in sugar manufacture called molasses, from which no more sucrose can be recovered by ordinary methods of concentrating and crystallizing. Therefore some different procedure must be resorted to if the remainder of the sugar is to be recovered.

Ordinarily the sugar in molasses from a beet sugar house amounts to 16 to 19 per cent of the total sugar content in the original beets, and the molasses from 6.5 to 7.5 per cent on the beet weight, though this is increased from 1 to 1.5 per cent by the wash water used in washing the raw sugar, giving us a product of approximately the following analysis:

Brix, deg.....	85-89
Sucrose, per cent.....	48-51
Apparent purity.....	56-60
Ash, per cent.....	10-13
Non-sugars, per cent.....	25-30
Organic non-sugars, per cent.....	18-20

COMMERCIAL RECOVERY PROCESSES

Numerous investigators have studied the problem of the recovery of sugar from molasses and there have been six or eight processes tried with varying success. Of these three only proved to have any commercial value, the osmose, the strontia and the Steffens precipitation processes, the last named being the one almost entirely used at present.

Recent inventions in settlers, thickeners and mechanical filters have done more for the Steffens process in reducing cost and increasing production than anything heretofore. The main essentials for Steffens house operation are good high-grade lime and an abundance of cold water, the water either from natural sources or cooled by refrigeration.

Limestone occurs abundantly in nature and is found in practically all stone formations, but only occasionally in the high state of purity that is necessary for the precipitation process. Only a high-grade stone containing a very low silica and magnesium content may be used. The following analysis is typical:

	Per Cent
Moisture.....	0.01
Silica.....	0.68
Iron and aluminum oxides.....	0.55
Calcium carbonate.....	98.47
Magnesium carbonate.....	0.09
Calcium sulphate.....	0.20
	100.00
Through 200 mesh.....	98.00

INSOLUBLE SACCHARATE PRODUCED

From practice and long experience it has been found that a solution of molasses and water containing 6.2 to 6.6 per cent sucrose is the most economical solution

in regard to lime consumption to handle in the Steffens process. The molasses is mixed with fresh water to contain this amount of sugar, then 15 to 20 per cent milk of lime to sugar solution is added. The milk of lime neutralizes any acids present in the molasses and forms calcium monosaccharate, the first saccharate formed in the process. Theoretically this takes place upon the addition of 17 per cent lime; in practice more is required. However, the addition of 20 per cent milk of lime will give the desired result. The use of milk of lime at this point is a saving in more than one way, because the overburned lime from the kiln is sent to the slaker and used, whereas the lime added as powder must be quick or caustic lime. The dicalcium and tricalcium saccharates are not formed unless the lime is unslaked.

After the addition of the milk of lime the solution is pumped to a cold room, where it is cooled by refrigeration. The temperature is lowered to 9 to 12 deg. C., at which temperature it is pumped to the coolers. The coolers consist of cylindrical vessels with tubes, exactly the same as a standard type evaporator. In the well of this vessel is a stirring arrangement to facilitate the circulation and thorough mixing of the lime.

The lime from the kiln, having been properly burned, is ground in mills, of which the Raymond is the most commonly used type. The powdered lime is blown by fans to storage bins above scales, thence fed to coolers.

Theoretically 54 parts of lime to 100 of sugar will form the tricalcium saccharate, but practically 90 to 125 per cent is added, depending upon the quality of lime, the fineness and the method of adding. The temperature in the coolers is held at about 16 to 18 deg. C., which has been found to give best results, by circulating brine in the calandria of the coolers. The temperature rise due to slaking is considerable and constant attention is required to prevent the temperature from passing 28 deg. C., at which decomposition of the saccharate already formed begins to take place.

FILTRATION

The filtration of the finished cooler solution and recovery of the saccharate is accomplished by means of continuous types of filters, of which the Oliver is used quite extensively. These filters consist of a cylindrical drum partly submerged in the finished cooler solution. The filters have a valve arrangement that allows vacuum to be applied to the lower half of the drum, thereby causing the saccharate cake to adhere to the cloth and the liquor to pass through. Upon revolving further water is applied, displacing the mother liquor and raising the purity of the cake. This washing and recovery of the saccharate are possible because tricalcium saccharate is very slightly soluble in cold water, about 1 part to 100 parts of water.

Any dicalcium saccharate present is washed away under ordinary conditions, as it is soluble in 33 parts of water. The mother liquor and wash water contain the bulk of the impurities originally present in the molasses, also some sugar, which was either dissolved by washing or had not combined with the lime to the formation of the tricalcium saccharate in the first place.

Upon heating this liquor the tricalcium saccharate is formed again, though the composition of the saccharate is slightly different from that formed in the cold.

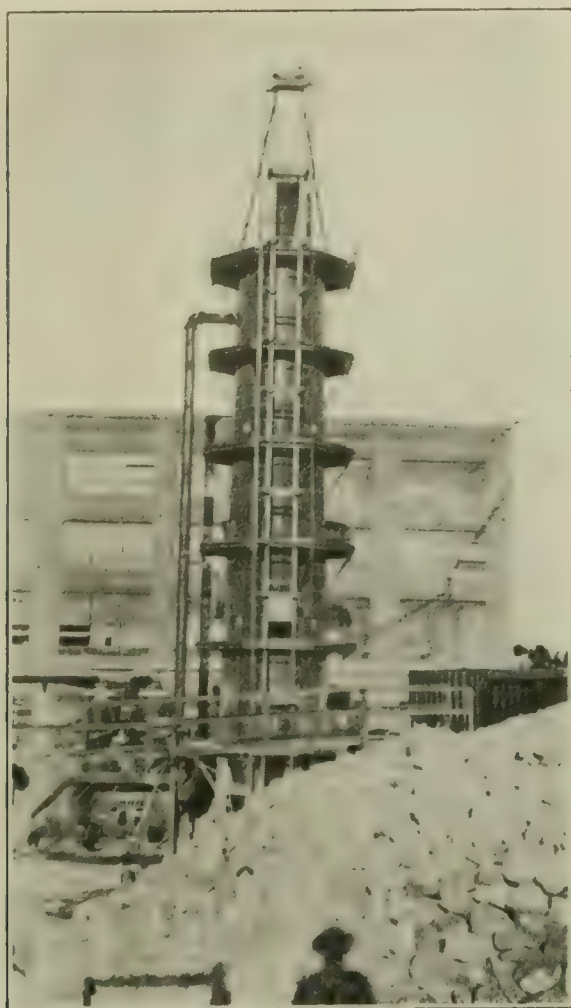


FIG. 1. LIMEKILN WITH CO₂ RECOVERY SYSTEM

Best results have been obtained by heating gradually in a series of tanks, carrying the final temperature to about 85 to 89 deg. C. As the volume of this solution is considerable, a thickener is made use of here, usually of the Dorr tray type, which removes approximately 70 per cent of the liquor, leaving the denser solution to be filtered again. The second filtration is accomplished in filters of exactly the same construction as the cold filter, only smaller in size. The proportion of hot cake to cold cake is about 1 to 7.

Wash water to the extent of 1 to 1½ lb. to 1 lb. of cake is necessary to replace the mother liquor, which is now practically exhausted of sucrose. The final waste to sewer contains only about 0.20 to 0.35 per cent sucrose, and is very high in impurities.

A valuable byproduct is recoverable from the waste water, though the cost of production is excessive at present. Potash of 32.5 per cent K₂O has been successfully recovered and put upon the market in the form of a char for use as fertilizer.

USE OF CALCIUM SACCHARATES

The mixed cold and hot precipitate or cakes are mixed with wash water from the presses in the factory proper or with thin juice, the purified juice of the beet ready for evaporation. This is mixed to a density of 30 to 32 deg. Brix and is used to defecate the raw

juice from the beets, being added in the carbonation tanks. In non-Steffens houses milk of lime is used for this purpose.

Upon the addition of carbon dioxide taken from the limekiln to the juice and the mixture of saccharate the latter breaks up, the lime combining with the CO₂, forming CaCO₃, and the sugar goes into solution with the juice present.

By good Steffens operation it is possible to recover from 92 to 95 per cent of the sugar originally present in the molasses. By reference to the chart or flow sheet a mental picture of the process is more clearly obtained. The quantities and analyses are only approximate, but are good examples of actual working condition in modern factories.

STATUS OF PROCESS

The photographs give some idea of the equipment necessary for the recovery of the sugar from the molasses. The Steffens process has never been applied successfully to the working of molasses from cane sugar products, due to the excessive amount of invert sugar present, though several processes have at times attracted attention, one in particular, that of Batelle, in which the glucose is destroyed at an early stage of the process and the resulting liquor worked the same as raw juice from beets. Nothing has ever been done on a large commercial scale as yet in this direction.

There is still unlimited room for improvement in the Steffens process, although it has reached a state of

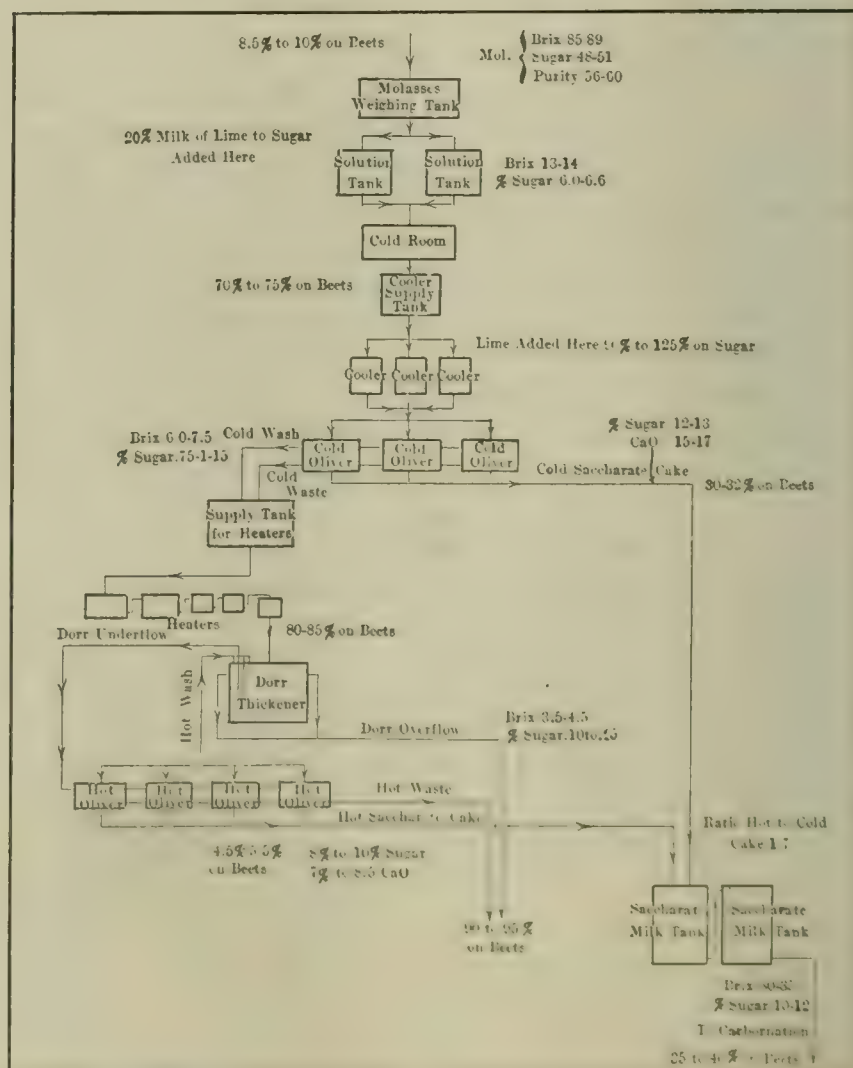


FIG. 2. STEFFENS HOUSE FLOW SHEET

high efficiency in the last few years. One of the problems is reduction of lime consumption. Why do we have to add from two to three times the theoretical amount necessary? Another phase of the industry is the recovery of the valuable salts present in the waste

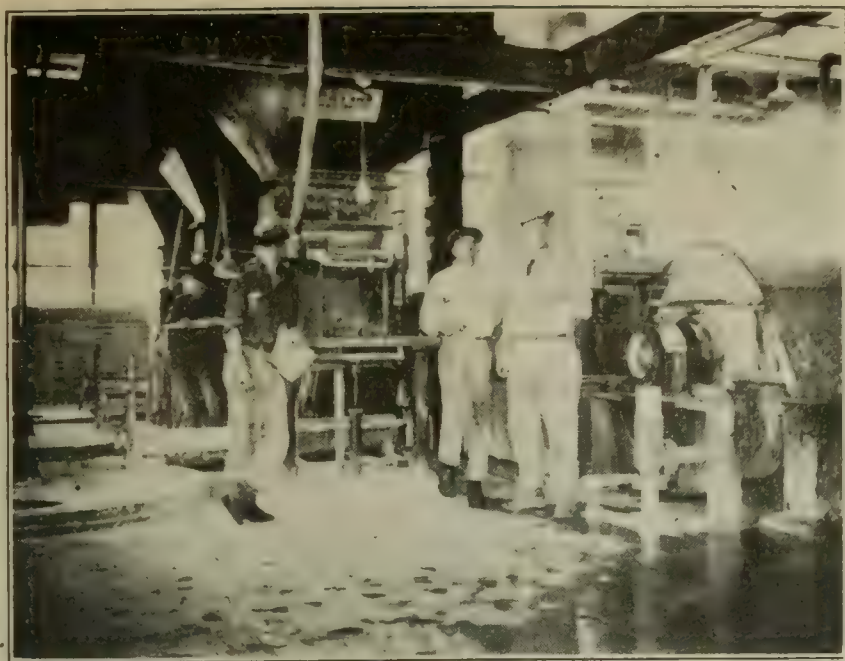


FIG. 3. FILTER, COOLER, LIME HOPPER AND SCALES

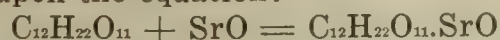
by some cheap recovery process. The sugar chemist and engineer have an open field in these lines, and no doubt new methods or equipment will be developed.

STRONTIA PROCESS

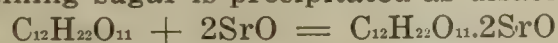
Recovery of sugar from molasses by the strontia process is based upon the fact that sugar will combine with the basic oxide of strontium, forming saccharates, rather more insoluble in water than the calcium salts. Of the alkaline earth combinations barium saccharate is the most insoluble, and is the most readily precipitated and filtered of the three, but its commercial application is hindered, due to the fact that an electric furnace is required to convert barium carbonate to barium oxide and because some of the salts which may remain in solution are poisonous. The Steffens process is much more simple than processes using barium or strontium, although the recovery of sugar is not as high nor the purities of the saccharates so obtained as good.

The strontia process was first applied commercially by Schiebler, though a French patent was issued to Dubrunfant and Leplay as early as 1849. Two methods have been developed, based

upon the use of strontium oxide, the mono- and di-saccharate. The method first tried, the monosaccharate, was based upon the equation:



The monosaccharate is only slightly soluble in water and about 60 per cent of the sugar can be recovered. The remaining sugar is precipitated as disaccharate:

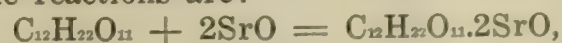


The advantages of the method were less strontia used than in the disaccharate process and a greater concentration of the waste water. Owing to the fact that a reversible action would at times set in, as may be seen by the equation, the process was abandoned for the disaccharate process:

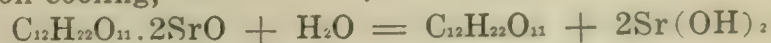


In the disaccharate method advantage is taken of the fact that the solubility of strontium disaccharate in

boiling solution is very low; upon cooling crystallized strontium hydroxide separates, leaving sugar in solution. The reactions are:

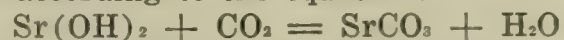


upon cooling,



Commercially the process is carried on as follows: An excess of strontium hydrate is added to the molasses solution, and the solution heated to boiling, precipitating the disaccharate, which is separated by filtration and washed. The filtrate is cooled to a low temperature and strontium hydrate crystallizes from the solution. The crystals are separated from the mother liquor by a centrifugal and returned to process. The disaccharate is suspended in water, a sugar solution, or in some instances separately, and is allowed to cool gradually, when the strontium hydrate crystallizes, leaving the sugar in solution. The strontium hydrate is separated by a centrifugal and the crystals are returned to process.

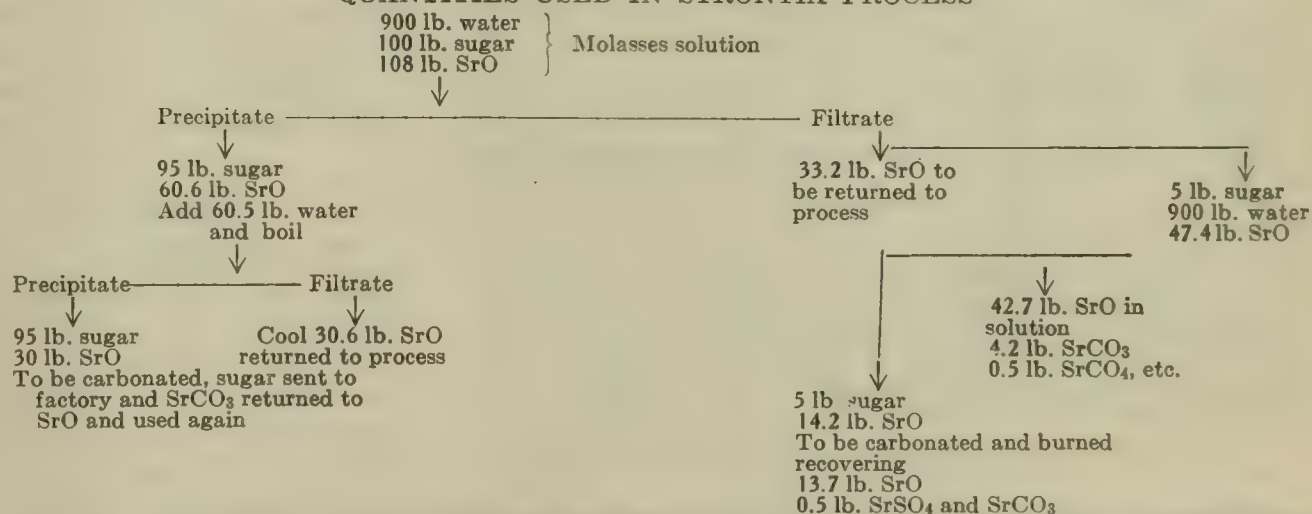
The remaining liquor, which is saturated with strontium hydrate, is carbonated, precipitating strontium carbonate according to the equation:



Strontium carbonate is recovered by filtration and reduced to the oxide in a specially designed furnace. The filtrate containing the sugar in solution passes to the evaporators of the sugar factory.

The strontium oxide from the furnace is dissolved in water, forming strontium hydroxide, and is used over again. The waste waters obtained from the solution after precipitation and removal of the disaccharate are cooled to allow the excess of strontium hydrate to crystallize out. These crystals are returned to the process and the mother liquors carbonated and filtered to recover the remaining strontium as strontium carbon-

QUANTITIES USED IN STRONTIA PROCESS



ate and the filtrate is concentrated to recover the potash and nitrogen contained.

The accompanying diagram will give an idea of the quantities used in general practice. These vary, of course, due to differences in equipment, in the grade of strontia used, and in the skill of the operators.

OPERATING DATA

A few figures of interest in the operation follow:

	Per Cent
SrO on sugar in molasses.....	105-112
Equivalent SrCO ₃ (SrO × factor 1.42).....	149-159
Loss in waste water.....	4- 7
Approximate recovery in strontia house.....	93- 96
Approximate recovery in main factory.....	92- 95
Loss of SrCO ₃	3.5- 5
Approximate moisture of SrCO ₃	55- 60

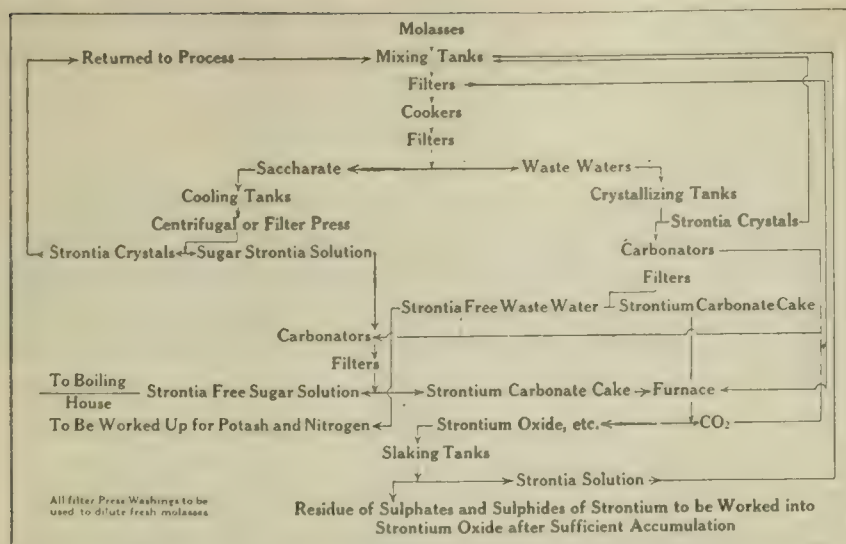


FIG. 4. STRONTIA PROCESS FLOW SHEET

If we were to follow one ton of molasses of 50 per cent sugar content through the entire strontia process we would have figures about as follows:

First Cycle

2,000 lb. molasses
1,000 lb. sugar
930 lb. sugar recovered in saccharate cake
865 lb. sugar recovered as granulated sugar
15 lb. sugar lost in press cake

Second Cycle

50 lb. sugar enter strontia house
47 lb. sugar recovered in saccharate cake
44 lb. sugar recovered as granulated sugar
1 lb. sugar lost in press cake

Third Cycle

2.0 lb. sugar enter strontia house
1.8 lb. sugar recovered in saccharate cake
1.5 lb. sugar recovered as granulated sugar
0.3 lb. sugar lost in press cake

Summarizing we have:

1,000 lb. sugar in molasses:

	Lb.
Granulated sugar obtained.....	910.5
Sugar lost in press cake.....	16.0
Sugar lost in waste waters.....	73.5

For the working up of one ton of molasses we would require:

	Lb.
Theoretical strontium oxide.....	1,136
Theoretical equivalent to strontia carbonate.....	1,631
Actual equivalent to strontia carbonate.....	1,925
Loss of strontia carbonate, 5 per cent on theoretical amount.....	81
Requiring an additional make-up of.....	96.25

REBURNING A DIFFICULTY

Approximately 40 per cent of the strontium oxide used in the process is recovered as the carbonate. This has to be calcined. The calcining of strontium carbonate is best carried on in a rotary kiln and a temperature of 1,175 to 1,250 deg. C. is required. The kiln should be driven by a variable speed motor at from 35 to 60 revolutions per hour. The fuel consumption will vary with the condition of the strontia carbonate, but ordinarily 55 to 65 gal. of oil per ton of calcined strontia will be sufficient, this giving approximately a 90 to 92 per cent conversion. Using gas as fuel, 8,500 to 9,500 cu.ft. of gas per ton will be sufficient.

The general application of the strontia process is hindered by the high cost of the rock and the cost of reburning to oxide. In the Steffens process the limestone used is so much cheaper that the recovery of the calcium carbonate and the reburning to the oxide is not necessary, although the reburning of calcium carbonate

is carried on at one large beet sugar factory here in the United States. The working up of the waste waters of the strontia process requires about 15 to 20 per cent less evaporation than does the waste from the Steffens process.

There is a large field for investigation in either process and no doubt we shall soon hear of improvements in both methods of extracting sugar from waste molasses.

Union Sugar Co.,
Betteravia, Cal.

[EDITOR'S NOTE: In the article by Mr. Montgomery in the March 16 issue of this journal, entitled "Refinery Practice in Beet Sugar Manufacture," lines 2 and 3, second column, page 469, should have read: "The quantity of cake varies with the process, but usually amounts to from 400 to 480 lb. per ton of beets sliced." The figures were inadvertently printed "40 to 48 lb."]

Guadeloupe's Vanilla Crop

The 1920-21 vanilla crop of Guadeloupe began to be picked and bought by buyers about Jan. 15, 1921, its movement before that time having been prohibited by the various municipalities to prevent its being picked too green, and also on account of the fact that the early crop offered for sale before that date is usually stolen vanilla.

Local buyers began by paying about 4.25 f. per kilo for green vanilla. This was increased gradually to a point where a few sales were made at 7 f., but the last rates quoted are 5 to 5.50 f.

When cured the vanilla will be sold for the most part in the United States at the prices then prevailing in New York, and there is therefore usually a large element of speculation in its purchase, due to the fluctuations in the New York market and to exchange.

It is estimated that the present crop of green vanilla is about 200,000 kilos, which when cured will amount to about 85,000 lb., more or less, according to the degree of shrinkage. This will be over twice as much as last year's cured product, which amounted to about 38,000 lb.

Manufacture of Dextrine in Japan

The manufacture of dextrine in Japan is a comparatively new industry, having been organized on a commercial scale only during the past three or four years. It is principally used in the textile industry. Japanese dextrine is exported chiefly to Great Britain, small quantities going to the United States, amounting in 1919 to 132,160 lb., valued at \$11,945. Vice-Consul Dickover notes that at present the manufacturers are not making a profit and unless living costs and wages are reduced, bringing a reduction in the cost of materials and manufacturing, it is possible that the industry will not survive the depression. The cost of production per 100 lb. is approximately \$5.53, while the price of dextrine in the markets of Osaka and Kobe is around \$5.13 per 100 lb. for white and \$5.58 for the yellow. There are three small dextrine factories in Japan, one in Osaka, one in Tokyo and one in Kyushu, and the total output for all Japan is about 300 tons per month.

Belgian Coal Production

Belgian coal mines during December produced 107 per cent of average monthly production during 1913. Coke and briquet yield in December equaled the March record of 123 per cent of 1913 average. Total coal production in Belgium for 1920 was 22,433,535 tons.

Coefficients of Equivalence in Ternary Alloys*

General Discussion of the Effect of Adding a Little of a Third Element to a Binary Alloy—Mathematical Development of Equations Defining Isomicrographic Lines, and Boundaries of Zones Showing Two Well-Defined Constituents

BY LÉON GUILLET AND ALBERT PORTEVIN

SYSTEMATIC studies on special brasses made by one of the authors¹ have shown that when an element is added to a binary alloy the following cases may occur:

(a) The added element retains its identity (Pb in brass).

(b) The added element forms an isolated special constituent—that is to say, a chemical compound or a solid solution (P and Mg in brass).

(c) The added element enters in solution in one or both of the normal constituents of the binary alloy.

The first case is of little industrial importance; in the second case the free constituent lowers the elongation and the electrical resistance of the alloy; the third case is very frequently met with in steels, brasses and bronzes and is of great industrial importance. It will be considered here in detail.

THE THIRD ELEMENT FORMS SOLID SOLUTIONS

When the added element enters into solid solution a double effect results which can be clearly explained in binary alloys having transformations and a eutectoid,

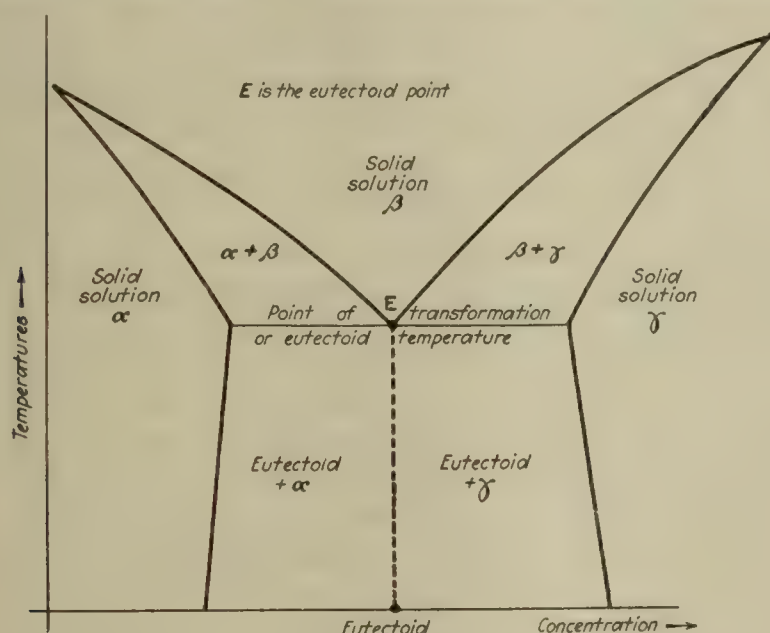


FIG. 1

and whose equilibrium diagram is as illustrated in Fig. 1. The incorporated element can then displace the eutectoid point *E* either vertically or horizontally, or both.

By vertical displacement extremely interesting results are obtained. Thus let us suppose that the transformation point corresponding to the formation of a eutectoid is at a sufficiently elevated temperature so that its structure may be well developed. It may then be easily studied with the microscope. A temperature in question

is the well-known $Ar_{1,2,3}$ in the iron:carbon system, 700 deg. C. (1,290 deg. F.). An alloying element can lower this temperature so that even with slow cooling Ac may lie between 350 deg. C. (660 deg. F.) and room temperature. It is known that under these conditions the metal is martensitic, or self-hardening. The transformation point may be lowered even to below atmospheric temperature, in which case the alloy presents an austenitic structure and consists of a solid solution which is stable at room temperature as well as high temperatures.

If the transformation point remains around 500 deg. C. (930 deg. F.) the lamellar or granular structure usual to eutectoids is replaced by the so-called osmondite, characterized by a uniform dark coloration when etched by a slightly acid reagent. These facts are illustrated by nickel steels and manganese steels. Martensitic structures have also been noted by Robin² in tin bronzes containing arsenic, and in aluminum bronzes containing both tin and zinc. (See also the work of Andrew and Edwards³ on the alloys Cu:Al:Sn.)

If a binary alloy possesses a eutectoid point which, at a normal cooling rate, occurs at a relatively low temperature, the alloy could present osmonditic, martensitic or austenitic structures, depending upon the quenching velocity. On the other hand, the presence of a third element might raise the transformation point and consequently produce very marked and variable effects, depending upon circumstances.

No martensitic or austenitic binary alloys are known—at least with certainty—although this ought to be the case for Fe:Ni and Fe:Mn alloys. It is probable that the presence of such an element as aluminum or silicon, which raises the transformation points, induces the decomposition of austenite and at times brings out the eutectoid structure characterized by pearlite.

STRUCTURE OF β BRASS

Some copper:zinc alloys naturally give an osmonditic structure. Due to the low temperature of the eutectoid point (470 deg. C.), the alloys with 53 to 63 per cent copper contain the then unstable constituent β , which has the aspect of a solid solution, the two eutectoid constituents into which it disintegrates cannot be distinguished. Carpenter has tried his best to agglomerate the particles of this eutectoid into microscopic dimensions, but without success, even after heating for four months at the boiling point of sulphur (445 deg. C. or 833 deg. F.). After "priming" the decomposition of β by fourteen days' contact at 445 deg. C. (833 deg. F.) with a brass containing 0.95 per cent vanadium and then continuing the heating for ten days at the same

*Abstracted from *Revue de Métallurgie*, vol. 17, August, 1920, pp. 561-567.

¹Léon Guillet, *Revue de Métallurgie*, vol. 1 (1905), p. 97, and vol. 2 (1906), p. 243. See also *CHEM. & MET. ENG.*, vol. 24, No. 4, p. 177, Jan. 26, 1921, and vol. 24, No. 6, p. 261, Feb. 9, 1921.

²*Société d'Encouragement pour l'Industrie Nationale*, vol. 119 (1913), p. 12.

³*Proc. Roy. Soc.*, vol. 82A, p. 568 (1909); *Jour. Inst. Metals*, vol. 2, p. 29 (1910).

temperature, he was able to render the components α and γ visible under the microscope.

One of the authors⁴ has resolved the eutectoid into the α and γ constituents by very slow cooling, taking seventy-five hours, from the liquid state to 300 deg. C. (570 deg. F.). By assuming that the respective sizes of the pro-eutectoid (α solid solution) and eutectoid constituents are modified in the same proportions as the cooling rate is varied, he was led to assign sizes of 0.1 to 0.01 μ to the constituents of the eutectoid after a normal rate of cooling—i.e., of the same magnitude as that of colloid particles.

In studying the influence of a third element on osmonditic structure in brass, Carpenter has found that the addition of bismuth, lead or manganese does not have any appreciable influence, whereas the addition of silicon, aluminum, iron and especially nickel and vanadium develops a characteristic eutectoid structure clearly. Guillet,⁵ working on nickel brasses, has found similar results, but he has also noticed the very important fact that whenever lamellar structure appears under the microscope, thermal analysis of the sample reveals an elevated transformation temperature.

THE EUTECTOID IS MOVED HORIZONTALLY

A change of the position of the eutectoid point in a horizontal direction due to the addition of a third element to a binary alloy corresponds to the creation of a fictitious composition when determined by the microscope and equilibrium diagram and which is different from that given by chemical analysis. One of the authors⁶ has made a detailed study of such changes in the position of the eutectoid point. It has been found that the presence of manganese and chromium in steel results in a modification of the relative proportions of pearlite and ferrite, and this causes a fictitious carbon content to result from computation based on planimetric survey.

It is to be noted that this is also the case for certain special steels, especially for eutectoid tungsten and molybdenum steels. In these the carbon content decreases with an increase of the tungsten or molybdenum contents. In brasses the eutectoid is not resolved, and the resulting structure appears the same as though ordinary room temperature were 500 deg. C. (932 deg. F.). In brasses the $\alpha + \beta$ zone permits determination of the fictitious composition with the microscope because in this zone the copper content is rigorously proportional to the amount of α constituent contained.

MATHEMATICAL EXPRESSION

The general study of the phenomenon can be expressed by the formula⁷

$$A' = \frac{100A}{100 + q(t - 1)} \quad (1)$$

which gives the relation between the real percentage of element A as determined by chemical analysis, the fictitious composition A' as determined by microscopic examination, the quantity q of the third element and its coefficient of equivalence t .

As before, t is defined indirectly thus: A third element added to a binary alloy A:B possesses a coefficient

of equivalence t when 1 per cent of this body will enter solid solution and replace t per cent of element B, the proportion thus obtained being figured to 100.

Let us consider the extreme case of a binary alloy formed of metal A and quantity q of C, the third element, as for example when passing from the ternary brass Cu:Zn:Al to the binary alloy Cu:Al.

We have then

$$A + q = 100; \text{ or } q = 100 - A$$

and by replacing this value of q in the general formula just above

$$A' = \frac{100A}{100 + (100 - A)(t - 1)} = \frac{100A}{100t - A(t - 1)}$$

and

$$A = \frac{100tA'}{100 + A'(t - 1)} \quad (2)$$

It is known⁷ that t for aluminum = 6.0, and that in ordinary brasses the zone $\alpha + \beta$ is limited by 63 and 53 per cent copper. What will these limits be in Cu:Al alloys?

$$\text{For } A' = 63 \quad A = \frac{100 \times 6 \times 63}{100 + 63 \times 5} = 91.1$$

$$\text{For } A' = 53 \quad A = \frac{100 \times 6 \times 53}{100 + 53 \times 5} = 87.1$$

The Cu:Al diagram indicates 92.5 and 87 as limits for the $\alpha + \beta$ zone. This shows how near the calculated data approach the real.

GENERAL REPRESENTATION

Let us now consider the case from the general point of view and utilize Fig. 2, the triangular diagram representing the composition of ternary alloys. To fix

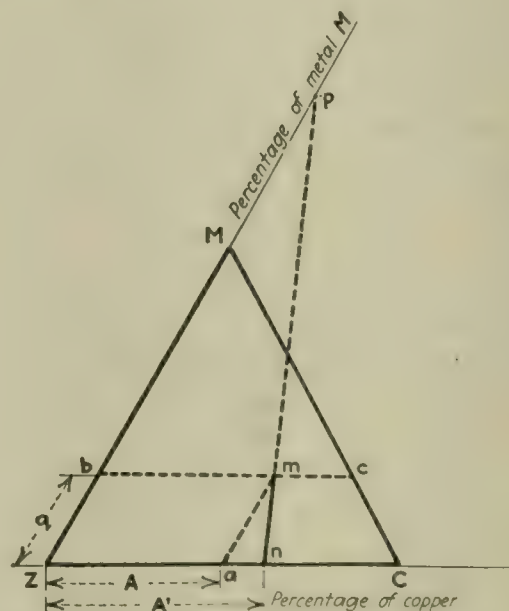


FIG. 2.

our thoughts, confine the discussion to brasses, and let the points Z, C and M correspond respectively to pure zinc, copper and the third metal M. By taking the point Z as origin, a point m situated in the interior of the equilateral triangle will represent an alloy of the composition: A per cent copper ($A = Za$), q per cent M ($q = Zb$) and B per cent zinc ($B = 100 - A - q = mc$).

Between 63 and 53 per cent copper the binary brasses are formed of two constituents α and β ; there exists therefore in the interior of the triangle a zone where these two constituents may be found and whose limits cut side ZC at the two points noted.

For a point m situated in the interior of this zone the alloy is formed of the two constituents in the ratio

⁴Albert Portevin, *Compt. rend.*, vol. 171 (1920), p. 350.

⁵Léon Guillet, *Revue de Métallurgie*, vol. 17, July, 1920; see also *CHEM. & MET. ENG.*, vol. 24, No. 6, p. 261, Feb. 9, 1921.

⁶Albert Portevin, *Revue de Métallurgie*, vol. 13 (1916), p. 426.

⁷See "Ternary Brasses," *CHEM. & MET. ENG.*, vol. 24, p. 177, Jan. 26, 1921.

$K = \frac{\alpha}{\beta}$. The locus of points m for which value K is constant is called an isomicrographic line, and cuts ZC at n , the fictitious composition of the brass. The micrography of these alloys will be defined by the ratio K , or by the fictitious content in copper (A').

Points such as m are fixed in relation to A , A' , t and q by equation 1 above. Assuming that within limits the value of t remains a constant for a certain metal, the co-ordinates of m (A and q) fulfill the equation

$$\frac{A}{A'} - \frac{t-1}{100} \times q = 1$$

derived from equation 1. Or more simply

$$\frac{A}{A'} + \lambda q = 1 \quad (3)$$

$$\text{where } \lambda = \frac{1-t}{100}.$$

Within the limits of constancy of A' and t equation 3 of the isomicrographic line, being of the first degree, plots as a straight line, and the intercepts on the ZC and ZM axes are A' and $\frac{1}{\lambda}$ or $\frac{100}{1-t}$ respectively. As A' varies, equation 3 represents a pencil of lines con-

verging on $q_0 = \frac{100}{1-t}$, as has already been indicated

by Cavalier.⁸ Further all the isomicrographic lines for a given element (t constant) pass through a point

defined by the co-ordinates $A = 0$ and $q_0 = \frac{1}{\lambda}$ —i.e.,

a point situated on the line ZM at a distance from Z equal to $\frac{1}{\lambda}$ (point p , Fig. 2). The outermost isomicro-

graphic lines converging from this point limit the zone $\alpha + \beta$, for instance, and separate it from the α and β areas. If λ is positive, the addition of the metal M to an ordinary brass of two constituents will lower

the proportion $\frac{\alpha}{\beta}$ between its constituents and *vice versa*.

With $\lambda = 0$, the isomicrographic lines are all parallel to ZM , and the substitution of the metal M for zinc therefore will not change the appearance of the alloy. That is to say, metal M is equivalent to zinc, or $t = 1$.

The notion of the coefficient of equivalence implies therefore two hypotheses: That t is a constant as long as the third element remains the same, and that A' is constant for various values of q . An identical mathematical expression results when one proceeds in the opposite direction—i.e., by assuming that the isomicrographic lines in the $\alpha + \beta$ zone are straight lines and that these lines converge to a point situated on the ZM axis. This double hypothesis is contained in the definition of the coefficient of equivalence which states that the coefficient has, for a given metal M , a numerical value which is independent of q and A' .

The intercept q_0 is positive or negative, according to whether t is smaller or greater than unity. There are therefore two categories of metals: One giving a fictitious composition greater than the real—i.e., increasing the ratio $\frac{\alpha}{\beta}$ (such as Ni, Co, Mn, Fe in brass), and the other lowering this ratio (Al, Si, Sn).

For $t > 1$, $q_0 < 0$. Point p is below the line ZC (Fig.

3). The isomicrographic lines n, m , and the limits of a certain structural area form an angle smaller than 60 deg. with ZC , and the prolongations of these lines intersect side MC of the equilibrium triangle.

For $t = 1$, $q_0 = \infty$. The isomicrographic lines n, m are parallel to axis ZM .

For $0 < t < 1$, $q_0 > 100$. Point p is beyond M on the

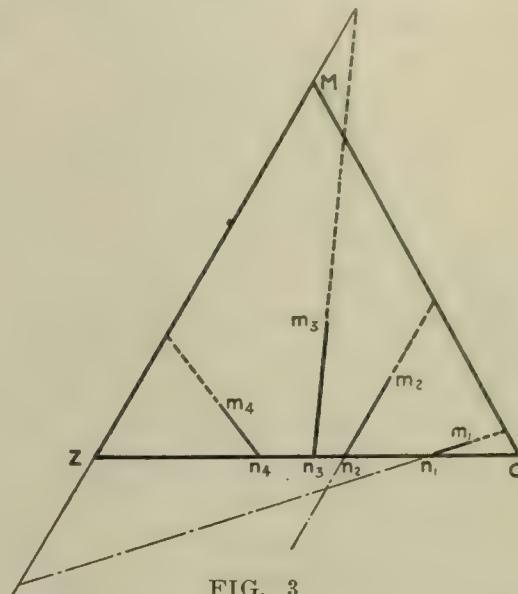


FIG. 3

line ZM and the isomicrographic lines n, m , will intersect side MC of the triangle.

For $t > 1$, $0 < q_0 < 100$. Point p is located between M and Z (isomicrographic lines n, m).

It is not advisable to extrapolate the results of these formulas, as the numerical values of the coefficients t have been obtained for relatively small values of q . Therefore it is unsafe to prolong these lines until they intersect the sides of the triangle. But when the ternary diagram as Cu:Zn:M contains a zone, such as $\alpha + \beta$, joining the two sides CZ and CM of the triangle (as is the case of the system Cu:Zn:Al), a satisfactory representation of the isomicrographic lines can be obtained by prolonging the lines across the triangle (Fig. 4).

The co-ordinates of the point of intersection of the isomicrographic lines with the side CM of the triangle are obtained by solving simultaneously equation 3

and $\frac{A}{100} + \frac{q}{100} = 1$, the equation of the CM axis.

This done, the abscissa or copper content is found to be $A_0 = \frac{t}{\frac{1}{A'} - \frac{1-t}{100}}$. Inspection shows this ex-

pression to be identical with equation 2.

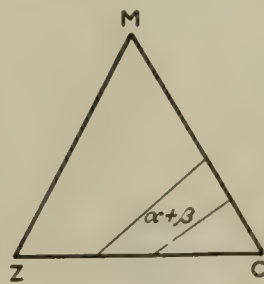


FIG. 4

The coefficient of equivalence of zinc when substituted for aluminum in a Cu:Al system can be obtained by similar reasoning.

If t_1 is the coefficient of equivalence of the metal M to Zn in the Cu:Zn system and t_2 the coefficient of equivalence of Zn to the metal M in the Cu:M system, the isomicrographic lines converge in a point

p on the side ZM . We have $\overline{Zp} + \overline{pM} = \overline{ZM}$.

But $\overline{Zp} = q_0 = \frac{100}{1-t_1}$. Hence by symmetry we get $t_1 t_2 = 1$, or $t_2 = \frac{1}{t_1}$. Thus, since the coefficient of

equivalence of the aluminum when substituted for Zn

⁸Cavalier, Leçons sur les alliages métalliques, Paris, Vuibert et Nony, 1909, p. 301.

in Cu:Zn brasses is 6, the coefficient of equivalence of zinc in aluminum bronzes for the $\alpha + \beta$ zone is equal to $\frac{1}{6}$.

These extrapolations seem to be possible only in the system Cu:Zn:Al, because in other ternary brasses the $\alpha + \beta$ zone does not extend across to the CM axis, its limit being a zone $\alpha + \beta + \gamma$, γ denoting a third phase constituted by a definite compound, by a solid solution, by a eutectic or a double or triple eutectoid.

It is to be noted that the coefficient of equivalence does not indicate the general attitude of a metal toward a pair of metals. The conception only applies to a zone of two well-determined constituents. Thus the coefficient of equivalence of Sn in Cu:Al alloys is approximately 0.3 to 0.4 for the $\alpha + \gamma$ area and equal to 1 for the $\gamma + \epsilon$ zone.

A specific property is not indicated by the coefficient of equivalence, but it is a sure and sufficiently precise guide to outline the modifications in the constitution of low ternary alloys and consequently in their properties.

The conception can be extended^o to all zones delimiting two constituents in ternary diagrams. Up to the present it has been considered only for special brasses. This is due to the fact that in these alloys the modifications of the properties are closely dependent upon the ratio of components and that the addition of a third metal to an ordinary binary brass is marked micrographically by a variation in the ratio of its two micrographic constituents.

In the case when three constituents are present, due to a defined reaction among four phases, the question of isomicrographic lines refers only to two of the three constituents.

Uniformity of Digester Chip Charges*

How uniform are the weights of wood in the digester charge, the unit commonly used in chemical pulp-mill operation, is indicated by data obtained in a millscale. For a period of three months at a certain mill it was possible to weigh all the chips entering one digester, to make accurate determinations of their moisture content, and so to compute the actual amount of wood substance in each charge.

The chip charges for thirty-eight cooks showed the following variation in weight, after deducting for moisture:

- 7 charges weighed between 11,600 and 12,600 lb.
- 24 charges weighed between 12,600 and 13,600 lb.
- 7 charges weighed between 13,600 and 14,600 lb.

Fifty per cent of the charges contained between 13,000 and 13,770 lb. of chips—a variation in weight within the limits of $\pm 2\frac{1}{2}$ per cent. Delays of more than twenty-four hours occurred in starting all the cooks with charges of more than 13,770 lb.; and since it was customary before bolting down the cover to fill with additional chips the space left by the settling of the charge, the longer filling periods account for the larger amounts of wood in these charges. The cooks with charges of less than 12,600 lb. were started without refilling after the liquor charge was added, and it was expected that they would be light.

The weighting experiments indicate that the digester charge is, in most instances, a reliable unit for pulp-mill operation, provided the operation is uninterrupted and the soundness and species of pulpwood do not vary.

Vegetable Seed Oil Extraction in Argentina

Linseed oil has for some time been an item in the Argentine exports. Great quantities of the seed are harvested annually and enough has been elaborated to satisfy the requirements of the domestic paint manufacturers as well as those of neighboring countries. For various reasons the principal consuming countries have preferred to purchase the seed for transportation to their own mills, but there is now in the process of construction near Rosario what is said to be the largest grinding plant in existence, reports Trade Commissioner P. S. Smith. It is owned by the Compañía Sud Americana de Cereales, a Dutch concern, which intends to produce various kinds of oil and ship both it and the cake to Europe.

Castor oil is also produced in appreciable quantities for industrial and medicinal purposes. Rape seed is found to be mixed with linseed and both it and colewort seed are worked for their oil content.

Cotton seed is not abundant as yet, but it is expected that the supply will be materially augmented each year from now on as a result of the increased acreage planted to cotton in the Territory of El Chaco. One new mill especially adapted for the production of cottonseed oil is being put up this year; in fact, all of the present plants elaborate the seed on a small scale.

Peanut oil is growing in importance, both it and cottonseed oil being employed locally to replace in part the imports of edible oils from Europe and the United States.

Olives have been grown in an experimental way in the Province of La Rioja and oil has been obtained from the native fruit, but future development along this line does not give promise of being rapid.

Corn oil is made by two companies, although the output as yet is insignificant with relation to the world's production.

A few of the plants extract the oil by solution, using either benzene or trichlorethylene as the solvent, following a well-known French process. The remaining mills employ vertical hydraulic presses of varying capacities and degrees of efficiency.

In general the oil-expelling plants are quite well equipped with machinery, although in some the seed-grinding apparatus could be improved. As the demand is small, the supplies are bought from local stores.

Effect of Mechanical Treatment Upon the Properties of Steel

The properties of steel and many other alloys are largely determined by three factors: composition, including structure; heat-treatment, and mechanical treatment. On account of the lack of suitable apparatus for the investigation of the last-named factor, this subject has received rather scant attention in the experimental study of steel. For this reason quite an elaborate study of the rolling of steel has been undertaken by the Bureau of Standards, where the special facilities—such as the small rolling mill—have proved to be of great value.

The investigation has been completed as far as the rolling operations are concerned and the test specimens are now being prepared for the different mechanical tests which together with other examinations—such as metallographic—will be used as a measure of the effect of the various factors which enter into the mechanical treatment of metals.

^oAlbert Portevin, *Revue de Métallurgie, Mémoires*, vol. 7, p. 1149 (1910).

*Technical Notes, Forest Products Laboratory.

Cloths for Mechanical Uses*

The Specific Mechanical Purposes for Which Cloths Are Used and an Enumeration of Their Applications in the Most Important Industries

BY JAMES W. COX, JR.†

CLOTHS for mechanical uses are made from practically all the well-known fibers, cotton predominating, with wool, asbestos, silk and linen following in about the order named. Occasionally other fibers are used in cloth for special purposes. Cloth is used for mechanical purposes where it only will function or as a substitute for leather, metal banding, metal cloth, rawhide, sheet metal, wire or wire screen. Cost is usually the principal consideration for substituting cloth for the above materials; also it has been found in many instances that a fabric did the work in a better manner than the original substances, flexibility being a large factor in its adoption.

These cloths can be classified as to specific uses and to different industrial groups. It is impossible in one paper to give every specific use of mechanical cloths. The following tabulation, however, roughly covers their most common uses:

Absorption	Facings	Partitioning
Aprons	Fabric bases	Patching (repair)
Backings	Filters	Polishing
Bagging	Flame protectors	Pressing
Belts	Formers	Screens
Binders	Gaskets	Sieves
Buffers	Grips	Slings
Bumpers	Hose	Steaming
Cabling	Inking	Straps
Carriers	Insulating	Tapes
Cleaners	Jacketing	Tracing
Conveyors	Laminated materials	Tubing
Covers	Leaders (machine)	Washers
Containers	Linings	Webbing
Cushion devices	Marking	Wicks
Curtaining	Moistening	Windings
Distributors	Packing	
Drying	Paddings	

Practically every industry uses cloth mechanically in some way, those listed below being the largest and perhaps the most prominent consumers:

Aircraft	Farm machinery	Paper
Army	Flour	Powder
Automobile	Gas manufacture	Printing
Baking	Household machinery	Pumping
Beverage	Laundry machinery	Railroads
Candy	Mining	Rubber
Canning	Musical instruments	Shipbuilding
Chemical	Office machinery	Shoe machinery
Conveyor	Oil	Textile
Electrical	Packing, mechanical	
Engraving	Paint	

Specific Uses

BELTING

Woven belts are made for practically every purpose a leather belt is used for, including conveyors and machine aprons. Woven belting is being used plain, or impregnated with various substances such as tar, rubber

and materials of this type. It has the advantages of being more nearly heat-, gas-, moisture- and water-proof and is usually cheaper. Belts of this type are made wholly of cotton, or if excessive strength is required the warp is of camel's hair. In general they are made from two- to eight-ply plain fabric formed like a webbing and resembling before treatment a heavy, thick, narrow duck.

Belts of canvas or light duck in two-ply and up are also made by stitching the length of the belt every half-inch or so apart. Then this is treated or impregnated in the same way as the solid-woven fabric.

ABSORPTIVES

Coarse plain-woven jute and cotton cloth are used for this purpose. In either case the material is impregnated chemically so that when put in a machine, room or mine it will absorb gases of various kinds, moisture, etc. Cloth for absorption purposes is generally known as "brattice cloth." Jute was almost universally used until the price mounted; now low grades of cotton and cotton waste are used to a large extent as a substitute.

BINDINGS AND CHECK STRAPS

Heavy cotton webbing is used on various types of machines for lifting mechanisms. It is used in loop form on automobiles to prevent the too rapid recoil of the springs, also in special patented devices to achieve the same purpose. It is used for check straps on machines, train signals, and in street and railroad cars. Impregnated, light cotton tape is used for making various pipe connections and in electrical wire splices.

CONVEYING

Cotton duck, from light army to heavy numbered, is used extensively in conveying machinery of all kinds. Camel's-hair, plain cotton and stitched canvas belting is also used either treated or plain, according to the conditions under which the conveyor is run. The widths and weights vary from a cotton webbing for conveying small machine parts, to a heavy double- or triple-width belt for a box, barrel, coal or iron conveyor, etc. In two industries, candy making and photographic-film making, cotton oilcloth is used on account of its smoothness and ease of cleansing.

FILTERING

The filtering or straining of gases, air and liquids is considered under this head, the sifting of solids being taken up under "Sieves." In some cases when the filtration is slow and the pressure great the process is known as "pressing," but the action is identically the same, taking out substances that are not desired.

In the manufacture of some commercial gases a fine

*Reprinted from *Mechanical Engineering*, vol. 43, p. 177, March, 1921.

†Textile Engineer, New York, N. Y.

plain-woven linen, cotton or woolen cloth is used to take out solid particles of matter which are occasionally present. Fine asbestos cloth is also used when a detrimental chemical action would take place on cotton, flax, or wool. Medium asbestos and cotton cloths are used as smoke screens where cinders are an objection. In a few types of air-filtration installations a coarse cotton sheeting is used to take out the heaviest dust particles as the air enters.

As strainers on the ends of flumes in power-house work coarse open-mesh cotton or woolen cloths are used. They are usually called "flume bags" and are used secondarily to wire mesh which prevents the large pieces of substances getting in the pipes. Cotton strainer cloths are used sometimes in the pipes leading to water filters. They are used in canning establishments for the straining of fruit and vegetable juices and somewhat in factories making soups, sauces, relishes, etc. In cider mills a heavier, more open, and thicker cotton cloth is used for the extraction of the apple juice. It is generally a two- to five-ply yarn, loosely woven fabric, resembling a tire fabric in many ways with the exception of the tightness of the weave. This type of cloth is also used in the preliminary straining of other fruit juices.

The filtering of liquid chemicals is done by many kinds of woolen, cotton, linen and asbestos cloth. Some paint makers use a cotton filter cloth also in their manufacturing processes.

In the oil industry cotton filter cloths are used extensively. Crude oil, kerosene, gasoline, benzine, naphtha, linseed oil, cottonseed oil, in fact all kinds of oil, are generally filtered or "pressed" in the making. The cloths range from thin sheeting to heavy duck or multiple-ply hair cloth. When the oil is quite fluid, cotton sheetings and twills are used, and as the viscosity increases the heaviness and thickness of the filtering cloth increase. So next, heavier, thick twills are used, more on the order of a denim, then light duck, army duck and finally the very thick and many-ply cloths where the liquid is forced through by great pressure. These fabrics are of cotton, horse and other hairs. For the heaviest work where they have tremendous strain and pressure, a camel's-hair three- or four-ply cloth is used. These latter types are called "press cloths." In general they are stretched between flanges in a pipe and the oil or liquid forced or "pressed" through them by great pressure, necessitating great strength.

In the case of garbage or sewage reduction the cloths used are of ply yarns, very open and plain weave. Asbestos cloth is used here to great advantage, as it can be cleansed easily by subjecting to fire.

LAMINATED CLOTH

One of the principal uses of laminated cloth is for polishing. Practically always cotton cloth is used, osnaburgs, sheetings and in some cases light duck. Woolen cloth is used in glass polishing to some extent. Laminated cotton-cloth buffers are built up to any desired thickness, stitched, die-cut in circular form and occasionally stitched again spirally. A center of metal or wood is inserted and the polishing wheel is ready for service. This type of polishing wheel is used for polishing leathers, artificial leathers, woods, metals and various kinds of composition materials. It is sometimes used in hat cleaning.

Laminated cotton sheeting impregnated with composition materials of various kinds has been used also in

certain types of universal joints. In the textile industry laminated numbered cotton duck stitched, riveted, or both, is used to some extent on looms in the form of lug straps, check straps and pickers. Fine sheeting and light duck laminated and impregnated with composition materials are used for the making of gears. The blank is built up and the gears are cut the same as if of iron, steel or rawhide. Laminated cotton sheeting alternated with a cheap, light woolen flannel is used at times for making pads on which great pressure is brought and where pressed felt would spread and cause an uneven surface. Laminated cloths are used for packing as noted under that heading.

PACKING

Cotton and asbestos cloths, plain and laminated, are used extensively for mechanical packing, in gaskets and in washers of various kinds. The cotton cloth is generally impregnated with composition materials of various kinds and cut in the desired shapes necessary. Asbestos cloth is used both plain and impregnated in the same manner as cotton cloth. It is used for the most part in places where there is great heat. It has this advantage over cotton-cloth packing, but under a tension the latter is generally better. Impregnated jute cloth is also used at times where a cheap packing is desired and no particular strain or heat is present.

A large amount of cloth packing is consumed by prime movers of various kinds; steam engines and turbines; and gas, kerosene, gasoline, and various kinds of oil engines. It is used generally about any power plant. Pipe joints use impregnated cloth packing of all kinds and the consumption of the material in this way is very large. Light army duck and sometimes a light flat duck are used as the outside covering of asbestos and magnesia pipe coverings.

PADS

Under this heading a closely woven cotton sheeting or sometimes a light twill is used as the covering on inking pads in the printing and engraving industry, particularly on flat-press work. As heretofore described, occasionally a laminated pad made of cotton sheeting and woolen flannel is used on work where there is much pressure against the pad.

Flat ironing machines as used in laundries and homes have a woolen-flannel backing covered with a thick sheeting or light duck as a press pad. This same type of machine somewhat modified is used in tailoring establishments where pressing is done in large quantities.

POLISHING

Cloth is extensively used in polishing all kinds of surfaces. Cotton cloths of various types are laminated, sewed or riveted and then cut in disk form for polishing and buffing. They are used for polishing leather, wood, compositions and metals of various kinds, in the shoe industry and automatic shoe-polishing machines. The jewelry and electroplating trades use this type of polisher to some extent. In some instances cotton webbing is used when a heavy pressure has to be brought to bear.

In the making of lenses and various articles of glass, polishing is done by heavily felted woolen cloths, which cover the polishing wheels. These cloths vary from a thin billiard cloth to a thick heavy melton. Woolen cloths are sometimes used in the finishing of hats.

PUMPING

Flexible cotton hose, plain or treated, is used very generally in pump connections for gases, air and liquids,

especially in industries where a portable pump is necessary. The number of uses is legion and the following are fair examples of its very wide application:

a. For gas work, in the handling of oxygen, nitrogen and most commercial gases.

b. For air use, in the portable vacuum-cleaning outfits on wagons and automobiles, on house, factory, and office cleaners, the connections on compressed-air drills of all kinds, connections on sand-blast cleaning outfits, and on outfits for pumping air to divers.

c. For combination air and liquid pumps, in the connections for various types of atomizers, spraying devices, etc.

d. For liquids, in the connections on water pumps of all kinds; e.g., gasoline motors, fire engines, mine pumps, etc. On spray-painting connections and pumps of that type.

e. For liquids mixed with solids, in the connections for contractors' pumps, dredge pumps, bilge and boat pumps of different kinds, filtration and sewerage pumps, etc.

SIEVES

Cloths of various kinds are used as sieves. The finest is known as silk bolting cloth and is a gauze-type fabric varying from about 20 meshes to the inch up to 200 for the very finest. This is made up to about forty inches in width and is used for sifting flour and any substance which has to be used in very fine powdered form as chalks, paint bases, chemicals, etc. Sieve cloths are made also of linen and cotton in various meshes and weights for not such fine work and where the silk cloth has not the required strength. The weave is practically always plain and the yarns fine.

TREATED CLOTH

Cotton cloth in the form of sheeting, duck, belting, webbing and tape is used extensively as backing for different types of impregnated fabrics, cloth made of other fibers being rarely used. The treated fabrics may be divided in the general classes of rubberized goods, oilcloths, artificial leathers, insulating materials, impregnated laminated cloths, and semi-transparent sheeting. They can best be described in this order.

Rubber-treated cloth is perhaps most used. Tires consume a large amount of sheeting and a special fabric. Belting and webbing are used for conveyors, belts, and straps. Sheeting and duck, plain and laminated, are used for packing gaskets and washers. Sheeting and duck are used for printers' blankets, bolster aprons on machines for removing hair from hides, paper machines, electric separators and various other purposes. Tubular fabrics are used for hose, tubing and sleeve work.

Sheeting and duck made into oilcloth are used in various ways. As a conveyor apron on office duplicating machines, as aprons on paper-mill machinery, as backing on the drums used on a tapestry carpet loom which prints its own filling, and as a conveyor on one of the machines used in fur-hat making. Oilcloth as belting or as webbing is used as a conveyor under certain circumstances where a smooth surface is desired. Its use in photographic-film manufacture and candy making are good examples of this. Oilcloth can in general be used to a great extent in places where a rubber-treated cloth is used.

Artificial leathers are a more recent development and have just started to prove their practicability in indus-

try. So far their use for mechanical purposes is practically nil.

Treated cloths for insulation are described under the heading "Electrical" and laminated treated cloths are discussed under the headings "Polishing and Laminated Cloth."

Semi-transparent treated cloths are used for shades, light filters, and in tracing cloth for mechanical drawings. The cloth used varies from a 4½-yd. cotton sheeting for shades down to a very fine linen for tracing cloth.

WICKS

Cotton webbing and in a few cases soft, thick flat duck are used on machinery for purposes of a wick to convey various kinds of liquids to a certain point. Soft webbing is used in heater appliances for the conveyance of gasoline, kerosene, and various oils to be burned. It is also used in moistening, oiling, gumming and inking machines of various types for conveying the liquid slowly to a certain point or surface.

Industrial Groups

AIRCRAFT

This heading is readily divided into three classes: airplanes, balloons and dirigibles. On airplanes cloth is used in all ways common to the gasoline motor, as described under the heading "Automobile." The wings use cloths of silk, linen or cotton or combinations of these, and the fuselage is sometimes cotton-cloth-covered. Around the gas tank is often found a thick layer of rubber covered with cotton cloth to prevent incendiary bullets from igniting the gasoline. The straps used on the seats are often of cotton webbing in place of leather. The grip of the steering lever is often cloth-covered. Balloons use silk, linen and cotton cloth for the bags. Dirigibles use the same type of cloths for the bags and body coverings.

ARMY

The cartridge carriers for automatic rifles and machine guns are metal or a combination of cotton webbing and canvas. The best types of the latter are woven as a part double cloth separated canvas and part webbing. In this manner is woven on one machine the belt in its entirety with pockets and flat spots as desired. Other carriers are made by stitching two webs or two layers of canvas. The slings and strappings for almost all guns are now cotton webbing in various widths and weights. The straps on gun carriages, wagons, tanks, tractors, etc., are practically all cotton web. Silk cloth is used for powder bags. It is generally a plain-weave, roughly made, silken fabric of coarse yarns spun of silk waste.

AUTOMOBILE

The automobile is a very large user of textile products for mechanical purposes. On the motor, treated-cotton or asbestos-cloth packing, gaskets and washers are used. The fan belt is often either a plain cotton webbing, treated webbing, or an endless belt made by cutting cotton cloth on the bias, building up two to four layers of same and then rubberizing. In this way an endless belt is made which has good wearing qualities. Asbestos wrapping is often used around the exhaust manifold. Practically all water-circulating systems, whether pump or thermostatic, use a rubber-impregnated cotton hose.

Asbestos cloth has been used as a facing for clutches.

Asbestos webbing is used for brake linings, plain, or more often with a wire warp and asbestos filling. Plain, thick cotton webbing is also used as brake linings on the cheaper cars. Foot-pedal grips are usually canvas-backed, rubber-treated cloth. Door straps are of heavy cotton webbing, plain, rubberized, or made into artificial leather.

On a certain type of cheap car a thick, narrow cotton webbing is used in the transmission. Cotton webbing in various widths and weights is used for plain check straps on the axles and for special devices for preventing too rapid recoil of the springs after going over a rough spot in the road.

In the electrical system impregnated silk or cotton cloth and cotton and asbestos tubing are found on the generator, motor, magneto, transformer coil, distributor and wires. A treated cotton sheeting is universally used for covers on the steering connections, magneto distributor, springs, etc. In the making of wheels, particularly a certain type of truck wheel, cotton canvas or duck is used. It is placed as a cushion and fitting device between the spokes and the felloe.

The automobile tire consumes a tremendous amount of cotton cloth annually. Plain tire fabric, cord fabric, breaker-strip cloth, and lining are so well known as to need no mention in this paper. Blow-out patches of a rubberized cotton fabric and tire-tread covers, used mostly in Europe, are usually a cotton-canvas backing reinforced in various ways. In the manufacture of tires a cotton sheeting is used in the mold.

BAKERIES

The majority of cloth consumed is heavy duck, principally "00" weight. It is used as conveyor aprons in the ovens, mixers, conveyors and wrappers in the most modern up-to-date bakeries. Some webbing is used the same way. Heavy sheets of asbestos cloth act as heat protectors in the ovens. When flour or other ingredients in the making of cake have to be finely sifted, a very fine cotton sheeting or silk bolting cloth is used.

CANDY FACTORIES

The same kind of cloths are used in this work as are used in bakeries, with the exception that some of the conveyor belting is of oilcloth, in order to have a smooth surface easily cleansed.

CHEMICAL WORK

Cloths of silk, cotton, linen, wool and asbestos are used in different ways in this industry. They are used principally for sieves and filters. Most of them are of fine, hard-twisted yarns, plain woven goods of various degrees of closeness, though twill weaves and double-cloth fabrics are occasionally used. Cotton goods are used in the greatest quantity and the others about in even proportions.

ELECTRICAL

In this industry cloth is used primarily for insulation work and generally impregnated with a composition material of some kind which is a non-conductor of electricity. For fine-wire insulation and very fine machine work silk tapes and cloth are used. As the sizes increase in each case the tendency is to use cotton tapes or sheeting. Abroad, linen tapes and sheeting are used somewhat, but their use in this country is not general on account of the cost and cotton can be substituted. On cable work cotton and asbestos tubing are also used.

Asbestos webbing is used in the making of large generators.

In the telephone industry the uses of cloth are similar to those already mentioned; one particular webbing, however, is of interest as it is not believed such a web is used in any way comparable to it. A 1½-in. web of wire warp of about forty ends is made with a heavy silk filling to insulate the warp. Diagonally at short intervals across the filling there are open spaces left, leaving the warp bare so that connections can be made. This web is used in switchboard work on board connections.

ENGRAVING

Fine cotton sheeting is used in this industry to cover the inking pads on certain types of engraving machinery. The backing of the engraving press itself is usually a woolen cloth. It is a very fine, closely woven, and closely sheared woolen, very much on the order of a billiard cloth.

FARM MACHINERY

Army and numbered duck, cotton webbing and belting, packing cloths and hose, plain or treated, are used in farm machinery in varying amounts. They are used on tractors, tractor plows, ditch diggers, harvesters, threshing machines and pump connections of all kinds.

HOUSEHOLD MACHINERY

Vacuum cleaners use treated cloth, usually cotton, as air and refuse bags and in certain types narrow cotton webbing is used as a drive belt. The hose connections are rubberized cotton hose. Some washing machines are partly cotton-cloth-lined to prevent splinters getting into the clothes. Narrow cotton webbing is used for driving belts. In certain kinds of carpet sweepers a rubberized narrow webbing is used as bands or rims to drive the brush rolls. Some mechanical mops use loosely bound laminated cotton cloth, generally a low-grade sheeting or osnaburg. On mechanical ironers cloths are used in the same way as in the laundry industry.

MUSICAL INDUSTRY

Both cotton and woolen cloths are used in the manufacture of pianos, inasmuch as felt will not cover every purpose. These are used in the actions and in the keyboards. In piano players cotton webbing also is used for belts and treated cotton cloth in the bellows. In organs cotton strapping is used, treated cotton cloth for bellows and, in case of mechanically driven organs, cotton belting for drive belts. Motor driven music boxes use webbing for belts.

On a few of the best-made phonographs a woolen cloth is placed on top of the metal plate holding the record while being played. This replaces pressed felt. The cloth used for this is very much like a thick, coarse billiard cloth. Heavy cotton sheeting or light twills, drills or flannel are used in the manufacture of the record itself.

LAUNDRY MACHINERY

Cotton or woolen cloth is used quite extensively on this machinery. The principal place, perhaps, is on the rolls of a cylinder ironing machine. These rolls are of metal. First is wound a cotton sheeting; next, many layers of what is termed laundry flannel until a good cushion backing is formed. This flannel is a heavy, straight or broken twill, all-woolen blanket. It is of a coarse wool and heavily napped to get the maximum

cushion effect. On top of this flannel is wound a covering of light duck, usually about a No. 12.

On flat press ironers, resembling an old ironing board, two or three layers of the woolen flannel are used, covered by a couple of layers of cotton sheeting. On the starching machines a very open-mesh cotton cloth is used as a conveyor apron. It is made of about eight-three's yarn counting about eight to twelve warp threads and picks to the inch. On other machinery where conveyor aprons are needed, duck is used but heavier than on the ironing machine. In general the duck is a No. 4, 5, or 6. Woolen strainer aprons or cotton sheets are used to some extent to prevent the cloths from touching the inside of the extractors. These are any old cloths available. In the washing machines or kiers where family "wet wash" is cleansed, open mesh bags are used to hold the cloths, in order to keep each lot separate as they turn over in the machine.

OFFICE MACHINERY

The equipment of most business offices includes typewriters and adding and bookkeeping machines. These all require an inked ribbon for their operation and here a fine textile product is used. It is a cotton cloth made of very fine combed yarns, plain weave and generally from 80 to 100 counts each way. It is split lengthwise, gummed at the edges, inked and wound on small spools ready for use. On the stenotype machines there are also ribbons of this character.

On some adding machines, bookkeeping machines and dictaphones there are belts for driving them by electric motors and these are in most cases fine, narrow cotton webbing. Cotton sheeting and flannel are used in the manufacture of the record for the dictaphone. On duplicator machines of various types the conveyor apron used is a cotton-back oilcloth.

PAPER INDUSTRY

This industry is one of the largest users of textile products, and is entirely dependent on them, as contrasted to other industries where the textile product may be only an aid in producing results. The fabrics used are made of wool or cotton and are called woolen or cotton "felts," as the case may be. A pressed felt was originally used for the purpose and the name has remained, although the product has changed to a woven piece of goods. Woolen "jackets" are also used. These are tubular woven cloths, for shrinking on steel rolls hereinafter described.

The first machine in the paper industry on which a fabric is used is the pulp machine. A thick, open-mesh, plain-weave, heavy, endless woolen fabric takes the stock from a tub and deposits it in layer form on a cylinder from which it is afterward cut in the form of sheets.

On paper-making machines, as the paper stock comes from a revolving wire screen, it is deposited on an endless woven "felt" and by this "felt" is carried through iron press rolls on which is shrunk the heavy woolen "jacket." In this manner the water is squeezed through the "felt" and the thin film of stock or partly formed paper is left on the top of the moving cloth. It is carried through numerous pairs of jacketed rolls and by thicker and finer "felts" and finally is formed paper.

The jackets are tubular two- to five-ply woolen cloths, very closely woven, and felted very hard. They are fulled down to a size less than the roll circumference, and sheared closely; then wet, stretched and placed on the roll. When dry they are so tight they are practically a part of the roll and form an excellent cushion.

The woolen felts mentioned above on which the paper is formed vary from a light, thin, open, well-napped blanket to a close, soft, thick cloth much on the order of a very heavy overcoating. They vary in degrees of openness, thickness, nap, etc., according to the conditions under which run. Double-cloth woolen "felts" having the back cloth a flat, smooth, hard-felted surface and the face cloth of hard yarns are used as "marking felts," to make a special design on the paper after it has left the regular forming felt. "Carrier felts" of coarse, heavy woolen yarns, heavily fulled, are also used at times to convey the paper from one set of rolls to another.

With the paper formed but wet, it is delivered to an endless cotton "felt," which carries it around many steam-heated cylinders until dry. The cotton drier "felt" is a very thick heavy duck. It is usually a three- to eight-ply cloth, each ply averaging as heavy as No. 4 duck. The weight, thickness and yarns used depend on the conditions under which it is run.

Heavy cotton webbing or doubled duck, impregnated with rubber, is used as a guard on each side of the wire screen which delivers the stock to the "felt." This cotton rubber-covered strip is called "deckle strap." Apron conveyors used between the wire screen and first woolen "felt" are made from cotton cloth or duck either rubberized or made into oilcloth.

RAILROAD WORK

Cotton hose, usually treated, is employed for practically all airbrake connections on cars of all types. Also in steam and water connections for cars, round-houses, stations and shops. Some parts of signaling systems use cotton webbing of different widths. On the individual electric car-lighting systems the generator is often driven by a rubberized cotton belt. Webbing in general is used as slings, straps, etc., in railroad-shop work. In steam packing for locomotives cloth is used in general as on a stationary engine. On electric locomotives insulating cloth is used as described under the head of electrical work.

PRINTING

In the printing of textiles, whether silks, linens, cottons, woolens or carpets, cloths are used in three ways. The cylinder which operates against the printing roll is first wound with a linen or linen and woolen lapping. The linen lapping gives a backing to the roll and is used on account of its strength. It is a plain-weave, tightly woven fabric. When the linen and woolen lapping is used, the warp is linen and the filling wool. This gives the requisite strength and more cushion. Stretched around this cylinder to another roll is an endless belt, a sort of woolen jacket, which being next to the cylinder lapping gives the cloth being printed a cushion to work against. This woolen belt is a two- or three-ply, very close, heavily felted cloth, woven endless usually to get a smooth no-lap effect. Under certain conditions of printing a part cotton or a rubberized cotton cloth is used in place of a woolen. In printing filling yarn on a tapestry carpet loom of a certain type a cotton-backed oilcloth is used on the drum. The third place where a cloth is used in this kind of printing is for a leader to carry the cloth to be printed into the machine. It is called the "backgrey" and is a heavy, closely woven cotton sheeting. No matter how many cylinders or printing rolls are used the principle is practically the same.

Narrow fabrics such as ribbons, tapes, fancy straps, suspender and other webbing are printed in practically

the same manner. This same method is also used in printing wallpaper. In rotary printing presses for printing newspapers, magazines, and other big work the principle is the same, the difference being in the method of application. This is likewise so in rotary engraving work, the cloths in general being the same.

When flat printing or engraving is done, however, a cotton-sheeting-covered pad, a heavily felted light woolen, or a laminated cotton cloth and flannel backing are used. When inking is done by pad the covering is cotton sheeting.

TEXTILES

In the manufacture of textiles, cotton, woolen, jute, camel's-hair, linen and asbestos cloths are used. These are so familiar to every engineer in the textile industry that no descriptions of them are necessary; therefore a tabulation only is given in order to have them in proper form. Cotton is used most extensively, approximately 80 per cent of the poundage being of that fiber:

a. Belting. (Cotton or camel's hair, plain or treated):

Main drives
Machine drives
Within machine drives
Narrow conveyors

b. Card Clothing. (Linen, cotton and wool):

Backing for various types of card clothing

c. Clearer, Slasher and Roller Cloths. (Wool and cotton):
Cotton, woolen and worsted work

d. Cotton Duck:

1. Aprons for:

Automatic feeds	Driers	Openers
Blamire feeds	Dusters	Pickers
Camel's-back feeds	Fiber softeners	Scouring machines
Carbonizers	Fur depositors	Take-up rolls
Conveyors	Gill boxes	
Crosser formers	Loom beams	

2. Machine leaders for:

Back filling	Drying	Shearing
Brushing	Felt hardening	Singeing
Calendering	Ironing	Sprinkling
Crabbing	Pressing	Starching
Dewing	Sanding	Water mangling

e. Jackets (Woolen):

Fulling-mill rolls
Gig rolls

f. Jute Cloth:

Aprons on take-up rolls Leader on felt hardeners
Aprons on loom beams

g. Laminated Cloth. (Cotton):

Check straps	Lug straps
Gears	Pickers
Harness straps	

h. Printing. (Cotton, linen and wool):

See general head "Printing"

i. Sheets. (Cotton or wool):

Extractor linings Fulling-mill linings

j. Steaming Blankets:

Wool

k. Tapes and Webbing. (Cotton and asbestos):

Apperly feed bands	Harness straps	Slubbers
Can drier leaders	Mules	Spinning frames
Condensers	Machine belts	Spoolers
Doublers	Reducers	Twisters
Finishers	Roving frames	Winders

SHIPBUILDING

The building of ships consumes much cloth in a mechanical way, not to mention the tons of duck used non-mechanically. It is used as cotton and asbestos packing in engines, turbines and pumps, pipes and pipe covering. Flexible cotton hose is used with certain types of ship pumps and it is also used for dredging sleeves for certain types of dredge pumps. Heavy cotton webbing is being gradually introduced to take the place of ropes where a flat surface is preferable to a round one; this is

particularly advantageous for ship cranes in loading and unloading light cargo.

SHOE INDUSTRY

Wide cotton numbered duck is used on the shoe machines which form the box toes and heels of ordinary shoes. It is used as a forming agent for the parts of the shoe mentioned. Light 12 to 16-oz. duck is also used as backers or formers on other machines. Laminated cotton cloth in the form of buffer wheels is used for polishing.

ASBESTOS

Asbestos cloth is such an unusual product, so unlike any other cloth, that it is advisable to take it up separately. The two main fundamental differences in its use are, first, its heat- and flame-resisting qualities; and second, its neutrality to the actions of acids and alkalis. For these two reasons it can be used in places where no other fabric can. The cloth is usually of heavy yarns and a plain weave, varying in closeness of mesh and thickness as the purpose requires.

The great bulk of this cloth goes into steam packing. It is invaluable in this respect. In this is included gaskets and cut washers. The next largest amount goes into brake linings of all kinds, principally automobile. These may be entirely asbestos or wire warp with asbestos filling. Clutch facings come next in volume.

Filter cloths of various degrees of openness and thickness are used, mostly in chemical plants. Wire backings may be used in this work. This type of filter cloth is also used in making such gases as oxygen and hydrogen, and in such plants where refuse or sewage has to be disposed of. The cloth is easily cleaned by subjecting to fire.

In the electrical industry asbestos cloth is used mostly in webbing or tape form in the manufacture of armatures, etc., and greatly in wire and cable manufacture. Tubing of this material is used also in cable manufacture and gives excellent protection.

For fire doors, heat screens, and curtains a heavy fabric is used, either plain or with a wire warp. Theater curtains are of this type. Iron and steel mills use this cloth around furnaces, etc. Light asbestos cloth is used to wrap asbestos or magnesia packing, but in general heavy cotton sheeting or light duck is best for this purpose.

The making of asbestos board, wall board, linings, shingles, etc., is practically dependent on a textile product, an endless woolen blanket a form of papermaker's felt. The sheet of asbestos is formed on this woolen blanket or felt, the stock being carried through press rolls and finally delivered in a formed but moist sheet to driers. This blanket is made of heavy woolen yarns about one-quarter to one-eighth run, twisted two, three or four strands together. It is a plain weave cloth, about six warps threads and six picks fullled heavily and lightly napped on one side to enable a new felt to easily start the stock. As to the exact workings of this endless woolen blanket or felt, see the paragraphs on "Paper Industry," the principle being the same.

It will be found that in what has gone before there are a number of repetitions due to the unavoidable use of conflicting headings. The author by no means considers that every mechanical use is covered by the paper, but he does feel that it gives an idea of the tremendous use of cloth for mechanical uses and its importance in machine design, construction and operation.

Practical Jokers Among Workmen

BY CHESLA C. SHERLOCK

THE practical joker is a pest only too well known to employers in general. He is found wherever men are gathered together in numbers, whether in shop, factory or office. He is of the type who has abundant faith in his own superintelligence and he does not believe in letting his talents lie dormant.

The sad thing about practical joking is that sooner or later it ends in injury to the victim of the prank; often it ends in death, and the employer is then faced with a very serious situation. Is he, as the employer of the victim, liable for damages to the dependents, or liable for compensation under the workmen's compensation acts? This is only one problem arising out of such horseplay among workmen.

A joke for a joke's sake may be commended and may have a real part in speeding up production and promoting good feeling among the workmen, but practical joking does not belong to this classification of harmless pastime. It has its inception in a deliberate desire to "hurt" someone—the fun of the incident supposedly resting in the subsequent behavior of the victim. It is a deliberate, malicious, mean attempt to trifle with the person or welfare of another, and as a "joke" can appeal only to those having bullying tendencies.

JOKER A SOURCE OF POTENTIAL DAMAGES

Employers ought to be aroused against this practice among workmen, for it is not only to their interest to manifest an efficient organization, but it is to their interest in a financial way to stop these losses of industrial wastage by prohibiting practical joking and horseplay with a firm hand. The employee who indulges in it should be promptly discharged. He may be a valuable man, but he is a constant source of potential danger if his tendency in this direction is allowed free hand.

Employers may be surprised to learn that hundreds of cases growing out of practical joking have found their way to the attention of the courts. Employers have lost thousands of dollars in damages and compensation in paying injured workmen and their dependents for the "jokes" which other employees have perpetrated upon the hapless victim. And the perpetrators of the jokes have gone through life saddened and burdened with the memory of the grim ending of their thoughtless pranks.

TYPICAL EXAMPLES OF PRACTICAL JOKES

In a certain shop the employees had been having considerable "fun" at the expense of a new man who was extremely sensitive and ticklish. One evening just before quitting time, this new employee was carrying a heavy case of material down stairs to the floor below. At the top of the stairs, sitting on the banister reading a newspaper, was another employee, one who had been bullying the new man for several days. Just as the new man started down stairs under his heavy load the other workman quietly folded up his paper and tickled the other fellow in the ribs with it. This caused the new workman to lose his footing and he fell the full length of the stairs, his burden crashing down upon him.

The instances where workmen feel that they have to "initiate" a new workman before he can become a full-fledged member of the organization are legion. The law reports are full of stories where these practical jokers

have worked substantial harm upon the unsuspecting victim.

In one factory it was the custom to require a new workman to look into a box and gaze upon the "Queen of Sheba." When he was intently studying the picture within, a nice shot of flour was released. One day, the workman whose duty it was to load the magazine of this near-infernal machine, mistook lime for flour. When the new fellow gazed into the box his eyes and face were filled with lime. Within three months he was totally blind, and he suffered intense agony.

In a machine shop a workman laid a dynamite cap on the anvil of a new man. Not noticing it, the new workman proceeded with his work and in a few minutes his hammer struck the cap, causing an explosion which deprived him of a thumb and forefinger, as well as causing pieces of metal to be embedded in his chest and forearm.

MACHINERY CATCHES VICTIM OF SKYLARKER

Two men were scuffling near moving machinery in another case. One gave the other a slight shove, causing him to lose his balance. Instinctively, he put out his hand in the direction of the nearby machine. His arm was caught in the belting and was torn from the socket in the twinkling of an eye.

In a factory where female workers were employed one worker dropped a piece of material on the floor. When she leaned over to pick it up a companion worker next to her gave her a shove. Her hair came in contact with the belting and the unfortunate woman was jerked out of her seat and carried to the shafting overhead. By the time the machinery was stopped the scalp had been torn out and the poor woman was disfigured for life. This was a fair sample of a "good-natured" practical joke.

The habit of workmen striking at each other, even in play, should not be tolerated for one moment by the serious-minded employer. Even though they are away from the machinery and there is apparently no immediate danger from a little byplay, it should not be permitted. An example of what may happen is shown in such a case where two workmen passed each other in a factory passageway. One made a swipe at the other, as if to punch his nose. The victim ducked, lost his balance, his feet flew out from under him and he struck his head on the concrete floor. A fractured skull was the result. The first workman testified that all he intended was to brush off the fellow's hat.

LIABILITY OF EMPLOYER FOR INJURY RESULTING FROM "PRACTICAL" JOKING

No employer who is familiar with the law on the subject will tolerate horseplay and practical joking on his premises. He cannot afford to do so, even though he may himself "see no harm" in idle fun. But when the appeal strikes at his financial responsibility, he sees the thing in its grim reality.

Under the common law the employer was not liable for any injury that might occur to a workman in his employ as a result of horseplay, if the one playing the prank was outside the scope of his employment at the time. The courts were very lenient toward employers under the common law régime and it was seldom indeed that a workman succeeded in recovering damages. He had to prove that the one playing the prank causing his injury was within the scope of his employment at the time he did it, and that was an extremely difficult

and sometimes impossible thing for the workman to prove. But, at that, employers did have to pay damages and they often paid them in large sums. When they did pay, they paid whatever the whim of a jury might award to the injured workman or his dependents.

EMPLOYER NOW MORE GENERALLY LIABLE

Now we are operating largely under the compensation system of adjustment of differences between employees and employers. And the rule is different from the common law rule. The common law rule has been completely abrogated and if the victim of the joke was at work within the scope of *his* employment then the employer is liable to him for the injuries received, regardless of the manner in which such injuries arose.

In the vast majority of cases, then, at the present time (in all but six states) the employer is liable for injuries received through horseplay and must foot the bill. Not only that, but there is a moral obligation resting on the employer to protect his workmen from such avoidable injury. And if the employer doesn't fulfill this moral obligation the law will penalize him when the workman is injured.

Therefore, as was said before, it is to the employer's financial benefit that he see to it that all horseplay is forbidden in his establishment, and if an employee persists in playing his practical jokes that he be told to find another field for his activities.

Synopsis of Recent Chemical & Metallurgical Literature

The Why of Aging Clay.—H. SPURRIER, in the February *Journal* of the American Ceramic Society, found in a series of experiments that the evolution of CO_2 continued for over thirty-four days after pugging, and, like the change of plasticity, proceeded more rapidly between 80 and 90 deg. F. than below 60 deg. He also found that the effect of replacing water by non-aqueous liquids was to inhibit the development of plasticity altogether, and that the effect of a dilute solution of H_2O_2 was to produce a pronounced increase of viscosity and also to stimulate the growth of filaments, algæ, with the consequent evolution of both CO and CO_2 . It seems possible, therefore, that the change of plasticity of clays with time is due in some way to the growth of such algæ. This theory would explain all the effects.

In studying the new chemical measure of the plasticity of clays the ratio of the amounts of Al_2O_3 and SiO_2 dissolved by caustic potash was found for three clays tested to decrease rapidly with diminishing plasticity and therefore might well be used as a quantitative measure of plasticity. The practical potter of experience distinguishes readily between sticky and plastic clays by the feel. The above procedure also does this and the result can fortunately be expressed in figures.

Ancient and Modern Methods of Glass Manufacture.—The February, 1921, issue of the *Journal* of the American Ceramic Society contained an original paper on this subject by H. L. DIXON, who has actively participated in the development of scientific methods used in various branches of the glass industry for over forty years. The manufacture of glass-house refractories in early times, the earlier types of furnaces, direct-fired and pot, are briefly described, together with the expansion of the glass-house refractories business.

In the early '70s all window glass and green and amber bottle glass were made in open pot furnaces of the primitive direct-fired type. The regenerative furnace was not

introduced in the United States until 1867. The regenerative pot furnaces are now extensively used with raw producer gas, clean producer gas and natural gas, and have been so improved that greater economy of fuel is obtained as well as largely increased production. These furnaces are built from 14- to 20-pot capacity, the pots being of such dimensions as to contain from 3,000 to 4,000 lb. of glass, the melts being made in about twenty-four hours after filling. The first tank furnace was introduced in the United States about 1880.

The glass industry has migrated with the discovery of natural gas. The first use of natural gas in a glass furnace was at the works of the Bradford Window Glass Co., Bradford, Pa., in 1883. In 1885 the discovery of natural gas in Ohio moved the glass industry West. Later Indiana enjoyed a further development. Still later the industry moved into Kansas and when these fields became exhausted to Oklahoma and Texas. There are few who realize the extent of the migration or evolution in the glass business. In Pittsburgh and the Ohio River districts a great many of the old-established glass-manufacturing companies have actually gone out of business, largely due to the unusual competition of cheap natural gas and the methods employed by newly created manufacturing institutions unfamiliar with the glass trade.

The Manufacture and Treatment of Glass Melting Pots.—W. K. BROWNLEE and A. S. GORTON are the authors of a paper on the manufacture and treatment of glass melting pots published in the February *Journal* of the American Ceramic Society which deals with the raw materials used and methods of grinding and mixing the raw clay and grog, and the way in which glass pots are built and dried.

At present only one grade of pot is made, but the difficulty of getting a pot suitable for all kinds of glass suggests the desirability of making special grades of pots for use with specified kinds of glass. After describing the process in some detail, the authors conclude by emphasizing the point that the technical treatment of pots in the glass plant be intrusted to specially trained men.

The furnace man for obvious reasons should not have this responsibility, and the foremen and the manager, while they have a deeper appreciation of technical matters, are very busy with other questions pertaining to production. Neither should the burden be placed on the chemist, who has all he can do to see to the purity of raw materials and to adjust the glass for color, etc. This duty may be safely intrusted to a young man who has been adequately trained in ceramics and physical chemistry. When more glass manufacturers see the justness of this procedure and employ such men in their plants, real teamwork between the pot factory and the glass factory will be possible and certain troubles which have afflicted the industry for years will disappear to a great extent.

Physical Properties of Materials.—During the past few years the Bureau of Standards has received numerous requests for information regarding the physical properties of materials, principally ferrous and non-ferrous metals and alloys. Some time ago the compilation of most of the available data on this subject was undertaken. The tables which were compiled as a result of this work were issued to a limited number of Government establishments in mimeographed form. As they seemed to fill a very real need, it was deemed advisable to issue them in the form of a Bureau publication, and Circular 101 is the outcome of this work. The circular aims to present in readily accessible form the best available data on the strength and related properties of materials. Among those treated are iron, carbon steel, alloy steels, wire and wire rope, semi-steel, aluminum, copper, miscellaneous metals and other alloys, rope, rubber, leather and wood. The tensile strength, proportional limit, percentage elongation in 2 in., percentage reduction of area, Brinell and scleroscope hardness corresponding to a certain composition, density, and method of preparation are shown in most cases for the metals and alloys. In addition, figures are given in many instances for the compressive and shearing strengths, moduli of rupture, and Erichsen values. The circular also includes definitions of the properties treated and references to sources.

Recent Chemical & Metallurgical Patents

British Patents

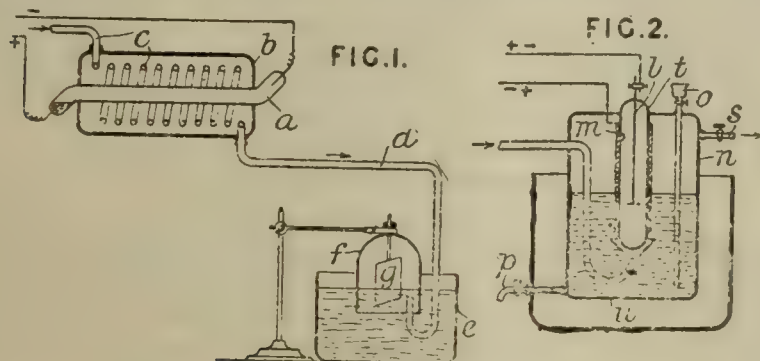
Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Viscose.—In a cyclic process for the manufacture of artificial threads, films, etc., from viscose, a solution of the latter is prepared with caustic soda obtained electrolytically, the hydrogen and chlorine from the electrolytic cell are united, as for example in an explosion motor, to form hydrochloric acid which with the addition of sodium chloride if necessary constitutes the precipitating bath, and the sodium chloride regenerated during the precipitation is returned to the electrolytic cell. (Br. Pat. 153,444; R. MULLER, Eilenburg, Saxony. Jan. 19, 1921.)

Solder for Enamelware.—In tinning and soldering porcelain enamelware, the solder is applied to the glazed surface of the enamel or to both the enamel and any exposed iron portion, by the use of a steel brush or other steel tool without the aid of a soldering iron or flux. The surface is cleaned and brightened and the vessel then heated over a gas-ring, etc. Solder is then applied by the steel tool, etc., until the surface is tinned and more solder then applied. The solder may consist of 30 per cent of tin, 10 per cent of zinc and 60 per cent of lead. According to the provisional specification, the solder may consist of 75 per cent of tin, 15 per cent of zinc and 10 per cent of lead. (Br. Pat. 153,445; W. B. JOHNSON, Tavistock, Devonshire. Jan. 19, 1921.)

Testing Milk and Cream.—In the process of making butter, the proportion of fat in the milk or diluted cream is estimated with the aid of a solution acting as a solvent for the casein, and containing a considerable amount of potassium sodium tartrate—for instance 150 to 250 g. per liter—and a quantity of alkali corresponding with 105 to 135 g. of sodium hydroxide per liter; 9.7 volumes of milk are mixed with 3.4 volumes of this solution and 0.6 to 62 volumes of isobutyl alcohol, heated to 60 to 70 deg. C., and the quantity of fat read off on the butyrometer glass. A modified solution for use with undiluted cream contains 70 to 135 g. of potassium sodium tartrate and 50 to 70 g. of sodium hydroxide per liter; and the proportions to be taken are 5 volumes of cream, 6.5 volumes of this solution, and 0.6 volumes of isobutyl alcohol. (Br. Pat. 153,446; H. M. HÖYBERG, Copenhagen. Jan. 19, 1921.)

Facilitating Chemical Reactions by Radiations.—The reaction between a gas and another substance is facilitated by subjecting the gas to the action of ultra-violet, Lenard, Becquerel or Röntgen rays and then bringing it into contact with a metallic surface, or by directing the gas on to a metallic surface which is itself subjected to the action of



ultraviolet or other rays. By subjection to the action of these rays, the gas is stated to emit cathode rays whose vibrations are amplified by contact with a metallic surface. Two forms of apparatus are described, corresponding to the alternative methods of activating the gas, such as hydrogen, oxygen or nitrogen. One form, Fig. 1, comprises

a mercury vapor lamp *a* enclosed in a vacuum jacket *b*, a quartz coil *c* through which the gas is passed, a tank *e* for the reacting liquid or the solution of the reacting solid, a bell-jar *f* containing a metallic plate *g*, and a tube *d* for conveying the activated gas into contact with the metallic surface *g* suspended in the reacting liquid or the solution of the reacting solids. The other form of apparatus, Fig. 2, consists of a vacuum bulb *t* provided with an internal electrode *l* and an external electrode *m* surrounding the bulb, the whole being fitted within a closed vessel *n* having inlet and outlet tubes *o* and *p* for the liquid and inlet and outlet tubes *u* and *s* for the gas. In this case the gas, on issuing from the tube *u*, rises through the reacting liquid or the solution of the reacting solid and forms a jacket round the lower part of the vacuum bulb *t*, through which an alternating discharge is taking place. The applications of this process are as follows: The hydrogenation of unsaturated fatty acids or their glycerides, of unsaturated hydrocarbons, of quinine to hydroquinine or of *p*-cresol to methylcyclohexanol; the reduction of fatty alcohols to hydrocarbons, of fatty oxacids to fatty acids, of aliphatic aldehydes to alcohols, of oxaldehydes to aldehydes, of nitriles to amines, of cinnamic acid to hydrocinnamic acid, of nitrobenzene to azoxybenzene, azobenzene, hydrazobenzene and aniline, of nitrobenzene to phenylhydroxylamine; and the syntheses of ammonia and hydrazine. (Br. Pat. 154,213, not yet accepted; E. STATINEANU, Cressy-Onex, near Geneva, Switzerland. Jan. 26, 1921.)

Ammonium Sulphate.—To remove mother liquor from wet sulphate of ammonia, the crystals are placed on a perforated plate *G* within a vessel *A* provided with a cover *D*, and dry steam or steam and air is blown in from the top of pipe by *F* in order to drive the liquid out by a pipe *J* to the saturator *L* or to the tank *K*. Ammonia may be introduced at any stage to neutralize remaining acid. The vessel *A*, which may be steam-jacketed and made of acid-resisting material, is mounted on trunnions *B* to allow of the dried crystals being tipped out into the storage chamber *M*.

(Br. Pat. 154,328; N. WILTON, London, Jan. 26, 1921.)

Hydrocarbon Cement.—Pitch, tar, or other substance consisting mainly of aromatic hydrocarbons, and having a specific gravity of not less than 1.1, is heated to 120 to 180 deg. C., and a powdered inorganic sulphate is stirred in, to produce a cement for general building, road-making, etc., purposes. The sulphates may be hydrated or anhydrous, chemically prepared or as found in nature, for example gypsum, anhydrite, alunite, barytes. The amount of sulphate added may vary between one and four volumes to one volume of tar, etc. The powdered sulphate is added gradually with stirring and the stirring is continued until foaming ceases. In a modification, the tar, etc., and sulphate are placed in a vessel and heated under pressure. The cement is applied at the temperature above stated. The material may also be used as a binder for sand, gravel, broken stone, sawdust or the like. A list of applications is given in the specification. (Br. Pat. 154,152, not yet accepted; W. S. BARRIE and L. CHADWICK, Townsville, Queensland, Australia. Jan. 26, 1921.)

Synthetic Tanning Agents.—An aromatic hydroxy compound or an alkali salt thereof, an aldehyde and an acid sulphite are condensed together in solution at ordinary pressures and at temperatures up to 100 deg. C. The phenol used may be a mixture and may be in the form of a solution of its alkali salt as obtained technically. According to examples, commercial phenol or carbolic liquor is condensed with formaldehyde or acetaldehyde, and sodium bisulphite. The products are suitable for tanning agents, with or without addition of other tanning agents or a metallic salt. (Br. Pat. 154,153, not yet accepted—see also Br. Pat. 154,162, not yet accepted—CHEMISCHE FABRIKEN WORMS, AKT. GES., Frankfurt-on-Main, Germany. Jan. 26, 1921.)

Current Events

in the Chemical and Metallurgical Industries

American Engineering Council Opposes Trade Commission Section of Patent Office Bill

The American Engineering Council of the Federated American Engineering Societies will seek at the opening of the special session of Congress to have the Nolan Patent Office bill passed. Failure of the measure in the last session is attributed to the presence of the Federal Trade Commission section, which Edwin J. Prindle of New York, chairman of the American Engineering Council's patents committee, in a report to L. W. Wallace, executive secretary of the Council, asserts should not be enacted into law in any form even as a separate bill. The committee report states its belief that this is a dangerous measure in itself and will open up a most unfortunate activity for the Government.

"The bill for the imperatively necessary relief of the Patent Office, after passing the House of Representatives with satisfactory provisions for the Patent Office, failed to pass the Senate at the session just closed, solely because of the presence in it of an unrelated section known as the Federal Trade Commission section," says the report.

"The former opposition in the Senate to the Patent Office relief and that which forced the unacceptable reductions in salaries and numbers of examiners and clerks (which the conference committee was persuaded to set aside) is largely and seemingly almost wholly overcome. But the opponents in the Senate to the Federal Trade Commission section are determined and have expressed an intention to prevent the Patent Office from getting the desired relief unless the section is removed from the bill.

"More than preventing the Patent Office relief, however, the section is believed to be a dangerous measure in itself. It provides that the Federal Trade Commission may receive assignments of and administer inventions and patents from governmental employees and is an entering wedge for further legislation to empower the Trade Commission to receive patents from non-governmental inventors or owners.

"An exclusive license would have to be granted, at least for a few years, to induce any one to undertake the almost always necessary development expense, and the Trade Commission would surely be charged with favoritism in granting such a license. In order to protect its licenses the Trade Commission would have to sue infringers, a most unfortunate activity for the Government. The industries would close their doors to the Government employees, fearing to disclose to them their secrets or unpatented inventions, and research by the industries would be discouraged for fear that Government employees, using Government facilities, might reach the result first and patent it.

"The Trade Commission, owning a large body of patents, in case one of its patents was found to be infringed during or at the close of a frequently very expensive development by private interests, would be able to dictate in the license the price at which the article which was the object of the development could be sold, or to dictate other similar conditions, thus depriving the development of much of its value; and could even require the licensee, as a condition for granting the needed license, practically to destroy some of its unrelated patents, as by licensing the trade generally when it would prefer to retain the monopoly for itself.

"The foregoing and other objections would result in making patents less desirable to own or to purchase, and consequently would decrease the incentive to produce inventions.

"The proposed section is unnecessary for the protection of Government employees, since they now have all the rights which non-governmental employees have to patent inventions and to sell them. It is therefore believed that the Federal Trade Commission section should not be enacted into law in any form, even as a separate bill."

Government Needs Chemists and Other Laboratory Workers

The United States Civil Service Commission states that there are openings in the Government service for associate chemists at \$2,500 to \$3,600 a year, assistant chemists at \$1,800 to \$2,500 a year and junior chemists at \$1,200 to \$1,800 a year. Appointees at an annual compensation of \$2,500 or less will also be allowed the increase of \$20 a month granted by Congress. It is stated that the openings offer opportunities for those who are qualified in the various specializations of chemistry.

The commission also announces that the Ordnance Department at Large, War Department, needs catalytical chemists at \$3,000 to \$4,000 a year, assistant catalytical chemists at \$2,000 to \$3,000 a year and junior catalytical chemists at \$1,600 to \$2,000 a year. The increase of \$20 a month is allowed for these positions also when the basic pay is not more than \$2,500 a year.

There is also need in a number of Government establishments for laboratory assistants, laboratory aids and laboratory apprentices of various kinds, requiring training in chemistry, physics, ceramics, textile technology, paper technology, civil, mechanical and electrical engineering, etc.

Full information and application blanks may be obtained by communicating with the United States Civil Service Commission, Washington, D. C., or by calling upon the secretary of the United States Civil Service Board at the post office or custom house in any city.

Steam Economy in Drying Paper

The March meeting of the Connecticut Valley Section of the Technical Association of the Pulp and Paper Industry was held in Holyoke March 21. Pursuant to the Section's policy in dealing thoroughly with the problem of paper drying at the meetings this year, the speaker was Mr. Fulton of the Fulton Engineering Co. of Middletown, Ohio, who discussed the process of controlled drying by the use of the equipment manufactured by his company.

The drying problem as a whole has suddenly become of great importance to paper makers, particularly those in New England, because of the price of coal and the necessity for cutting costs of manufacture. Mr. Fulton showed how it was possible to get greatly increased production without the use of additional steam for drying. As many mills average 2 lb. of steam to dry 1 lb. of paper, such results are well worth while, particularly when machines that have required live steam for drying are able by the use of an efficient separating system to substitute exhaust steam. The driers on a paper machine make ideal condensers, and when the proper valves are in place to insure the removal of air and exhaust steam used with efficient traps and a closed system, so that nearly all the condensate is recovered free of dissolved gases, the cost of operating the power plant may be often materially reduced.

Laundering Problems

The Laundry Owners Association of the Hampden County district of Massachusetts held an open meeting in Holyoke March 25. Miss Wakefield of the Mellon Institute of Industrial Research was the principal speaker. Her address was illustrated with slides showing in detail some of the trials of the laundryman, particularly in connection with faulty or cheap textiles which may be so woven as to conceal defects which soon become apparent when the goods are laundered. She also described in detail the work of the National Laundryman's Association fellowship at Mellon Institute.

Progress in Survey of Industrial Waste

The committee of the American Engineering Council on "Elimination of Waste in Industry" is making rapid progress in its field surveys. Ten basic industries have been selected for the investigation, and at least six plants in each industry will be covered. These industries are: Bituminous coal, transportation, building trades, men's clothing, paper, printing, metal trades, textiles, shoes and rubber. Information is being obtained systematically through a questionnaire that has been prepared for the field workers, and the selection of plants has been so made as to give a geographical cross-section of each industry. In addition to the national inquiry into the ten basic industries a regional survey will be made of industries in the city of Worcester, Mass. The results of each survey will be embodied in reports of the field directors for each industry as follows: First, a full engineering report; second, a 3,000 to 5,000-word digest for the technical press; third, a 1,200 to 1,500-word digest for the daily press, and fourth, 500 to 600-word articles for the daily press. It is hoped and expected that these reports will be completed and ready for distribution within the next sixty to ninety days.

Program of Atlantic City Meeting of Electrochemical Society

Unusual interest is being manifested in the forthcoming meeting of the American Electrochemical Society at Atlantic City, April 21 to 23. In addition to an unusually good technical program, the essential features of which are presented herewith, special attention has been given to social events that will make the convention attractive. Acheson Smith and Carl Schluederberg have announced an old-fashioned reunion of the "Us Old Trappers Association" for the purpose of demonstrating their prowess with the rifle and pistol in one of the shooting galleries on the Boardwalk. A trapping exhibition is also announced, but details are suppressed. Prizes will be provided for all grades of marksmanship. All of the foregoing is arranged in addition to the golf tournament for the championship of the Electrochemical Society.

Headquarters will be at the Chalfonte Hotel and registration will begin at 6 p.m., Wednesday, April 20. Ladies are especially welcome and will be entertained by a committee which is arranging some interesting events. A feature of the technical program is a symposium on corrosion. Details of the program follow:

THURSDAY, APRIL 21

9:30 a.m. Session for Reading and Discussion of Papers.

Symposium on Corrosion

William H. Walker: Introduction to Symposium on Corrosion of Iron and Steel.

W. D. Richardson: The Gap Between Theory and Practice in the Production of Corrosion-Resisting Iron and Steel.

A. S. Cushman and G. W. Coggeshall: Anomalies Encountered in a Study of Immersion Tests of Iron and Steel.

J. M. Aupperle and D. M. Strickland: Observations on the Corrosion of Iron and Steel.

F. N. Speller: Practical Means of Preventing Corrosion of Iron and Steel Where Not Exposed Directly to the Atmosphere.

D. M. Buck: Some Observations on the Mechanism of the Increased Corrosion Resistance of Steel and Iron Due to Small Copper Contents.

O. P. Watts and H. C. Knapp: The Effect of Copper and Silver Salts on the Corrosion of Iron by Acids.

E. A. Richardson and L. T. Richardson: The Corrosion of Old Iron.

O. W. Storey: The Corrosion of Steel Ranges.

B. G. Worth: Unusual Boiler Tube Corrosion by Carbon Dioxide.

2 p.m.

Sports and recreations, contests, etc.

6 p.m.

The board of directors will hold a dinner-meeting, at the Chalfonte Hotel, for transaction of usual business.

8 p.m.

Lecture in the auditorium of the Chalfonte Hotel (across North Carolina Ave. from the hotel). R. B. Moore, of the Bureau of Mines, Washington, D. C., will lecture on

"Helium: Its Production, Properties and Uses." After the lecture informal discussion and conversazione. Award of prizes for the sport contests held Thursday.

FRIDAY, APRIL 22

9:30 a.m. Annual Business Meeting of the Society

Report of the board of directors.

Announcement of annual election.

Reports of various committees.

Presidential address of the retiring president, W. S. Landis.

Reading and Discussion of Papers

Symposium on Corrosion (continued)

H. A. Gardner: Metal Protective Paints.

O. P. Watts: Principles of Alloying to Resist Corrosion.

H. S. Rawdon: Some Types of Non-Ferrous Corrosion.

E. R. Shepard: Electrolytic Corrosion of Lead by Continuous and Periodic Currents.

Other Papers

O. H. Eschholz: Phenomena of Arc Welding.

H. W. Gillett: Electric Furnaces for Non-Ferrous Metals.

Carl Hering: Electrodynamical Forces in Electric Furnaces.

E. F. Northrup: Recent Progress in High Frequency Induction Heating.

W. G. Mylius: The Regulation of Electric Steel Arc Furnaces Using Movable Electrodes.

2 p.m.

Sports and recreations, contests, etc.

8 p.m.

Exhibition of moving pictures of industrial plants in the auditorium of the Chalfonte Hotel:

The Chuquicamata, Chile, Copper Extraction Plant of the Chile Exploration Co.

The Muscle Shoals Nitrate Plant of the American Cyanamid Co.

Dancing after the picture show as soon as the seats can be removed from the auditorium.

Award of prizes for the sport contests held on Friday.

SATURDAY, APRIL 23

9:30 a.m. Reading and Discussion of Papers

T. R. Briggs and W. J. Bartlett: Adsorption of Arsenious Oxide by Metastannic Acid.

L. Kahlenberg and W. J. Trautmann: Reduction by Means of Silicon.

Theodore W. Case: A Photo-Electric Effect in Audion Bulbs of the Oxide-Coated Filament Type.

S. E. Sheppard: Electrochemical Aspects of Photographic Development.

A. S. McDaniel, L. Schneider and A. Ballard: The Electrolytic Manufacture of Para-aminophenol.

W. A. Noyes: Some Aspects of Electrolytic Iron.

William Blum: Use of Fluorides in Solutions for Nickel Deposition.

C. P. Madsen: Ductile Electrolytic Nickel.

C. W. Hazelett: A New High Capacity Storage Battery.

C. W. Marsh: Marsh Electrolytic Cell Batteries for Chlorine, Caustic Soda and Hydrogen.

Government Smokeless Powder Sold

The Director of Sales, War Department, announces the sale, through the agency of the Ordnance Salvage Board, of 28,000,000 lb. smokeless powder to the Bethlehem Chemical Co. of Washington, D. C.

The price to be paid by the purchaser is $\frac{1}{2}$ c. per lb., "as is, where is." By the terms of this sale the United States is to receive 60 per cent of the net amount received by the purchaser in the event that any of this material is resold or reworked and resold for use as smokeless powder.

General Fries Gets Recess Appointment

General Amos A. Fries, head of the Chemical Warfare Service, has been given a recess appointment by President Harding to assume the rank of Brigadier General. General Fries was one of a large number of Army officers whose promotions were not confirmed at the recent session of Congress. The reasons were political and in no way reflected upon the nominations for positions other than those commonly classed as patronage. In order to reserve for the incoming Administration as many as possible of the patronage positions practically no confirmations were made during the last session.

Personnel Research Federation

Under the auspices of the National Research Council and Engineering Foundation, the Personnel Research Federation has been organized to bring about interchange of research information among the numerous organizations which are engaged in personnel research. It is reported to the new federation by the Bureau of Labor Statistics, of the Department of Labor, that there are 250 such organizations in the United States. The Personnel Research Federation will collect research information, will encourage research through individuals and organizations and will co-ordinate research activities. This federation includes in its membership scientific, engineering, labor, management and educational bodies.

Temporary officers have been elected as follows: Chairman, Robert M. Yerkes, representing National Research Council; vice-chairman, Samuel Gompers, representing American Federation of Labor; treasurer, Robert W. Bruere, representing Bureau of Industrial Research; secretary, Alfred D. Flinn, representing Engineering Foundation; acting director, Beardsley Ruml, assistant to the president of Carnegie Corporation of New York.

The aims of the new organization are:

Increased efficiency of all the personnel elements of industry—employer, manager, worker—and improved safety, health, comfort and relationships.

The immediate purposes of the Personnel Research Federation will be:

To learn what organizations are studying one or more problems relating to personnel and the scope of their endeavors.

To determine whether these endeavors can be harmonized, duplication minimized, neglected phases of the problems considered, and advanced work undertaken.

Present Status of Nitrogen Fixation in Germany

Calcium cyanamide factories engaged in the production of nitrogen fertilizers by process of fixation of atmospheric nitrogen were in operation in Germany before the war, but during the war these plants were extensively enlarged and are now in process of completion. The total output of these plants when properly supplied with coal is estimated at 600,000 tons, with a nitrogen content of 120,000 tons. Several plants representing this production, together with the possible output of each, are as follows:

	Tons
Mitteldeutsche Stickstoffwerke A. G. Plesteritz.....	175,000
Oberschlesische Stickstoffwerke A. G. Chorzow.....	150,000
Aktiengesellschaft für Stickstoffduenger, Knapsack, Gross Kayna	140,000
Bayerische Stickstoffwerke A. G., Trostberg and Margarethenberg	75,000
Lonzawerke, Waldshut	60,000
Total	600,000

At the present time these plants are producing approximately 500,000 tons of calcium cyanamide, with a nitrogen content of 100,000 tons.

Prior to the war the production of nitrogen fertilizers by coke and gas industries reached a figure of 580,000 tons, with a nitrogen content of 116,000 tons. However, the coal shortage has militated against the maintenance of production at these figures.

The Badische Anilin und Sodafabrik is the only concern producing nitrogen fertilizers by the Haber-Bosch process. Its first factory for this purpose was constructed at Oppau. Operations began at this plant in 1913. A second plant, known as the Ammonia Works of Merseburg, which is twice the size of the Oppau plant, was later erected, and has been in operation since 1917. When properly supplied with raw material the annual output of nitrogen in both of these plants is 300,000 tons, corresponding to 1,500,000 tons of sulphate of ammonia.

Before the war Germany's annual agricultural requirements of nitrogen fertilizers were 210,000 tons of nitrogen, of which 100,000 tons was in the form of nitrate of soda and nitrate of lime (imported), 100,000 tons in the form of sulphate of ammonia of home production and 10,000 tons in the form of calcium cyanamide, likewise of home production. At the outbreak of the war there was only 40,000

tons of nitrate of soda within the country, which was immediately taken for the manufacture of ammunition. The total production of nitrogen fertilizers by the plants now existing and those in process of construction will approximate 500,000 tons of nitrogen, equal to more than twice the amount required for agricultural purposes before the war.

In spite of their high cost nitrogen fertilizers are in great demand in Germany today. A quantity of sulphate of ammonia containing 1 kilo of nitrogen cost 1.35 marks in 1913, as against 12 marks in 1920. At the same time 100 kilos of ammonia fertilizer with 20 per cent nitrogen cost 27 marks in 1913, as against 240 marks in 1920.

Legislators Visit Edgewood Arsenal

A number of members of the Committees on Military Affairs of the Senate and of the House visited Edgewood Arsenal March 31 as the guests of General Fries. General Fries has been trying for some time to induce members of Congress, who are charged with duties pertaining to the Chemical Warfare Service, to get a first-hand idea of the work which is being conducted by the service. Despite the proximity of Edgewood to Washington this is the first time it has been possible to get any considerable number of legislators together for such a trip.

Radium Production

The Standard Chemical Co., of Pittsburgh, reports a production of 18 g. of radium sulphate for 1920. Most of it was used for medical purposes, although some went into the manufacture of luminous dials for watches.

Treatment at the mines of 500 tons of Colorado carnotite yields 125 tons of concentrate, which is shipped to Pittsburgh. Preliminary refining reduces this amount to 0.5 ton and approximately 1 g. of radium results from further refining. The product is put up in milligrams and sealed by the Bureau of Standards. It sells for \$120,000 a gram.

A.S.M.E. to Discuss Steam Equipment Codes

Nineteen Power Test Codes, constituting what their framers style "a national common law" in the field of power plant testing are being framed by 125 leading engineers, scientists and educators under the auspices of the American Society of Mechanical Engineers, and will be discussed at the Chicago meeting May 23 to 26.

The codes, when completed, will affect a wide range of industrial enterprises, large and small. They will provide courses of procedure by which everything from an electrical superstation to a boiler fed pump shall be tested to see if they comply with the terms of purchase or if they are operating at the desired efficiency.

The discussion at the Chicago meeting will relate to the adoption of the Power Test Code containing rules for conducting tests of steam engines and evaporating apparatus, and will be open to the public. Manufacturers, members of engineering societies and technical and scientific men from many cities are planning to give their views on the question of adoption of these codes prior to their final sanction by the Society.

The third of the nineteen to be completed is described by the committee as intended primarily for the testing of apparatus heated by steam, such as vacuum pans, or single- and multiple-effect evaporators. The principal use for such evaporators is in the manufacture of alkali, salt, sugar, condensed milk, extracts from chemicals, and similar processes.

The committee in charge of the preparation of this code is headed by E. N. Trump of the Solvay Process Co., Syracuse, N. Y. The other members of the committee are B. N. Bump and L. C. Rogers of the Solvay Process Co.; E. A. Newhall, designing and construction engineer, of Philadelphia, and H. L. Parr, assistant professor of mechanical engineering, Columbia University.

Three codes have already been completed: one, in the nature of a preliminary set of rules, is entitled "General Instructions." This code was prepared by a committee under the chairmanship of William H. Kavanaugh, professor of

experimental engineering in the University of Pennsylvania. His associates on the committee are C. J. Bacon of E. I. du Pont de Nemours & Co., Wilmington, Del.; Prof. Arthur M. Greene, Jr., of Rensselaer Polytechnic Institute, Troy, N. Y.; and C. F. Hirshfeld of the Detroit Edison Co., Detroit, Mich.

The individual committee in charge of a test code first submits a preliminary draft to the secretary of the main committee. This draft is edited and returned to members of the individual committee by the secretary, to whom an edited revision is returned approved. The draft is then set in type and proofs are distributed to a selected list of from one to two hundred engineers for criticism, after which the individual committee submits the revised code to the main committee. The main committee then returns the code to the individual committee for further revision, and then submits the revised draft of the code to the Council, the governing body of the Society, and asks permission to print and present it to the Society. When the Council, consisting of thirty members representing cities East and West, gives leave to print, the code appears in *Mechanical Engineering*, the official journal of the Society. The next step is the submission of the code to the Society at a regular meeting, where it is either approved and adopted or is returned for further revision.

This Chicago public presentation and discussion of three test codes will be one event in an elaborate program of social, economic and technical discussions in which men of nationwide prominence will figure.

Personal

WILLIAM P. ALLEN, director of the service department at the works of E. I. du Pont de Nemours & Co., Wilmington, Del., has been appointed assistant treasurer of the company. At one time Mr. Allen was employed as a research chemist at the company's plant at Repauno, N. J., and later was located in the chemical department at the Wilmington works. He will be succeeded in the service department by William B. Foster, who has heretofore been assistant chief engineer.

WILLIAM V. ANDERSON, who was formerly with the Aetna Explosives Co. as superintendent of acid plants, has gone into consulting and construction service for acid manufacture at Garvanza, Cal.

JAMES W. BOILEAU, metallurgist and consulting engineer, El Paso, Tex., was in Chicago recently on business.

R. V. BROWN, superintendent of the Sherwin-Williams Co. Chicago plant, spoke before the Chicago Chemists Club March 22 on "The Application of Chemistry to Paint and Varnish."

Dr. HAROLD HIBBERT, assistant professor of chemistry in Yale University, has been promoted to an associate professorship of applied chemistry, and assigned to the Graduate School and the Sheffield Scientific School.

Dr. F. GOWLAND HOPKINS, professor of biochemistry at the University of Cambridge, delivered the ninth Harvey Society lecture at the New York Academy of Medicine Saturday evening, April 2. His subject was "The Chemical Dynamics of Muscle."

CHARLES S. MADDOCK, JR., of the Thomas Maddock's Sons Co., Trenton, N. J., manufacturer of chinaware, gave an interesting address on the subject of bone china before the members of the local Rotary Club March 24.

Prof. A. A. MICHELSON, head of the department of physics at the University of Chicago, has been appointed exchange professor at the University of Paris. His course of lectures will be on the general subject of "Physics" and will be given in the French language.

Dr. ERNEST FOX NICHOLS, director of scientific research at the Nela Park laboratory of the National Electric Lamp Association, Cleveland, Ohio, has been elected president of

the Massachusetts Institute of Technology, to take office on July 1. Dr. Nichols was formerly professor of physics at Yale University and also held the presidency of Dartmouth College.

Dr. ROBERT F. RUTTAN, head of the department of chemistry, McGill University, has been appointed to succeed Dr. Duncan G. MacCallum as administrative chairman of the Advisory Council for Scientific and Industrial Research in Canada.

ALEXANDER SILVERMAN gave a timely illustrated address on the subject "The Contributions of Chemistry to the Comfort of Man," at the Carnegie Lecture Hall, Pittsburgh, on March 24.

CLINTON K. TEXTOD has severed his connection with the Mead Research Co. to accept a position as chemical engineer with the Northwest Paper Co., Cloquet, Minn., in connection with proposed developments which are not yet announced.

CHARLES S. WITHERELL, formerly metallurgical engineer for the Chile Exploration Co., announces that he is open for engagement in a consulting capacity on metallurgical plants and processes. His new office is at 150 Nassau St., New York City.

Obituary

C. E. HAVILAND, of the Haviland China Co., died on March 30 at Limoges, France. Mr. Haviland was of American descent, the founder of the firm, Theodore Haviland, having left the United States because of the difficulty in obtaining local porcelain artisans. The American origin of the firm served it well in 1905 during a labor riot. Mr. Haviland flew the Stars and Stripes over his plant when the mob became menacing and being a United States consular representative, the area of the works became legally American territory, as a consequence of which the mob was overawed.

THOMAS LYNTON BRIGGS, of the General Chemical Co., died Sunday morning, April 3, of heart disease, at his home, 188 Central Ave., Flushing, L. I. Mr. Briggs was born on Dec. 27, 1857, in London, and received his doctor's degree under Fresenius. He came to America in 1886 and joined the G. C. Co. at Laurel Hill twenty-one years ago on the first of this month. He is survived by his wife and children, Prof. Thomas R. Briggs of Cornell and Miss Adelaide Briggs.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, April 4, 1921.

A gradual improvement has been noted in the demand for production in the first-hand market for heavy chemicals. March has been decidedly better from the manufacturer's viewpoint than any month since the present period of depression. The country's industrial wheels are making slow but steady progress and with this development more conservative buying can be expected. General conditions have shown a larger vein of optimism and leading factors are sure of a brighter future. Profits have been comparatively small and prices have been on the decline in the face of foreign competition, but the business which is being conducted now seems of a steadier character and limited to a conservative trade between makers and consumers. Speculators have gradually dwindled from the market owing to the continued uncertainty of the price situation and while there still are a few left their territory is confined to only a few items of comparatively small lots that have no mate-

rial bearing on the industry. The unsettled political outlook in Germany has been reflected in the potash market as well as in other chemicals which recently have been offered for import from leading German interests. In spite of continued adversities arising every now and then in several directions, the domestic situation seems very promising and a gradually increasing feeling of confidence is being felt throughout the trade.

With the advent of spring encouraging reports are heard from the paint and building trades. The textile mills are running along in better swing at most points than at any other previous time this year and the present demand from consumers of woollens has kept woolen mills in steady operation. Demand for paper appears to be temporarily satisfactory and the call for chemicals used at paper mills is not as active as noted at the beginning of the year. Soap factories are taking chemicals only for immediate necessities. Shoe factories seem to be doing a very good business and have been in the market for miscellaneous chemicals quite frequently.

Export buying has not been featured by any important activity.

GENERAL CHEMICALS

Among the week's developments were further reports of curtailment of caustic soda output and buyers experienced some difficulty in securing any special brands. Leading producers of caustic seem to be firm in their belief that prices cannot be lowered from 3½c. per lb., basis 60 per cent, works and make a legitimate profit. Soda ash has ruled comparatively steady and buyers experienced great difficulty in obtaining carlots at low figures. Bichromate of soda declined to 7½c. per lb., but closed above this figure when inquiries were noted from exporters for large quantities. Producers were naming 8@8½c. per lb. for the soda and 12@13c. for the potash. Acetate of soda fell to a new low record for the year under an absence of support from consuming trades. Bleaching powder has been offered by prominent sellers, including manufacturers, at new low prices. Muriate of potash sold as low as \$57 per ton, basis 80 per cent, delivered. Carbonate of potash sold down to 7c. per lb. Resale lots of formaldehyde sold as low as 15c. per lb. under second-hand competition. Commercial white powdered arsenic has declined under a quiet inquiry. Red arsenic is also a trifle weaker. Leading producers of cyanide of soda have been able to maintain their regular price of 30c. per lb. and buyers have been willing to pay their price on account of the sterling quality regardless of the low prices named on imported goods. Prussiate of soda has not recovered from its recent slump and trading has been of a very limited nature throughout the week.

Supplies of *glacial acetic acid* in second hands have been pretty well worked off and the recent low priced goods are gradually being taken off the market. One large producer is holding spot goods at \$9.30@\$11 per 100 lb., depending on quantity. Manufacturers of *ammonia alum* have reduced their prices and are now quoting on a basis of 4c. per lb. Imported white granular *sal ammoniac* is to be had on the spot market at 7@7½c. per lb. Domestic producers are still holding their prices well above this level, but are doing no noticeable business. American producers of *barium chloride* are still quoting \$85 per ton, with the imported material quoted on the spot market at \$65@\$70 per ton. Shipment prices on German chloride have been heard as low as \$60. Manufacturers of *bleaching powder* have openly announced a reduction in price to \$2.75 per 100 lb. f.o.b. works, but the trade has refused to come into the market in view of repeated offers from second hands at figures well below this quotation. Prices as low as \$2.40 f.o.b. works have been done by producers for round quantities and offers were heard even lower. The spot market is around 2½c. per lb. Producers of *chlorate of soda* named 10c. per lb. for standard American material. Odd lots of resale stock are reaching the market at 9@9½c. per lb. with occasional lots of imported goods down as low as 8½c. per lb. Moderate trading was noted during the week with small lot business predominating. Prices quoted for *permanganate of potash*, U.S.P., are lower on spot at 35@40c. per lb., although it is under-

stood that offerings of imported material in large lots are well below this figure.

Trading in the coal-tar products market during the past week reflected a shade of improvement and many are prompted to believe that the consuming demand will show favorable developments. Sales in general were confined mostly to small lots and were pretty well scattered. Progress in this industry will no doubt be of a very slow nature, but the next few months will undoubtedly witness a substantial increase in trading as resale stocks become less apparent.

The crude market is fairly active and some increase in the volume of business is noted. Benzene, toluene and solvent naphtha are lower. Resale interests are finding their stocks dwindling and makers generally have been content to hold prices up until all this resale material has been taken up.

Makers of intermediates are finding a very slow demand in the majority of cases, but are doing a gradually increased amount of business with the reopening of fur dye houses and woolen mills.

Refiners of *benzene* are quoting lower prices following a lack of interest from consumers and also due to keen competition in some quarters. The present prices of pure benzene are given as 27c. per gal. in tank cars and 29@32c. per gal. in drums, according to quantity. The 90 per cent grade is quoted on the same basis at 25@28c. per gal. Business has shown some signs of improvement and the reduced prices are believed to be a spur for the consuming element to come into the market. Stocks of *naphthalene* in second hands are being gradually worked off and while it is still possible to pick up an odd lot at 8c. per lb., the market in general is showing a very firm tendency. Makers' prices are being held at 8½@9½c. per lb. for the flake and 9½@10½c. for the balls. Producers of *solvent naphtha* have reduced their quoted prices and now name 25@28c. per gal. in tank cars and drums, according to quantity. *Toluene* prices have also been reduced by makers and it is quoted at 28@31c. per gal. The consuming demand has been very slow of late.

Some *aniline oil* business is being done by producers, as stocks in second hands have failed to come up to specifications. Prices remain more or less uncertain and are subject to shading on firm business. Makers quote 23@28c. per lb., according to seller, while distressed lots are offered freely at 21c. and lower. Manufacturers of *beta naphthol* reported some new export business, but it seems that the spot market is still in control of second hands, who are quoting around 33c. per lb. Makers are holding the prices up around 40@45c. per lb. Business in *para amidophenol* among fur dyers is very active and stocks are moving quite freely. Prices have remained unchanged at former levels with the base quoted at \$1.90 per lb. and the HCl at \$2.10.

VEGETABLE OILS

The market for *castor oil* was inactive and the undertone barely steady despite the recent reduction in prices announced by manufacturers. First hands quote the U.S.P. grade at 9½c. per lb. No. 3 oil was nominal at 8½@8¾c. Prices named for *chinawood oil* both here and at the Coast vary somewhat. There were sellers on the spot at prices ranging from 9@9½c. per lb., while on the Coast prices ranged from 7½@8c. The market for *coconut oil* during the week was rather dull, but prices appeared to be on a fairly steady basis, reflecting firmer ideas on the part of some sellers. *Ceylon style oil* of domestic make was offered at 8½c. per lb., nearby delivery, in sellers' tanks. Barrels was nominal at 9½c. per lb. Producers of *corn oil* quoted the market for crude material unchanged on the basis of 8c. per lb. The market for *palm oil* was quiet and prices were unsettled. Lagos held at 7c. c.i.f. N. Y. for immediate shipment and niger at 6½c.

WAXES

The market for *beeswax* was a quiet affair, but prices closed about unchanged on all varieties. There were no important changes in the *carnauba wax* market. Prices for the lower grades were steady on the basis of 20c. per lb. for the chalky and 18c. for the No. 3 North Country. Quota-

tions for the higher grades were more or less nominal. Spot offerings of *Japan* wax were moderate and with no apparent selling pressure quotations were maintained at 19@20c. per lb. New business in *paraffine* wax came forward rather slowly and with offerings of crude and the lower grades of refined noted on a somewhat liberal scale, prices presented an unsettled appearance. Some operators reported a steadier tone for the higher grades of refined. Producers offered scale wax, 124-126 deg. melting point, for immediate shipment at 2½c. per lb. in carlots. There were sellers of the 130 deg. m.p. refined as low as 5c. per lb.

The Iron and Steel Market

PITTSBURGH, April 1, 1921.

It seems now to have become well established that the iron and steel market is to be uneventful in that it will not for some time exhibit startling changes in degree of activity or in price changes. The whole trade would be gratified if it became possible to repeat market performances of the past, when sharp declines in prices were followed by a "buying movement," as in the fall of 1904, February, 1909, the fall of 1911, and the year 1914. Cutting by independent steel producers of the Steel Corporation or Industrial Board price schedule began approximately two months ago, following the decline late last year of the independent market to the Steel Corporation level. In the first few weeks the declining tendency was sharp, but in the past month there has been but little declining tendency, and in the past week declines have been exceptional. Rather there has been a firming or steadying tendency, noticed chiefly in bars, shapes and plates, which are quotable in carload lots, with desirable specifications, at 2c. for bars and 2.10c. for shapes and plates for two or three weeks past, but with less disposition than formerly to shade these prices for larger lots. This is the logical result of demand being of its present character. The prices mentioned are below those of the Steel Corporation by \$7 a ton on bars and shapes and \$11 on plates. Yet the corporation receives probably as much business as the independents, or more, in fresh orders and in releases against orders previously suspended.

In black sheets 4.75c. can be done as readily on carloads as 4.85c. a week ago, with galvanized similarly at 4.80c. against 5c. In standard steel pipe concessions of 2½ or 5 per cent are more common than a week ago, being possible on less desirable orders than formerly. Many products are so inactive as not to disclose any well defined market price.

DEMAND

The demand for steel products continues to broaden, in point of number of orders or of releases on orders previously suspended, but all the demand is of hand to mouth character, chiefly in carload lots, and representing depletion of stocks rather than an increase in actual consumption. One cannot, thus far at least, observe a tendency for consumption to increase now that spring is here. The manufacture of automobiles is gradually picking up, but the consumption is chiefly of steel already in stock. Whether production of automobiles will continue to increase when it must be with fresh steel remains to be seen.

PIG IRON

The basic pig iron market remains in charge of the steel interests that have stocks of iron, their price being \$23 valley or possibly less, while the merchant furnaces have pegged their price at \$25 and are hoping the stocks will be exhausted in a few months. Bessemer pig iron has been quoted at \$25 valley, against the former nominal quotation of \$27. Foundry iron remains at the \$25 price to which it declined somewhat over a week ago.

Mattie furnace, Girard, Ohio, goes out of blast to-day, while Perry at Erie is going in. The resumption threw a little light on coke market conditions, as a three months' supply was bought at \$4.50 or a shade less. With additional wage reductions effective at some works today it is thought the next sale will be at nearer \$4.25, the test being probably furnished by a purchase to be made for a furnace at Portsmouth, Ohio, which is to blow in and will require Connellsville coke for about six weeks, 500 tons a day, until its byproduct coke plant can be started.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	\$0.12 - \$0.12½	\$0.40 - \$0.45
Acetone.....lb.	2.50 - 2.75	1.5 - 1.4
Acid, acetic, 28 per cent.....100 lbs.	4.00 - 4.25	3.00 - 3.25
Acetic, 56 per cent.....100 lbs.	9.30 - 9.50	4.50 - 5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	14 - 15	9.75 - 10.00
Boric, crystals.....lb.	15 - 16	1.5 - 1.6
Boric, powder.....lb.	14 - 15	1.7 - 1.8
Citric.....lb.	1.60 - 1.75	47 - 50
Hydrochloric.....100 lb.	13 - 13½	2.00 - 2.20
Hydrofluoric, 52 per cent.....lb.	10 - 11	14 - 14½
Lactic, 44 per cent tech.....lb.	04 - 05	11 - 12
Lactic, 22 per cent tech.....lb.	4.00 - 4.50	06 - 07
Molybdic, C. P.....lb.	06 - 07	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.	07 - 08	07 - 07½
Nitric, 40 deg.....lb.	07 - 08	08 - 08½
Nitric, 42 deg.....lb.	16 - 17	17 - 17½
Oxalic, crystals.....lb.	17 - 18	18 - 19
Phosphoric, Ortho, 50 per cent solution.....lb.	30 - 32	35 - 40
Picric.....lb.	1.90 - 2.15	1.90 - 2.15
Pyrogallol, resublimed.....lb.	15.00 - 16.00	15.00 - 16.00
Sulphuric, 60 deg., tank cars.....ton	19.00 - 20.00	23.00 - 23.50
Sulphuric, 60 deg., drums.....ton	22.00 - 22.50	23.00 - 23.50
Sulphuric, 66 deg., tank cars.....ton	23.00 - 24.00	23.00 - 23.50
Sulphuric, 66 deg., drums.....ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, 66 deg., carboys.....ton	32.00 - 35.00	40.00 - 45.00
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	1.15 - 1.25	1.15 - 1.25
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	48 - 50	48 - 50
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	36 - 40	36 - 40
Tannic, U. S. P.....lb.	1.30 - 1.40	1.30 - 1.40
Tannic (tech.).....lb.	4.75 - 5.00	4.75 - 5.00
Tartaric, crystals.....lb.	40 - 45	40 - 45
Tungstic, per lb. of WO.....lb.	50 - 54	50 - 54
Alcohol, Ethyl.....gal.	04 - 04½	04 - 04½
Alcohol, Methyl (see methanol).....gal.	05 - 06	06 - 06½
Alcohol, denatured, 188 proof.....gal.	13 - 13½	14 - 14½
Alcohol, denatured, 190 proof.....gal.	02 - 02½	02 - 02½
Alum, ammonia lump.....lb.	03 - 03½	03 - 03½
Alum, potash lump.....lb.	07 - 07½	07 - 07½
Alum, chrome lump.....lb.	30 - 32	33 - 35
Aluminum sulphate, commercial.....lb.	09 - 09½	10 - 11
Aluminum sulphate, iron free.....lb.	08 - 08½	09 - 09½
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	08 - 08½	09 - 09½
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	2.90 - 3.00	3.10 - 3.20
Ammonium carbonate, powder.....lb.	4.00 - 4.25	4.00 - 4.25
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	3.25 - 3.50	3.25 - 3.50
Ammonium chloride, granular (gray salamoniac).....lb.	08 - 08½	09 - 10
Ammonium nitrate.....lb.	08 - 08½	09 - 10
Ammonium sulphate.....100 lb.	2.90 - 3.00	3.10 - 3.20
Amylacetate.....gal.	4.00 - 4.25	4.00 - 4.25
Amylacetate tech.....gal.	3.25 - 3.50	3.25 - 3.50
Arsenic oxide, (white arsenic) powdered lb.	08 - 08½	09 - 10
Arsenic, sulphide, powdered (red arsenic) lb.	12 - 12½	13 - 14
Barium chloride.....ton	60.00 - 65.00	70.00 - 75.00
Barium dioxide (peroxide).....lb.	19 - 20	21 - 22
Barium nitrate.....lb.	11 - 11½	12 - 12½
Barium sulphate (precip.) (blanc fixe).....lb.	04 - 05	05 - 06
Bleaching powder (see calc. hypochlorite).....lb.	04 - 05	05 - 06
Blue vitriol (see copper sulphate).....lb.	04 - 05	05 - 06
Borax (see sodium borate).....lb.	04 - 05	05 - 06
Brimstone (see sulphur, roll).....lb.	40 - 41	42 - 45
Bromine.....lb.	40 - 41	42 - 45
Calcium acetate.....100 lbs.	1.60 - 2.00	1.60 - 2.00
Calcium carbide.....lb.	04 - 04½	04 - 04½
Calcium chloride, fused, lump.....ton	27.00 - 29.00	30.00 - 32.00
Calcium chloride, granulated.....lb.	01 - 01½	02 - 02½
Calcium hypochlorite (bleach'g powder) 100 lb.	2.40 - 2.60	2.75 - 3.00
Calcium peroxide.....lb.	1.25 - 1.50	1.25 - 1.50
Calcium phosphate, tribasic.....lb.	15 - 16	15 - 16
Camphor.....lb.	65 - 68	65 - 68
Carbon bisulphide.....lb.	07 - 08	08 - 08½
Carbon tetrachloride, drums.....lb.	10 - 10½	11 - 12
Carbonyl chloride (phosgene).....lb.	75 - 1.00	75 - 1.00
Caustic potash (see potassium hydroxide).....lb.	08 - 09	09 - 10
Caustic soda (see sodium hydroxide).....lb.	08 - 09	09 - 10
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	08 - 09	09 - 10
Chloroform.....lb.	38 - 40	38 - 40
Cobalt oxide.....lb.	3.00 - 3.10	3.00 - 3.10
Copperas (see iron sulphate).....lb.	24 - 25	26 - 27
Copper carbonate, green precipitate.....lb.	05 - 05½	06 - 06½
Copper cyanide.....lb.	05 - 05½	06 - 06½
Copper sulphate, crystals.....lb.	05 - 05½	06 - 06½
Cream of tartar (see potassium bitartrate).....lb.	05 - 05½	06 - 06½
Epsom salt (see magnesium sulphate).....lb.	05 - 05½	06 - 06½
Ethyl Acetate Com. 85%.....gal.	90 - 1.00	90 - 1.00
Ethyl Acetate pure (acetic ether 98% to 100%).....gal.	15 - 15½	15 - 15½
Formaldehyde, 40 per cent.....lb.	15 - 15½	15 - 15½
Fusel oil, ref.....gal.	3.50 - 3.75	3.50 - 3.75
Fusel oil, crude.....gal.	2.00 - 2.25	2.00 - 2.25
Glauber's salt (see sodium sulphate).....lb.	18 - 19	18 - 19
Glycerine, C. P. drums extra.....lb.	3.75 - 3.85	3.75 - 3.85
Iodine, resublimed.....lb.	10 - 20	10 - 20
Iron oxide, red.....lb.	1.20 - 1.40	1.20 - 1.40
Iron sulphate (copperas).....100 lb.	1.05 - 1.10	1.20 - 1.40
Lead acetate.....lb.	13 - 14	13 - 14
Lead arsenate, pas e.....lb.	08 - 09	09 - 10
Lead nitrate.....lb.	15 - 20	15 - 20
Litharge.....lb.	08 - 09	09 - 10
Lithium carbonate.....lb.	1.25 - 1.50	1.25 - 1.50
Magnesium carbonate, technical.....lb.	10 - 11	11 - 12
Magnesium sulphate, U. S. P.....100 lb.	2.75 - 3.00	2.75 - 3.00
Magnesium sulphate, technical.....100 lb.	2.25 - 2.50	2.25 - 2.50
Methanol, 95%.....gal.	75 - 77	75 - 77
Methanol, 97%.....gal.	78 - 82	78 - 82
Nickel salt, double.....lb.	13 - 14	13 - 14
Nickel salt, single.....lb.	14 - 14½	14 - 14½
Phosgene (see carbonyl chloride).....lb.	45 - 46	47 - 50
Phosphorus, red.....lb.	35 - 37	35 - 37
Phosphorus, yellow.....lb.	12 - 12½	13 - 14
Potassium bichromate.....lb.	12 - 12½	13 - 14

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$. . . \$. . .	\$0.30 - \$0.35
Potassium bromide, granular..... lb.		.20 - .40
Potassium carbonate, U. S. P..... lb.	.35 - .40	.45 - .50
Potassium carbonate, crude..... lb.	.07 - .08	.09 - .10
Potassium chlorate, crystals..... lb.	.08 - .10	.11 - .15
Potassium cyanide..... lb.		.40 - .45
Potassium hydroxide (caustic potash)..... lb.	.09½ - .10	.10½ - .11½
Potassium muriate..... ton	57.00 - 65.00	
Potassium iodide..... lb.		2.75 - 3.00
Potassium nitrate..... lb.	.09½ - .09½	.10 - .12½
Potassium permanganate..... lb.	.35 - .37	.38 - .40
Potassium prussiate, red..... lb.	.48 - .50	.51 - .53
Potassium prussiate, yellow..... lb.	.26 - .27	.28 - .29
Potassium sulphate (powdered)..... per unit		2.15 - 2.25
Rochelle salts (see sodium potas. tartrate)		
Salammoniac (see ammonium chloride)		
Sal soda (see sodium carbonate)		
Salt cake..... ton		32.00 - 34.00
Silver cyanide..... oz.		1.30 - 1.35
Silver nitrate..... oz.		.38 - .40
Soda ash, light..... 100 lb.	1.95 - 2.10	2.15 - 2.40
Soda ash, dense..... 100 lb.	2.20 - 2.30	2.40 - 2.60
Sodium acetate..... lb.	.05 - .05½	.05½ - .06
Sodium bicarbonate..... 100 lb.	2.50 - 2.60	2.70 - 3.00
Sodium bichromate..... lb.	.07½ - .07½	.07½ - .08
Sodium bisulphate (nitre cake)..... ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphate powdered, U.S.P..... lb.	.05½ - .05½	.06 - .06½
Sodium borate (borax)..... lb.	.06½ - .06½	.07 - .07½
Sodium carbonate (sal soda)..... 100 lb.	1.90 - 2.00	2.25 - 2.50
Sodium chlorate..... lb.	.09 - .09½	.10 - .10½
Sodium cyanide, 96-98 per cent..... lb.	.19 - .20	.21 - .30
Sodium fluoride..... lb.	.12 - .12½	.13 - .14
Sodium hydroxide (caustic soda)..... 100 lb.	3.60 - 3.70	3.80 - 4.00
Sodium hyposulphite..... lb.		.03½ - .04
Sodium nitrate..... 100 lb.	2.60 - . . .	2.70 - . . .
Sodium nitrite..... lb.	.06 - .06½	.06½ - .07
Sodium peroxide, powdered..... lb.	.28 - .29	.30 - .32
Sodium phosphate, dibasic..... lb.	.04½ - .04½	.05 - .05½
Sodium potassium tartrate (Rochelle salts) lb.		.27 - .28
Sodium prussiate, yellow..... lb.	.13 - .13½	.13½ - .14
Sodium silicate, solution (40 deg.)..... lb.	1.25 - 1.35	1.40 - 1.50
Sodium silicate, solution (60 deg.)..... lb.	.03 - .03½	.03½ - .03½
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.75 - 2.00	2.25 - 2.50
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.05½ - .05½	.05½ - .06
Sodium sulphite, crystals..... lb.	.04 - .04½	.04½ - .05
Strontium nitrate, powdered..... lb.	.15 - .15½	.16 - .17
Sulphur chrl. ride, red..... lb.	.07 - .07½	.07½ - .08
Sulphur, crude..... ton	20.00 - 22.00	
Sulphur dioxide, liquid, cylinders..... lb.	.08 - .08½	.09 - .10
Sulphur (sublimed), flour..... 100 lb.		2.25 - 3.10
Sulphur, roll (brimstone)..... 100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent..... lb.	.18 - .19	
Tin oxide..... lb.		.40 - .42
Zinc carbonate, precipitate..... lb.	.16 - .18	.19 - .20
Zinc chloride, gran..... lb.	.11 - .11½	.11½ - .12
Zinc cyanide..... lb.	.45 - .49	.50 - .60
Zinc dust..... lb.	.12 - .13	.13½ - .14
Zinc oxide, XX..... lb.	.08½ - .09	.09½ - .10
Zinc sulphate..... lb.	.03½ - .03½	.04 - .05

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.15 - \$1.25
Alpha-naphthol, refined..... lb.	1.45 - 1.50
Alpha-naphthylamine..... lb.	.38 - .40
Aniline oil, drums extra..... lb.	.20 - .26
Aniline salts..... lb.	.26 - .29
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1.00
Benzaldehyde U.S.P..... lb.	1.00 - 1.50
Benzidine, base..... lb.	.90 - 1.00
Benzidine sulphate..... lb.	.75 - .80
Benzoic acid, U.S.P..... lb.	.65 - .70
Benzoate of soda, U.S.P..... lb.	.65 - .70
Benzene, pure, water-white, in drums (100 gal.) gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 - .28
Benzyl chloride, 95-97%, refined..... lb.	.28 - .30
Benzyl chloride, tech..... lb.	.25 - .27
Beta-naphthol benzoate..... lb.	3.50 - 4.00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.33 - .45
Beta-naphthylamine, sublimed..... lb.	2.25 - 2.40
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 - .18
Ortho-cresol, in drums (100 lb.)..... lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.90 - .95
Cresylic acid, 75-97%, dark, in drums..... gal.	.85 - .90
Cresylic acid, 50%, first quality, drums..... gal.	.55 - .60
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	1.25 - 1.30
Dimethylaniline..... lb.	.50 - .60
Dinitrobenzene..... lb.	.30 - .32
Dinitrochlorobenzene..... lb.	.25 - .30
Dinitronaphthalene..... lb.	.33 - .35
Dinitrophenol..... lb.	.40 - .45
Dinitrotoluene..... lb.	.25 - .27
Dip oil, 25%, tar acids, car lots, in drums..... gal.	.38 - .40
Diphenylamine..... lb.	.60 - .70
H-acid..... lb.	1.30 - 1.50
Meta-phenylenediamine..... lb.	1.20 - 1.25
Monochlorobenzene..... lb.	.14 - .16
Monoethylaniline..... lb.	1.90 - 2.00
Naphthalene crushed, in bbls. (250 lb.)..... lb.	.08 - .08½
Naphthalene, flake..... lb.	.08 - .09½
Naphthalene, balls..... lb.	.09½ - .10
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.16 - .18
Ortho-amidophenol..... lb.	3.20 - 3.75
Ortho-dichlor-benzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.75 - .80
Ortho-nitro-toluene..... lb.	.17 - .20
Ortho-toluidine..... lb.	.25 - .30
Para-amidophenol, base..... lb.	1.90 - 2.00
Para-amidophenol, HCl..... lb.	2.10 - 2.20

Para-dichlorobenzene..... lb.	.15 - .20
Paranitroaniline..... lb.	.85 - .90
Para-nitrotoluene..... lb.	.90 - 1.05
Para-phenylenediamine..... lb.	1.90 - 2.00
Para-toluidine..... lb.	1.25 - 1.60
Phthalic anhydride..... lb.	.50 - .60
Phenol, U. S. P., drums (dest.), (240 lb.)..... lb.	.11 - .13
Pyridine..... gal.	2.00 - 3.50
Resorcinol, technical..... lb.	1.85 - 2.00
Resorcinol, pure..... lb.	2.30 - 2.50
Salicylic acid, tech., in bbls. (110 lb.)..... lb.	.22 - .23
Salicylic acid, U. S. P..... lb.	.24 - .26
Salol..... lb.	.85 - .95
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 - .16
Sulphanilic acid, crude..... lb.	.30 - .35
Tolidine..... lb.	1.35 - 1.45
Toluidine, mixed..... lb.	.40 - .45
Toluene, in tank cars..... gal.	.25 - .28
Toluene, in drums..... gal.	.28 - .31
Xylidines, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.42 - .45
Xylene, pure, in tank cars..... gal.	.45 - . . .
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.30 - . . .

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.24 - \$0.26
Beeswax, refined, light..... lb.	.27 - .28
Beeswax, white pure..... lb.	.40 - .45
Carnauba, Florida..... lb.	.68 - .70
Carnauba, No. 2, North Country..... lb.	.30 - .32
Carnauba, No. 3, North Country..... lb.	.18 - .19
Japan..... lb.	.19½ - .20
Montan, crude..... lb.	.07 - .08
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03½ - .03½
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.02½ - .03
Paraffine waxes, refined, 118-120 m.p..... lb.	.04 - .04½
Paraffine waxes, refined, 125 m.p..... lb.	.04½ - .05
Paraffine waxes, refined, 128-130 m.p..... lb.	.05 - .06
Paraffine waxes, refined, 133-135 m.p..... lb.	.06 - .06½
Paraffine waxes, refined, 135-137 m.p..... lb.	.06½ - .06½
Stearic acid, single pressed..... lb.	.11 - . . .
Stearic acid, double pressed..... lb.	.11½ - . . .
Stearic acid, triple pressed..... lb.	.12 - .12½

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.70
Pine oil, pure, dest. dist..... gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.36
Turpentine, crude, sp. gr. 0.900-0.970..... gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990..... gal.	.37
Pinewood creosote, ref..... gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl..... 280 lb.	\$4.90 - . . .
Rosin E-I..... 280 lb.	5.15 - . . .
Rosin K-N..... 280 lb.	5.50 - . . .
Rosin W. G.-W. W..... 280 lb.	6.00 - . . .
Wood rosin, bbl..... 280 lb.	6.25 - . . .
Spirits of turpentine..... gal.	.59 - . . .
Wood turpentine, steam dist..... gal.	.57 - . . .
Wood turpentine, dest. dist..... gal.	.56 - . . .
Pine tar pitch, bbl..... 200 lb.	. . . - 7.00
Tar, kiln burned, bbl. (500 lb.)..... bbl.	. . . - 14.50
Retort tar, bbl..... 500 lb.	15.00 - 14.75
Rosin oil, first run..... gal.	.45 - . . .
Rosin oil, second run..... gal.	.48 - . . .
Rosin oil, third run..... gal.	.60 - . . .

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41
70-72 deg., steel bbls. (85 lb.)..... gal.	.39
68-70 deg., steel bbls. (85 lb.)..... gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30

Crude Rubber

Para-Upriver fine..... lb.	\$0.17 - \$0.18
Upriver coarse..... lb.	.11½ - .12½
Upriver caucho ball..... lb.	.14 - .14½
Plantation—First latex crepe..... lb.	.18½ - . . .
Ribbed smoked sheets..... lb.	.16 - . . .
Brown crepe, thin, clean..... lb.	.18 - . . .
Amber crepe No. 1..... lb.	.20 - . . .

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.08½ - \$0.08½
Castor oil, AA, in bbls..... lb.	.09 - .10
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.07 - .07½
Cocoonut oil, Ceylon grade, in bbls..... lb.	.09 - .09½
Cocoonut oil, Cochin grade, in bbls..... lb.	.09 - .10
Corn oil, crude, in bbls..... lb.	.08 - .08½
Cottonseed oil, crude (f. o. b. mill)..... lb.	.04 - .04½
Cottonseed oil, summer yellow..... lb.	.06 - . . .
Cottonseed oil, winter yellow..... lb.	.07 - .07½
Linseed oil, raw, car lots (domestic)..... gal.	.65 - . . .
Linseed oil, raw, tank cars (domestic)..... gal.	.58 - . . .
Linseed oil, in 5-bbl lots (domestic)..... gal.	.68 - .70

Olive oil, commercial.....	gal.	\$1.90	—	\$2.50
Palm, Lagos.....	lb.	.07	—	.07½
Palm, Niger.....	lb.	.06	—	.06½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.05½	—	.05½
Peanut oil, refined, in bbls.....	lb.	.10½	—	.11
Rapeseed oil, refined in bbls.....	gal.	1.05	—	1.10
Rapeseed oil, blown, in bbls.....	gal.	1.15	—	1.20
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07½	—	.07½
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.04½	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.45	—	\$0.47
Yellow bleached menhaden.....	gal.	.47	—	.....
White bleached menhaden.....	gal.	.49	—	.....
Blown menhaden.....	gal.	.84	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	.....
Blanc fixe, dry.....	lb.	.05	—	.05½
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.16
Chalk, domestic, extra light.....	lb.	.05	—	.05½
Chalk, domestic, light.....	lb.	.04½	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04½	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Fla.....	net ton	25.00	—	.....
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	30.00	—	35.00
Graphite, Ceylon lump, first quality.....	lb.	.08	—	.09
Graphite, Ceylon chip.....	lb.	.07	—	.08
Graphite, higher lubricating grades.....	lb.	.11	—	.40
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.57	—	.....
Shellac, orange superfine.....	lb.	.60	—	.....
Shellac, A. C. garnet.....	lb.	.45	—	.....
Shellac, T. N.....	lb.	.45	—	.....
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	14.00	—	15.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	12.00	—	22.00
Talc, roofing grades, f.o.b. Vermont.....	ton	9.50	—	15.00
Talc, rubber grades, f.o.b. Vermont.....	ton	12.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	12.00	—	15.00
Talc, imported.....	ton	40.00	—	50.00
Talc, California talcum powder grade.....	ton	20.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	.....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	80-100	.....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	45-50	.....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	.....	55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	.....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	.....
Magnesite brick, 9-in. straight.....	net ton	90	.....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105	.....
Magnesite brick, soaps and splits.....	net ton	120	.....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	45-55	.....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	45-55	.....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	45-55	.....

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.15	—	.16
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.16	—	.17
Ferromanganese, 76-80% Mn, domestic.....	gross ton	90.00	—	95.00
Ferromanganese, 76-80% Mn, English.....	gross ton	90.00	—	95.00
Spiegelisen, 18-22% Mn.....	gross ton	30.00	—	35.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50	—	.....
Ferrosilicon, 10-15%.....	gross ton	50.00	—	55.00
Ferrosilicon, 50%.....	gross ton	85.00	—	90.00
Ferrosilicon, 75%.....	gross ton	145.00	—	150.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45	—	.50
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	.....
Ferrovanadium, 30-40% per lb. of contained V.....	lb.	5.00	—	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.45	—	.50
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.45	—	.50
Coke, foundry, f.o.b. ovens.....	net ton	5.50	—	6.50
Coke, furnace, f.o.b. ovens.....	net ton	4.75	—	5.25
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00	—	16.00
Fluorspar, lump, f.o.b. Heahden, New Mexico.....	net ton	17.50	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	—	25.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.30	—	.35
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.16	—	.....
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.16½	—	.....
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	—	3.25
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	.....
Zircon, washed, iron free.....	lb.	.03	—	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.75
Aluminum, 98 to 99 per cent.....	28.3 @ 28.5
Antimony, wholesale lots, Chinese and Japanese.....	5½ @ 5½
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	.35
Monel me al. ingots.....	.38
Monel metal, sheet bars.....	.40
Tin, 5-ton lots.....	29.25
Lead, New York, spot.....	4.20 @ 4.30
Lead, E. St. Louis, spot.....	4.10 @ 4.15
Zinc, spot, New York.....	5.15
Zinc, spot, E. St. Louis.....	4.65

OTHER METALS

Silver (commercial).....	oz.	\$0.56½
Cadmium.....	lb.	1.10
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.65
Cobalt.....	lb.	4.50
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00-75.00
Iridium.....	oz.	250.00 @ 300.00
Palladium.....	oz.	65.30 @ 70.00
Mercury.....	75 lb.	46.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	20.25
Copper bottoms.....	27.75
Copper rods.....	18.75
High brass wire.....	18.25
High brass rods.....	15.25
Low brass wire.....	20.25
Low brass rods.....	20.25
Brazed brass tubing.....	29.50
Brazed bronze tubing.....	34.25
Seamless copper tubing.....	22.00
Seamless high brass tubing.....	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York				
	Current	One Year Ago	Cleveland	Chicago	
Copper, heavy and crucible.....	8.50 @ 9.00	18.50	10.00	10.50	
Copper, heavy and wire.....	8.00 @ 8.25	16.50	9.50	9.50	
Copper, light and bottoms.....	7.00 @ 7.50	14.50	9.00	8.50	
Lead, heavy.....	3.00 @ 3.50	7.25	4.00	4.00	
Lead, tea.....	2.00 @ 2.12½	5.25	3.00	3.00	
Brass, heavy.....	4.25 @ 4.50	9.50	7.00	10.00	
Brass, light.....	3.00 @ 3.25	8.00	5.00	5.50	
No. 1 yellow brass turnings.....	4.00 @ 4.25	9.50	5.50	6.00	
Zinc.....	2.00 @ 2.50	5.00	3.00	3.50	

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	*Current	One Month Ago	One Year Ago	Current	One Year Ago	Current	One Year Ago
Structural shapes.....	\$2.50	\$3.80	\$3.47	\$3.58	\$3.37	\$3.58	\$3.47
Soft steel bars.....	2.50	3.70	3.52	3.34	3.27	3.48	3.52
Soft steel bar shapes.....	2.50	3.70	3.52	3.48	3.27	3.48	3.52
Soft steel bands.....	2.85	4.65	4.22	6.25	.....	.....	.....
Plates, ½ to 1 in. thick.....	2.50	4.00	3.67	3.78	3.57	3.78	3.67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

DECATUR—The Alabama Brick & Tile Co., Scottsboro, Ala., has preliminary plans under way for the erection of a new plant on the Tennessee River, near Decatur, for the manufacture of brick, tile and other burned clay products. W. B. Neher heads the company.

California

GLENDALE—The Tropico Potteries, Inc., recently organized, has taken over the plant of the Pacific Minerals & Chemical Co., Tropico district, for its proposed new works. Plans are under way for a number of extensions and the installation of considerable new equipment, including a continuous tunnel kiln, drying apparatus, etc. The plant will be devoted to the manufacture of architectural terra cotta, faience tile, vitrified clay sewer pipe and other burned clay products. B. M. Wotkyans is president; F. B. Ortman, formerly connected with the Northwestern Terra Cotta Co., Chicago, Ill., is vice-president and general manager.

Idaho

WEISER—Brizenline Bros. is reported to be planning for the construction of a new plant for the manufacture of brick and other burned clay products. A tract of clay lands near the city now owned by the company will be used.

Illinois

CHICAGO—The Imperial Japanning & Enameling Co., 408 West Grand Ave., has awarded a contract to Holton, Seelye & Co., 140 South Dearborn St., for the erection of a new 1-story and basement plant, 48x205 ft., at 1644 West Austin Ave., to cost about \$40,000. William Link is general manager.

CHICAGO—Sewell Clapp Envelopes, Inc., 23 North Desplaines St., manufacturer of paper specialties, will take bids early in May for the erection of its proposed new 1- and 2-story plant, 200x209 ft., at Belmont and Tripp Sts., to cost about \$250,000 with machinery. M. D. Strong is president.

Indiana

HAMMOND—The Moorhead Oil Co. is considering the rebuilding of the portion of its plant destroyed by fire March 21, with loss estimated at about \$200,000.

EVANSVILLE—The Pretty Soap Co., recently organized with a capital of \$100,000, has acquired the former plant of the Melzer Soap Co., and will operate the works for the manufacture of soap, oils and kindred products. The factory will be remodeled and improved. It is planned to inaugurate operations at an early date. The new company is headed by Henry N. Mannheimer and Adolph Decker.

NOBLESVILLE—The American Strawboard Co. has resumed operations at its local plant after a shutdown of about two months, giving employment to approximately 100 men.

Kansas

CHANUTE—The Ash Grove Lime & Portland Cement Co., Grand Avenue Temple Bldg., Kansas City, Mo., will commence construction at once of a new power plant at its works at Chanute, 80x160 ft., to cost about \$100,000.

Kentucky

LOUISVILLE—The Standard Sanitary Mfg. Co., 628 Shipp St., manufacturer of sanitary earthenware products, has awarded a contract to C. A. Koerner, Floyd and Burnett Sts., for the erection of a new 1-story and basement pottery, 75x200 ft., to cost about \$75,000. It will be equipped for the manufacture of sanitary porcelain specialties.

Maryland

BEL AIR—The Maryland Flint & Feldspar Co. has acquired the property of the Husband Flint Products Co., on Deer Creek, Harford County, consisting of about 140 acres of land with mill and other buildings. The new owner will enlarge the works and plans for extensive development. Ground flint and feldspar for the pottery industry will be produced at the plant. The work is estimated to cost about \$150,000. C. L. Gray is president.

BALTIMORE—The Piedmont-Mt. Airy Guano Co., operating a plant at Curtis Bay for the manufacture of fertilizer products, has arranged for a bond issue of \$500,000, the proceeds to be used for extensions, general operations, etc. Edwin W. Levering is president.

BALTIMORE—Fire on March 27 destroyed one of the buildings at the plant of the Excelsior Brick Co., Benson Ave., Violetville. An official estimate of the loss has not been made.

BALTIMORE—The Gwynns Falls Paper Co. is being organized to construct a new plant at Gwynns Falls, near Baltimore, for the manufacture of boxboard and paper products. The company is capitalized at \$600,000, and it is said that the new mill will cost in excess of \$150,000 with machinery. Joseph H. Wallace & Co., 5 Beekman St., New York, are engineers for the project.

Massachusetts

TAUNTON—The Presbrey Stove Lining Co., Weir Village, has plans under way for the rebuilding of its firebrick and refractory plant, recently destroyed by fire, with loss estimated at about \$100,000, including equipment. A total of 20 buildings on the 5-acre site occupied by the plant were destroyed or damaged.

SPRINGFIELD—The United States Envelope Co. is planning for the early occupancy of its new plant, now nearing completion. The factory will be four-story brick, and with machinery will cost about \$400,000. The Casper Ranger Construction Co., Bond St., Holyoke, Mass., is the building contractor.

Michigan

BATTLE CREEK—The American Stamping Co. has taken bids and will soon award the contract for the erection of its proposed new 1- and 2-story plant for the manufacture of stamped metal goods, 110x225 ft. J. C. Llewellyn, 38 South Dearborn St., Chicago, Ill., is architect.

DURAND—The Briggs Co., Lansing, has plans under way for the erection of a new plant at Durand for the manufacture of brick, tile and kindred burned clay products. The company has a 100-acre tract of property here, and will utilize a portion of the site for the new works. It is now operating a similar plant at Grand Ledge, Mich.

New Jersey

EDGEWATER—The Archer Daniels Linseed Co., Minneapolis, Minn., manufacturer of oil products, is taking bids for the erection of its proposed new plant on property recently acquired at Edgewater; it will be 1-story brick.

NEWARK—The Noxon Co., manufacturer of metal polishes and kindred specialties, has purchased the 3-story and basement plant at 66-78 Morris Ave., totaling about 16,000 sq.ft., on site 100x212 ft., for a local works.

TRENTON—The Adamtex Brick Co., 171 Madison Ave., New York, organized recently with a capital of \$1,000,000, is planning for the construction of a new branch plant at Trenton. W. L. Wootan is president, and Newton A. K. Bugbee, vice-president and treasurer.

New York

NEW YORK—The Jespersen Newsprint Corp. has arranged for a stock issue of \$250,000, a large portion of the proceeds

to be used for the establishment of a new paper mill in the vicinity of New York. The plant will have an initial capacity of about 35 tons, and will be operated under a special chemical and mechanical process. Other mills will be constructed at a later date. Fremont W. Spicer, vice-president of the *Fourth Estate*, 232 West Fifty-ninth St., is secretary.

NEW YORK—The American Agricultural Chemical Co., 2 Rector St., has disposed of a bond issue of \$30,000,000, the proceeds to be used in part for proposed expansion and improvements in fertilizer plants. A mortgage on the company's property to an amount of \$36,000,000, to secure the bonds, has been filed. The Vance Guano Works, a subsidiary organization, has plans under way for the erection of a new fertilizer manufacturing plant in the vicinity of Henderson, Ga., to cost about \$500,000 with machinery. It will have a capacity of about 50,000 tons per year.

NEW YORK—The Vacuum Oil Co., 61 B'way, operating refineries at Rochester and Olean, N. Y., and Bayonne, N. J., has arranged for a note issue of \$20,000,000.

North Carolina

HAMLET—The Carolina Pine Products Co. has plans under way for the construction of a new local refinery for the manufacture of pine tar, pine oil, turpentine and kindred products. A list of equipment for installation has been arranged. C. R. Poole is president.

Ohio

YOUNGSTOWN—The benzol plant at the works of the Brier Hill Steel Co. was partly destroyed by fire March 18, with loss estimated at \$25,000.

TIFFIN—The Standard Sanitary Mfg. Co. is completing the installation of new pressing department. The machinery at the former local building is being removed to a new factory.

CANTON—The United Alloy Steel Corp. has been merged with the Berger Mfg. Co. and the United Furnace Co., all of this place, under the first noted name. Plans are under way for the construction of a new open-hearth furnace and finishing mill.

Pennsylvania

PITTSBURGH—The Standard Sanitary Mfg. Co., manufacturer of sanitary earthenware, has purchased property from the Pennsylvania Light, Heat & Power Co., at Margaret St. and Ontario Ave., Northside, to be used in connection with its plant extensions.

READING—The Standard Chemical Works has inaugurated operations at its new local plant for the manufacture of compounds, insecticides and chemical products.

MARCUS HOOK—The Union Petroleum Co., 17 Battery Pl., New York, has acquired property totaling about 200 acres of land, known as the "Reading Farm," located between Marcus Hook and Chester, and is reported to be planning to use the site for the construction of a new oil refining plant.

Quebec

MONTREAL—The Industrial & Educational Publishing Co. is planning for the erection of a new paper mill at St. Ann-de-Bellevue, about 20 miles from Montreal, to be used for the manufacture of high-grade paper products.

Texas

FORT WORTH—The Invincible Oil Corporation, operating a local refinery, with similar plant at Shreveport, La., has arranged for a bond issue of \$3,000,000, the proceeds to be used for expansion, operations, etc. J. B. Shearer is vice-president.

COMMERCE—The Trinity Paper Mills, Dallas, is planning for the construction of a new local paper mill, with initial output of about 50 tons per day. The plant will specialize in the manufacture of writing paper, tissue and blotting paper. It will be operated in conjunction with a new pulp mill, now nearing completion, and which is expected to be ready for service during April; this pulp mill is located at Commerce. George W. Lull is president.

Washington

BLEWETT—The Amalgamated Gold Mines Co. is planning for the erection of a new hydro-electric power plant at its property to cost about \$60,000. C. R. Hesseltine is president.

New Companies

THE LOCKWOOD GLASS CO., 929 Clinton St., Ottawa, Ill., has been incorporated with a capital of \$200,000 to manufacture glassware. The incorporators are H. C. Lockwood, W. I. Hibbs and Lothrop Perkins.

THE AMERICAN PINE PRODUCTS REFINING CO., Salisbury, Md., has been incorporated with a capital of \$250,000 to manufacture refined oils, etc. The incorporators are H. D. Elliott, Salisbury; B. A. Deal, Jr., Nashville, Ga.; and H. F. Hogeboom, Savannah, Ga.

THE GERUS MFG. & CHEMICAL CORP., New York, N. Y., has been incorporated under Delaware laws with a capital of \$1,500,000 to manufacture chemicals and chemical by-products. The company is represented by Arthur W. Britton, 34 Cedar St.

THE FUEL OIL CORP., Brooklyn, N. Y., has been incorporated with a capital of \$2,000,000 to manufacture petroleum products. The incorporators are I. Gordon, C. A. Kursel and J. J. Dodson, 291 Adams St.

THE FEDERAL LEATHER CO., Salem, Mass., has been incorporated with a capital of \$60,000 to manufacture leather products. The incorporators are Arthur G. Frothingham, A. G. Frothingham, Sr., and H. W. Nolan, Salem.

THE FRANKLIN DRUG & CHEMICAL CO., 227 West Austin Ave., Chicago, Ill., has been incorporated with a capital of \$25,000 to manufacture chemicals and affiliated products. The incorporators are Benjamin and John Segal.

THE CROSS LABORATORIES, INC., New York, N. Y., has been incorporated with a capital of \$50,000 to manufacture rubber specialties. The incorporators are S. H. Sears, F. H. Butehorn and J. L. Watson, 37 Wall St.

MARCUS WARD, INC., Boston, Mass., has been incorporated with a capital of 234,600 to manufacture paper products. The incorporators are Alexander W. Murray, Marcus E. Mahon and Ray Henry, Boston.

THE OLEANDER OIL CO., Richmond Hill, L. I., has been incorporated with a capital of \$75,000 to manufacture oil products. The incorporators are D. F. Sullivan, J. E. McPoland and W. M. Duffy, Richmond Hill.

THE PACIFIC RUBBER ACE CO., Los Angeles, Cal., has been incorporated with a capital of \$250,000 to manufacture rubber goods. The incorporators are S. L. Ploeser, B. F. Jacobs and H. W. Hanson, all of Los Angeles.

THE YOUTH-GLAND CHEMICAL LABORATORIES, INC., 56 East Randolph St., Chicago, Ill., has been incorporated with a capital of \$30,000 to manufacture chemicals and chemical byproducts. The incorporators are Walter Haenichen, Leonard Breckwoldt and Lewis J. Ruskin.

THE NICHOLSON SUPPLY CORP., Fredericksburg, Va., has been incorporated with a capital of \$30,000 to manufacture mineral and vegetable oils. The incorporators are George B. Nicholson, Arthur D. Nicholson, both of Pittsburgh, Pa.; and C. O'Connor Goolrick, Fredericksburg.

THE RICHARDSON SPECIALTIES CO., Napoleon, Mich., has been incorporated with a capital of \$25,000 to manufacture chemical products. The incorporators are Joseph M. Richardson, Napoleon; Charles W. Chapman and Adam L. Gloor, 439 Henry St., Detroit, Mich.

THE AMERICAN PAPETERIE CO., Boston, Mass., has been incorporated with a capital of \$400,000 to manufacture paper goods. The incorporators are Alexander W. Murray and Marcus E. Mahon, 43 Leon St. The company will be affiliated with Marcus Ward, Inc., Boston.

THE AMYLAC CO., 208 North Wabash Ave., Chicago, Ill., has been incorporated with a capital of \$10,000 to manufacture glues, pastes, etc. The incorporators are Paul Kreismann, Rae and Austin H. Woods.

THE NIAGARA PETROLEUM CO., Lockport, N. Y., has been incorporated with a capital of \$250,000 to manufacture petroleum products. The incorporators are Roy J. Chase, Louis L. Patterson and Alfred B. Leibold, Lockport.

THE WHITE CROSS CHEMICAL CO., Lynn, Mass., has filed notice of organization to manufacture chemical compounds. The company is headed by G. A. Liljgren, 40 Elmwood Ave.

THE KNOXVILLE FERTILIZER CO., Knoxville, Tenn., has been incorporated with a capital of \$500,000 to manufacture fer-

tilizers. The incorporators are H. L. Dullin, James W. Dean and S. B. Carter, Knoxville.

THE CADILLAC GLASS CO., Detroit, Mich., has been incorporated with a capital of \$50,000 to manufacture glass products. The incorporators are Fred L. Stoker, Ray L. Martin and Henry J. Berndt, 1147 Marlborough Ave.

THE EDEA OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$150,000 to manufacture petroleum products. The incorporators are E. A. Rany, E. W. Butcher and N. E. Canfield, Los Angeles.

THE FERRO CHINA BLOTTO CO., New York, N. Y., has been incorporated with a capital of \$15,000 to manufacture chemicals and chemical byproducts. The incorporators are M. M. Hirsch, D. B. Goodman and F. E. Mandel, 44 Cedar St.

THE CRYSTAL OIL CO., 407 Milliken Bldg., Decatur, Ill., has been incorporated with a capital of \$25,000 to manufacture oil products. The incorporators are C. M. Lamson, Thomas T. Roberts and William L. Shellabarger, Jr.

THE PROVIDENCE CHEMICAL CO., 51 Empire St., Providence, R. I., has filed notice of organization to manufacture chemical products. Herman M. Davis heads the company.

F. C. DONOVAN, INC., Boston, Mass., has been incorporated with a capital of \$10,000 to manufacture leather products. E. Barton Chapin is president; R. J. White, secretary; and J. Frederick Mann, 83 Gainsboro St., treasurer.

THE CHELSEA BRICK CO., Chelsea, Okla., has been incorporated with a capital of \$50,000 to manufacture brick and other burned clay products. The incorporators are Leon C. Merritt, J. A. Morrison, Chelsea; and W. L. Buckles, Okmulgee, Okla.

THE HOWE SPECIALTY CO., 191 Murray St., Newark, N. J., has filed notice of organization to manufacture rubber products. Walter J. Leatherow, 5 Thomas St., heads the company.

THE STANDARD PORCELAIN ENAMELING CORP., New York, N. Y., has been incorporated with a capital of \$22,500 to manufacture porcelain enamelware products. The incorporators are N. Chusid, M. and E. Ullman, 517 West 149th St.

THE GOLDEN DOME OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are Charles Gardner, M. H. Pearson and J. M. Brunner. James E. Mahon is representative for the company.

THE STANDARD CARBIDE SALES CO., New York, N. Y., has been incorporated with a capital of \$50,000 to manufacture coal and tar products. The incorporators are S. Null, W. B. Ragatz and R. M. Smith, Plattsburg, N. Y.

THE C. H. FRIANT RUBBER CO., 417 West Franklin St., Baltimore, Md., has been incorporated with a capital of \$50,000 to manufacture rubber products. The incorporators are Charles H. Friant, Charles P. Thompson and Charles Hess, Jr.

THE ACME TILE CO., Passaic, N. J., has been incorporated with a capital of \$750,000 to manufacture building tile and other burned clay products. The incorporators are Albert W. Reese, Daniel E. Saal, Clifton, N. J.; and Thomas H. Hogan, Passaic.

THE CENTRAL PAPER BOX CORP., New York, N. Y., has been incorporated with a capital of \$5,000 to manufacture paper boxes and containers. The incorporators are M. Ruskin, A. Pinkham and M. Hirschorn, 25 Monroe St., Brooklyn.

THE CHEMICAL COSMETIC CO., Newport, R. I., has been incorporated with a capital of \$25,000 to manufacture chemicals and chemical byproducts. The incorporators are Charles D. Campbell, 69 Levin St., Newport; Marcus F. Whitland and Jacob S. Blake.

THE ORIENT SPRAY CO., 230 Pleasant St., Baltimore, Md., has been incorporated with a capital of \$10,000 to manufacture disinfecting oils, chemicals, etc. The incorporators are Percy C. Thornton, John W. Krauss and Edwin J. Farber.

THE NATIONAL EXTRACT & CHEMICAL CO., Boston, Mass., has been incorporated with a capital of \$15,000 to manufacture chemicals and chemical byproducts. The incorporators are Samuel F. Ruskin, David Rosenfield and Morris Kramer, all of Boston.

THE PERFECTION PAINT & COLOR CO., Indianapolis, Ind., has been incorporated

with a capital of \$20,000 to manufacture paints, varnishes, etc. The incorporators are William McCabe, T. E. Madden, and T. J. Gannon, Indianapolis.

MOSEY & CO., INC., New York, N. Y., has been incorporated with a capital of \$50,000 to manufacture oil products. The incorporators are R. F. Thomas, C. E. Moser and A. D. Emil, 1168 Fifty-third St., Brooklyn, N. Y.

THE ROCHESTER RUBBER CEMENT CO., Rochester, N. Y., has been incorporated with a capital of \$10,000 to manufacture adhesive products. The incorporators are J. T. Voll, G. A. Veomett and F. E. Frey, Rochester.

JAMES A. MILLER, INC., New York, has been incorporated with a capital of \$20,000 to manufacture chemicals and chemical byproducts. The incorporators are C. Pechner, E. H. Reichman and James A. Miller, 368 Greenwich St.

Capital Increases, Etc.

THE INTERSTATE CORRUGATED BOX CO., 790 Grand Ave., Brooklyn, N. Y., manufacturer of corrugated paper boxes, etc., has filed notice of increase in capital from \$100,000 to \$500,000.

THE WULBERN FERTILIZER CO., Charleston, S. C., has filed notice of increase in capital from \$100,000 to \$350,000. W. E. Jones is secretary.

THE VAN DYKE SMELTING & REFINING WORKS, 94 Van Dyke St., Brooklyn, N. Y., has filed notice of increase in capital from \$500,000 to \$1,000,000.

THE CORBIN BRICK CO., Corbin, Ky., has filed notice of increase in capital from \$30,000 to \$50,000.

THE CASTUS OIL CO., San Antonio, Tex., has filed notice of increase in capital from \$30,000 to \$100,000.

THE EBENEZER OIL CO., Wellsville, N. Y., has filed notice of increase in capital to \$100,000.

THE VASSAR FOUNDRY CO., Vassar, Mich., has filed notice of increase in capital from \$100,000 to \$200,000.

THE MORTON SALT CO., Port Huron, Mich., an Illinois corporation, has filed notice of increase in capital from \$1,500,000 to \$4,000,000.

THE UNITED STATES COLOR CARD CO., 632 Sherman St., Chicago, Ill., has filed notice of increase in capital from \$5,000 to \$50,000.

THE KENNELLY PAPER CO., 200 Fifth Ave., New York, has increased its capital to \$100,000.

THE STANDARD PAINT CO., Woolworth Bldg., New York, a New Jersey corporation, has filed notice of change of name to the Ruberoid Co.

THE DOVAN CHEMICAL CORP., a Delaware corporation, has filed notice of organization to operate in New York. R. G. Thach, 120 Bway., is local representative.

THE INTERSTATE RUBBER CO., 217 Smith St., Perth Amboy, N. J., has filed notice of dissolution under state laws.

THE STANDARD OIL CO. OF CALIFORNIA, 200 Bush St., San Francisco, has filed notice of increase in capital from \$100,000,000 to \$115,000,000.

Industrial Notes

H. S. GREENE has been elected vice-president in charge of sales for the Barber-Greene Co., Aurora, Ill. Mr. Greene was formerly with the National Carbon Co. of Cleveland, O., where for several years he was assistant sales manager. He is a brother of W. B. Greene, vice-president and treasurer of the Barber-Greene Co. and has been a director of the company for some time.

THE NORTH AMERICAN CAR CO., which operates a fleet of 1,050 tank cars between the Oklahoma and Kansas oil fields, has developed an oil terminal in Blue Island, Ill. Steel tank storage is under construction and will be available about July 1.

JAGENBERG MACHINE CO., INC., has moved its sales office to 2587 Third Ave., New York City, to have this office in the same building with the manufacturing plant.

HOGANAS BILLESOLMS AKTIEBOLAG, HOGANAS, Sweden, would like to correspond with American firms interested in buying chloride of aluminum, liquid technical or crystalline chemically pure.

New Publications

BOOKS

A TEXT BOOK OF CHEMICAL ENGINEERING. By *Edward Hart, Ph.D.*, professor of chemical engineering in Lafayette College, president of Baker & Adamson Chemical Co. Pp. 211; 200 figs. Easton, Pa.: The Chemical Publishing Co., 1920. Price \$4.

Literature in the English language on the fundamental operations and equipment used in chemical engineering has been woefully inadequate and scattered. Chemical engineers are therefore indebted to Prof. Hart for having made available data from his rich experience. It is admittedly not the last word on the subject, but is intended rather as a general introduction. The practical side of chemical engineering has advanced more rapidly than the theoretical, with the result that many operations are carried out every day in the plant which are but little understood from the point of view of the fundamental, physical and chemical phenomena involved. It is to be hoped that an increasing chemical engineering literature will encourage the study of these fundamentals, for in no other way can real advances be made.

In this book the author attempts to outline the different problems encountered in each phase of chemical engineering and to illustrate the types of apparatus which have successfully met these conditions.

The first chapter deals with what is probably the most important problem which the chemical engineer is called upon to solve—the choice of a construction material for apparatus. Cast iron, mild steel, silicon-iron alloys, copper, lead, aluminum, glass, fused silica, chemical stoneware and bakelite are discussed in turn. Location and construction of plants is next considered, followed by chapters on boilers and prime movers. Piping, including the handling of lead, stoneware and silica pipe, is treated briefly. The remaining chapters are devoted to operations and equipment: Crushing, dissolving, filtration, tanks, evaporation, crystallization, drying, distillation, absorption of gases, mixing and kneading, containers.

The illustrations are excellent and cover a wide range of chemical equipment.

APPLIED COLLOID CHEMISTRY—GENERAL THEORY. By *Wilder D. Bancroft, Ph.D.*, professor of physical chemistry at Cornell University. Pp. 345. New York: McGraw-Hill Book Co., 1921. Price \$3.

Prof. Bancroft needs no introduction to those interested in the subject of colloid chemistry. His thought in preparing this book is best expressed in his own words:

"The earlier books on colloid chemistry presented the subject empirically because no other method was then possible. While we do not now know much about gelatinous precipitates and jellies, the theory of the rest of the subject is in fairly good shape and consequently I have written this book deductively. . . . This volume on general theory should be followed by at least one volume on each of the following subjects: Silicate industries; paints and varnishes; plastics; fibers and dyeing; photochemistry and photography; petroleum industries; ore flotation and allied subjects; foods and beverages; soils and crops; biology and medicine."

GENERAL AND INDUSTRIAL ORGANIC CHEMISTRY, Part I, Second Edition. By *Dr. Ettore Molinari*, professor of industrial chemistry at the Royal Milan Polytechnic. Translated from the third Italian edition by Thomas H. Pope, F.I.C. Pp. 456; 254 illustrations, Philadelphia: P. Blakiston's Son & Co., 1921. Price \$8.

This volume treats from both general and industrial viewpoints the following classes of aliphatic compounds or methane derivatives: Hydrocarbons; halogen derivatives of hydrocarbons; alcohols and their derivatives; acids and their derivatives. In addition to the discussions of individual compounds descriptions of important industries are included at appropriate points. Among these may be mentioned: Illuminating gas; petroleum industry; alcohol and the fermentation industries; explosives; wood distillation; tartar and citrus industries.

MODERN WELDING METHODS. By *Victor W. Pagé*. Pp. 292; 113 illustrations. New York: Norman W. Henley Pub. Co., 1920. Price \$3.

Much practical information on welding operations will be found in this book. In addition to oxyacetylene and electrical welding chapters are included on the thermit and its applications, soldering and brazing, forge welding and heat treatment of steel.

CHEMISTRY OF PLANT LIFE. By *Roscoe W. Thatcher, D. Agr.*, dean of the department of agriculture and director of

the agricultural experiment stations, University of Minnesota. Pp. 268. New York: McGraw-Hill Book Co., Inc., 1921. Price \$3.

VITAMINES. By *Benjamin Harrow, Ph.D.*, associate in physiological chemistry, College of Physicians and Surgeons, Columbia University. Pp. 219; 8 charts. New York: E. P. Dutton & Co., 1921. Price \$2.50.

THE PLATINUM METALS. By *A. D. Lumb*, lately of the scientific and technical department, Imperial Institute. Pp. 63. London: John Murray, 1920. Price 3s. 6d.

This is one of the monographs on mineral resources with special reference to the British Empire prepared under the direction of the mineral resources committee of the Imperial Institute, with the assistance of the scientific and technical staff.

GOLD. By *Benjamin White*. Pp. 128, illustrated. London and New York: Sir Isaac Pitman & Sons, Ltd., 1920. Price \$1.

LEAD. By *J. A. Smythe, Ph.D.* Pp. 120; 17 illustrations. London and New York: Sir Isaac Pitman & Sons, Ltd., 1920. Price \$1.

These two little books form part of a series on common commodities and industries numbering about forty-five volumes at the present time. The treatment of each subject is brief and popular, the aim being to present a general rather than a detailed or technical survey.

MECHANICAL WORLD YEAR BOOK, 1921. Pp. 328; 93 illustrations. Manchester: Emmott & Co., Ltd. 1921. Price 2s. 6d.

MECHANICAL WORLD ELECTRICAL POCKET BOOK, 1921. Pp. 306; 108 illustrations. Manchester: Emmott & Co., Ltd., 1921. Price 2s.

FINDING AND STOPPING WASTE IN MODERN BOILER ROOMS. Second edition. Pp. 414, illustrated. Philadelphia: H. S. B. W.-Cochrane Corp., 1921. Price \$1.

As the title would indicate, this is a compilation of data from various sources on fuels, combustion, heat absorption, boiler efficiency, boiler testing, boiler plant proportioning and management. An immense amount of information is presented in a most usable form.

THE ORIFICE METER AND GAS MEASUREMENT. By *Willis C. Brown and Malcolm B. Hall*. Pp. 112, illustrated. Foxboro, Mass.: The Foxboro Co., Inc. Price, cloth \$3.50; leather \$4.50.

Manufacturers' Catalogs

THE CUTLER-HAMMER MFG. Co., Milwaukee, Wis., is distributing a four-page leaflet and an 8-page folder. Both of these publications are illustrated with views of space heaters installed in airplane hangars, crane cabs, valve houses, etc., and give lists of uses to which these heaters have been put.

PAWLING & HARNISCHFEGER Co., Milwaukee, Wis., announces a new edition (dated January, 1921) of its Bull. 5X, on the P. & H. Excavator-Crane No. 205. This bulletin describes the many and various uses of this general utility cranes, the photographic illustrations showing the excavator at work, equipped with a digging bucket, a back-filling scraper bucket, clamshell bucket, lifting magnet, special grapple for lumber and sling chains. Details of construction, specifications and operation are also included.

REPUBLIC CARBON Co., INC., Niagara Falls, N. Y., has issued a booklet on "Republic Electrodes." Illustrations are given of the various types of furnaces using the many sizes of electrodes, together with descriptions of the electric furnace, the electrode, manufacture, desirability of electrode, electrode consumption, making of joints and sizes. Tables are given of tensile strength of metals, composition of some typical engineering alloys, international atomic weights, melting points of various refractories, heat units, etc.

BAUSCH & LOMB OPTICAL Co., Rochester, N. Y., has issued a new projection catalog. This complete catalog of projection apparatus, which is the first this company has been in a position to publish since 1916. Of particular interest is the new model BC Balopticon for lantern slides, the projection of large opaque objects, the improved apparatus for microscopical projection and the more general application of the gas-filled mazda lamp.

E. F. HOUGHTON & Co., Philadelphia, Pa., had an investigation made by its research staff as to the causes of skin sores and boils among metal workers which has been

published in booklet form. The foreword, by Charles E. Carpenter, president of the company, outlines and summarizes the main features in plain, non-scientific language, easily understood by the practical man. He says: "While it is recognized that even this comprehensive work is not conclusive, it is nevertheless thoroughly practical. Wherever the suggestions for the prevention of infection have been applied in a common-sense manner the prevalence of infection has been cut down, and in some cases eliminated."

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29. Headquarters will be at the Hotel Rochester.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17. Headquarters will be at the Congress Hotel.

AMERICAN PAPER & PULP ASSOCIATION will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

AMERICAN WELDING SOCIETY, METROPOLITAN SECTION, will hold its regular meeting April 19 at the Engineering Societies Building, New York City.

AMERICAN ZINC INSTITUTE will hold its annual meeting in St. Louis May 9 and 10.

ASSOCIATION OF SCIENTIFIC APPARATUS MAKERS OF THE U. S. A. will hold its meeting at the Hotel Raleigh, Washington, D. C., April 14 to 16.

BRITISH IRON AND STEEL INSTITUTE will hold its spring meeting May 5 and 6, at the Institution of Civil Engineers, Great George St., S. W. 1, London, England.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

HARVARD ALUMNI CHEMISTS' ASSOCIATION will meet Tuesday noon April 26 at Rochester, N. Y., for luncheon.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27 to 29.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY will hold its annual meeting at the Waldorf-Astoria and Hotel Astor, N. Y., April 11 to 14.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

ALAN G. WIKOFF
R. S. McBRIDE
CHARLES N. HULBURT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

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New York, April 13, 1921

Number 15

Prevention of Food Waste

Aim of Research Institute

THE happy-go-lucky manner in which this country has blundered through every war in which it has ever engaged indicates that the forefathers adopted a fitting motto, "In God we trust." With the exception of maintaining a Navy and a skeleton of an Army, we have never made any preparation until actual hostilities were begun.

In the matter of food supply for our forces in the field we have been notoriously and sometimes criminally lax. Fortunately the commissariat was arranged better in the late war than in the conflict with Spain, which tarnished many reputations, though it fattened some pocketbooks. But feeding the army in the field is only a small part of the problem. There is the vast army at home whose work in winning a war is not less important than that of the fighting forces. HERBERT HOOVER and the Allied food administrators faced a task as hard as that of any general on the firing line—that of seeing that food was produced in sufficient quantities and distributed so as to insure the maximum efficiency. Things were ordered differently in Germany. There the whole matter had been thought out and when the war came the system of feeding the industrial army worked like the well-oiled machine it was.

When the food administrators of the Allied and associated countries met during the late war they agreed to do all in their power to secure a systematic study of this matter in their respective countries so that some kind of system might be available in another emergency. With the close of the war Mr. HOOVER did not forget this agreement. As there seemed to be no chance to get the Government to act in the matter, he went to work in his characteristic manner to get action in some other way. Due to his efforts the Carnegie Corporation has agreed to furnish the finances for a period of seven to ten years and the Food Research Institute of Stanford University has been brought into being. Its work will be divided into three groups, each in charge of a director. One group will study the economic and statistical features, another will study nutrition and the third will study the industrial side. Only one director has as yet been chosen, Dr. C. L. ALSBERG, who will be at the head of the third group. It is promised that the men appointed to the other directorships will be of equally high caliber.

It should not be necessary to wait for a war to prove the advantages of such a work as will be undertaken by the Food Research Institute. It is important in peace time that the industrial army—which takes in pretty nearly all of us—should be fed adequately and properly.

There is enormous waste in our system of food distribution, lack of statistics and other economic data and poorly organized knowledge of nutrition. Why

should we wait until a war or some national emergency compels us to investigate these problems and correlate the findings? The Food Research Institute will be a means for determining the facts. The mechanism for availing ourselves fully of the findings and putting them to practical use does not yet appear, but undoubtedly it will be evolved later, so that not only will the hopes of the founders be justified but a distinct service will result to the whole country.

Idealism Tempered

With Common Sense

IN THE INDUSTRIAL life of a young and growing nation such as this there is often a tendency to the superlative in ideal or ambition that cannot altogether be justified. This perhaps is the excuse for the existence of pessimists, much as we hate that sort of creature. It is well, however, without becoming a pessimist, that we should temper our ambitions and our idealism with a generous measure of common sense.

Industrially the application of this principle means a careful consideration of the relative merits of old and new processes. That a new process is technically successful is not enough; it must also be a demonstrated commercial achievement before any great credit can be given to it in "practical affairs." The new process or product must afford a sufficiently wide margin of advantage above the old or current practice in order to justify a certain measure of risk in its adoption. One must never forget that any new development may prove to have altogether unsuspected deficiencies or defects. A wider margin of apparent advantage is, therefore, necessary to offset such possible contingencies.

Moreover, if the new process or product requires new investment it is very important to have a margin of financial profit sufficient to provide for the amortization of the old equipment or investment which must be discarded. Industrially there is little fear that this last factor will be ignored, for the banker, to whom we all go for the last word regarding new developments, is very careful to have this phase of new investment carefully considered before he will arrange for loans.

The research man often has what appears to him brilliant developments to offer, but finds unsympathetic or inattentive listeners when he presents his ideas for commercial development. Perhaps he may avoid the embarrassment of premature presentation of his projects and secure a more sympathetic hearing if he will bear in mind that it is necessary to present a certain margin of advance before he can claim to have made any real achievement. If he will do so he will contribute not only more to industry but also more to the advancement of research itself. This is particularly true in circumstances where partially developed, "half-baked" research is presented for the approval of management. Naturally the manager after repeated

experience of this sort is inclined to look with doubt upon all new developments offered from the research department, a result most unfortunate to that department and to the management as well.

The Merit and Value of Ceremony

THERE was a quality about that celebration at the Chemists' Club on March 17 that makes an interesting subject for discussion. The conferring of honorary membership on eight great chemists was made a very formal occasion. Every word and every move were planned beforehand; nothing was done off-hand, and, thanks to Dr. BASKERVILLE, who was chairman of the committee of arrangements, an impressive ceremony was devised.

Well, what's the use of ceremony anyway? Men of science have neither the "livery of heaven" nor professional millinery. It is their principal business to think straight and to talk straight; their symbols represent definite concepts and not, like the astrologer's pointed cap, mystic twaddle, or even any claim of authority. They have no robes of office or insignia of power; they wield neither magic wand nor scepter. Why wouldn't it be the sensible thing, if a body of chemists wants to make someone an honorary member, for the secretary to write him a letter, telling him of the fact, and then to let it go at that? The men would know, and all the business would be completed without any fuss or feathers.

We think the authorities of the club were wise in their generation in taking the opposite view. We live by symbols. We raise our hand and take an oath and then we are "under oath." If we lie at such a time there are dire consequences awaiting us. When a judge mounts the bench he wears his robe of office. When a policeman goes upon his beat to keep the peace he dresses for the part he is to take and he wears a uniform with brass buttons and a shield. The President of the United States does not wear a uniform, but he is encompassed by the White House, which is an official symbol of place. When the president of a university confers a degree he doesn't dictate a letter and post it to the recipient; he confers the honor with great dignity and formality. It is right that a distinguished occasion should be characterized by a fitting and proper ceremony. It makes a picture, and it is a serious mistake to think that anybody is too old or too wise to want to see a picture, or even to take a part in it.

Science has suffered from its informality. We claim participation in affairs, but we do not very often dress the part that we claim. We need to impress upon the rest of the world the dignity of science. Ceremony and formality are the gestures of life.

At the meeting in question there were eight distinguished members of the club appointed to meet, each one, the new honorary member or his representative, to whom he had been assigned, to conduct him upstairs and present him to the president, to escort him to dinner, and after dinner to escort him to the hall. Then when the president had called the meeting to order the chairman of the committee cited in alphabetical order, first those of the foreign nations present, then the Americans, by name, whereupon the escorting member stepped with his charge to the platform and formally presented him in words that had already been prepared. The president shook his hand, gave him a

beautiful certificate of honorary membership, and assigned him to his seat on the platform under his national flag.

There were no little jokes, nobody tried to be funny, and no one was embarrassed. Or if anybody was he was not placed in a position to be ridiculous. We believe that all who were present will remember the occasion as one on which the things which were done were done right.

Popular Appeal In Industrial Reels

THE people are the audience of the moving picture shows. They pay the price of admission primarily for amusement, which may be any form of mental satisfaction, comic, pathetic, educational, intelligent or otherwise. Propaganda films have a monopoly on the last three classifications, and especially of the last. Of the manufacturers HENRY FORD has probably propagandized most successfully, leaving the "otherwise" classification to his newspaper efforts. Ford reels have cultivated the acquaintance of the public by displays all the way from the marvels of the Detroit factory to touring through Florida in the winter and Canada in the summer à la Ford. Thousands of Fords on the highways could not begin to get the popular appeal that has been produced by these few thousand feet of picture reels.

Picture campaigns are costly, with negatives of interiors at four dollars per foot or second of display time. Movie operators ordinarily pay rent for the use of reels, but charge advertising rates for anything of a propaganda nature. Thirty thousand dollars per reel is said to be the average expense of covering the circuits throughout the United States, which makes the girls on the covers of our most popular magazines blush at their valuation.

Industrial movies in restricted circuits such as society meetings and educational institutions do not require silver wheels to put them across. While their function from the many selfish points of view may be limited, they have an influence that is well worth the effort spent to produce them.

Popularizing Science

AT LAST chemists can welcome an agency of publicity which is generously endowed for the promotion of scientific matters which does not propose as the first step of its activity to publish a new magazine. The scientific literature of the country is already so extensive that technical men are overburdened with new periodicals. In fact, as one engineer recently remarked, "The first function of a new association always seems to be to rent an office and hire a secretary; the second, to get out a new magazine." It is a great pleasure, therefore, to find that Science Service takes an entirely different stand in its proposal to work only through existing publications.

This new Service, which is headed by Dr. EDWIN E. SLOSSON, as editor, and HOWARD WHEELER, as manager, is generously endowed. It seems certain to succeed in its effort to popularize scientific information; and if we may judge its prospects of success from the splendid work which its editor has done in his volumes on "Creative Chemistry" and "Easy Lessons in Einstein" it is assured a splendid future.

Chemists and engineers will be well served by the existence of such an agency, for it will do much good in bringing these professional men before the general public through new channels. It is contemplated that the popular press, motion pictures and lectures will all be used in furthering the ideals of Science Service, which include instruction of "the public about the methods employed by science in discovering the secrets of nature," and also in bringing before the general public "the means by which industry and science operate to make available and distribute these supplies (the natural resources of the country)."

Even the technical men of today find it difficult to keep in touch with all scientific and technologic literature which is of value to them. It is easy to realize how much more difficult it is for the lay public to get even an elementary idea of many developments in which it is generally interested. If Science Service can even in a small degree satisfy the popular craving for reliable and yet intensely interesting information of new or spectacular developments it will have accomplished great good for the sciences and the branches of engineering with which it deals. Every effort of scientific and technical men to support the Service will, therefore, be well expended.

Rail Statistics For 1920

THE American Iron and Steel Institute reports the production of rails in the United States in 1920 at 2,604,116 gross tons, against 2,203,843 tons in 1919, about 1,900,000 tons in 1908 and 1914 and 3,977,887 tons in 1906, the record year for rail production. The production of late has been entirely of steel rails, the last iron rail production reported being 234 tons, in 1911. The rails made in 1920 were chiefly priced at \$45 for bessemer and \$47 for open-hearth, and higher, against prices of \$28 for bessemer and \$30 for open-hearth for many years prior to May 1, 1916.

The production of rails is not an index of railroad prosperity to anything like the extent that is commonly assumed. Of all classes of material bought by railroads, rails are among the least promising of increased revenue and the most dangerous to do without when needed. Ten years ago a much smaller tonnage of the total output was used for replacements than at present, while large tonnages were used for building new track. Long ago one function of branch lines of railroad was to remove the necessity of driving wagons through mud. The motor vehicle and highway improvement have filled that bill very largely, furnishing one of several reasons why additional branch lines are not built to so great an extent as formerly.

The decrease in the consumption of rails by the standard steam roads is really greater than appears from the production statistics. In 1906 total production was 3,977,887 tons, rail exports amounted to 328,036 tons, imports being 4,943 tons, while 284,612 tons of rails under forty-five pounds per yard were made, an unknown proportion of these light rails being exported. The domestic consumption of rails forty-five pounds and over was therefore about 3,500,000 tons. In 1920 production was 2,604,116 tons, including 489,043 tons of rails under fifty pounds per yard, exports were 594,634 tons and imports were 45,684 tons, making the domestic consumption of rails fifty pounds and over probably under 1,750,000 tons, or

a decrease of 50 per cent from 1906, whereas the total production declined by only about 35 per cent. The increase in the manufacture of light rails in the fourteen years, 60 or 65 per cent, is an interesting point.

The domestic consumption of standard section rails last year was of course almost wholly for replacement purposes. The building of new line dwindled to insignificant proportions several years ago, and the laying of additional track has been very small of late. The occasion for rail replacement is not in all cases simply normal wear. On account of heavier wheel loads the requirements in a rail increase. The old rail deteriorates rapidly and is replaced by a rail that will bear up better. The improvement is partly in quality and partly by increasing the section. Twenty years ago the 100-pound rail was a rarity, but in 1920 729,118 tons of rails were rolled in sections 100 pounds and over.

Titanium-treated rails came back a trifle in 1920, the tonnage so treated being 11,652 tons, against 6,207 tons in 1919 and 2,891 tons in 1918, the low year for titanium. In 1910 256,759 tons of rails were made with titanium treatment, but three years later less than one-fifth as many tons.

Theoretical Organic Chemistry and Synthetic Chemical Technology

ORGANIC chemists are becoming less and less dependent on their knowledge of college lecture black-board reactions showing the interaction of constituent groups of molecules taking place to suit the fancy of the crayonist. They are culling over the mass of descriptive records available in the literature and gradually evolving a few generalizations. If these prove to be useful they will sooner or later become a part of theoretical organic chemistry, and be applied in organic chemical technology.

The organic chemist, for example, knows that benzoic acid has not been prepared by the simple addition of carbon dioxide to benzene or monoxide to phenol. If he is a student of catalysis he may try to find a material that will induce carboxyl addition. It is accomplished in the synthesis of salicylic acid under the influence of the hydroxyl group and there is no evidence leading to the conclusion that results along catalytic lines cannot be obtained. Nevertheless sulphur and other catalyzer poisons are not removed from the purest commercial benzene to the extent of not being lethal in cumulative doses to such catalysts as nickel, and so the practical possibilities of such a process are indeed limited.

In substitution methods the organic chemist finds a much easier mode of attack. With toluene as the source the synthesis deals with simple atomic reactions, chlorine being substituted for the hydrogen in the radical with comparative ease and giving a product that can readily be hydrolyzed to benzoic acid. With benzene as the initial material the reaction deals with group molecular subdivisions and is very difficult to control. In this issue the investigation of Prof. McKEE and Dr. STRAUSS is being published not because it suggests a revolution in benzoic acid technology but as an example of diligent synthetic work along particularly difficult lines. The groups transferred are not atomically inactive to each other and of course the sulphonic group tends to be reduced and the other oxidized. The authors show considerable technique in handling the investigation and certainly have contributed in full measure to the literature in a spot where it is rather meager.

Readers' Views and Comments

A Compilation of American Dye Patents in Abstract Form

To the Editor of Chemical & Metallurgical Engineering

SIR:—Early in the development of the Color Investigation Laboratory the need was felt for a compilation of the American patents on dyes, and Miss Aida M. Doyle, at that time employed by this laboratory, undertook the task. It was our intention to publish it, but, owing to its size and the lack of funds available for such a publication from the Department of Agriculture, it has been found that it is impossible to do so. Consequently, the Bureau of Chemistry has decided to call the attention of those interested in such a work to the fact that the Color Investigation Laboratory has this in its files, where it may be consulted at any time. It should be borne in mind, however, that it is not possible for the laboratory to undertake patent searches.

The compilation is in the following form:

Each patent was abstracted under seven different headings, in order to make the compilation accessible from as many points of inquiry as possible. The abstract was typed on 3 x 5-in. cards, of which as many copies were made as was necessary. A separate file was made for each of the seven headings, so that it is completely cross-indexed, and any patent may be found in any one of seven different ways:

1. Scientific name, when known or given in the patent.
2. Intermediates used, with a very condensed statement of the method of manufacture.
3. Class of dye, according to Schultz's eighteen chemical classes.
4. Color of dye.
5. Method of use.
6. Fiber or material for which suitable.
7. Name of owner, and, in parentheses, name of patentee.

In making the first file, it was found that the scientific name was so seldom given and was apparently of so little importance that the file was finally arranged in strict numerical order. Besides the above information the number and date of patent are given, and, in the upper right hand corner, the Schultz number of the dye, when it is possible to locate it, together with the most common trade name, or the trade name given in the patent itself. Any additional information is added as a note at the bottom of the card. The chemical nomenclature and abbreviations used are those sponsored by *Chemical Abstracts*.

In order to make the explanation more intelligible, a specimen card is herewith reproduced.

No. 546,177

S. No. 607

9-10-1895

"Rheonin A."

1. Product like phosphine in properties

BENZOPHENONE condensed with *m*-PHENYLENE DIAMIN HCl and *m*-PHENYLENE DIAMIN by heating with ZnCl₂ in closed enameled vessel, on oil bath to 195-215 deg. The *m*-amino phenyl AURAMIN first formed combines with diamine to form the new dye.

2. Tetra methyl diamine

3. Acidic

4. Yellow, brownish-

5. Basic mordant

6. Cotton, leather

7. Badische (C. L. Müller).

It is to be seen that the abstracts, and the whole compilation in fact, are not intended to do away with the consulting of the patents themselves, but merely

to serve as a cross-index to them. At the same time the cards contain enough information to enable the user to decide which of several possible patents is the one he is looking for, without the necessity of handling the patents themselves, thus cutting down on their wear and tear as well as saving his time.

The compilation has been brought up to date of Jan. 1, 1921, by Max Phillips and Dr. L. D. Smith of this laboratory, and will be kept as complete as possible.

Any one desiring to make use of this compilation should either visit or address the Color Investigation Laboratory.

JOSEPH A. AMBLER,
Acting Chemist-in-Charge.

Color Investigation Laboratory,
Bureau of Chemistry,
Department of Agriculture,
Washington, D. C.

Senatorial Science

To the Editor of Chemical & Metallurgical Engineering

SIR:—The venerable Senators of the United States in high conclave assembled undertook on Feb. 25 last to discuss fertilizer materials. It had to do with an appropriation of \$86,000 "to determine possible sources of supply and methods of obtaining potash, nitrates and other natural fertilizers." The discourse of these learned men was so illuminating that I cannot forbear to copy some of their words of wisdom from the *Congressional Record*, in the hope that you will give your readers the benefit.

BY SENATOR WALSH: The Geological Survey has issued numerous bulletins concerning the supply of potash and nitrates . . . which have been referred to from time to time on the floor here. Bear in mind, I commend the investigation as one that ought to be encouraged, but we are certainly embarking the Agricultural Department in investigations that are particularly appropriate to mining operations.

SENATOR FLETCHER: In some respects it pertains to mining operations, but in other respects I think the investigation does not; because the Agricultural Department is making experiments now in the matter of developing potash, nitrates and acids for reducing potash into sulphate of ammonia, ammonium potash and so forth.

Here we have a balance of originality. Senator Walsh contributes the mining note on the fixation of nitrogen which disturbs Senator Fletcher's chemical conscience. As an offset to his conservatism, on the other hand, he gives us the new reaction of potash to ammonium sulphate and the new product, ammonium potash.

Senator Smith of South Carolina reminded his colleagues that the Department of Agriculture had made extensive investigations and reports in regard to obtaining potash from the kelp weed, to which Senator Walsh replied: "If the Senator from South Carolina will permit me, that is entirely proper. Kelp is an *agricultural product*. . . . There is also considerable quantity of potash discovered in reducing coal to coke. . . ."

We have made bold to italicize the new features of the learned Senator's comment.

Senator McNary thought they were drifting afield under the lead of Senator Smith. He did not think the appropriation indicated the performance of any

work in connection with processes for obtaining potash from kelp. "I think," said he, "the appropriation in the item under discussion is not even used for the purpose of studying the habits of the nitrates that may be obtained from leguminous plants." Here is a chance for cheap celluloid by the McNary process. Extract your cellulose already nitrated from the nitrated legumes, mix it with camphor, press it, and there you are! This should gladden the heart of Clarence Joyce if he sees it. Senator Smoot thought that the work should be done by the Bureau of Mines and the Geological Survey, because "Potash deposits are frequently found on public lands, for instance."

"Neither of these services actually makes experiments, as I take it," said Senator Fletcher. "They merely locate deposits and map and plot them, and that sort of thing, and show where the products possibly can be obtained, but the Department of Agriculture has a bureau which actually experiments with these different elements to determine the commercial value of the product."

Alas for Dr. Charles L. Parsons! Eheu, Dr. Cottrell! Væ, Dr. R. B. Moore! Senator Fletcher is in Washington; he is on the spot; and his remarks would seem to indicate that all these three gentlemen, as consecutive chief chemists to the Bureau of Mines, had been twirling their thumbs in idleness for years and years and years. We can hardly believe it. For a fact, we don't. Indeed, Senator Smoot corrected him. He told how the Bureau of Mines had spent hundreds of thousands of dollars for the investigation of "certain rock deposits in New Jersey for the purpose of extracting potash from the same." We take it that the "certain rock deposits" are green sands. He also said that the Bureau of Mines had "spent thousands and tens of thousands of dollars in developing the nitrate deposits in America." He probably referred to our aerial deposits of nitrogen.

Later in the discussion Senator Smoot said that "the great bulk of potash produced in the United States—and this statement will be as true in the future—has come from the extraction of potash or nitrates from the rocks which are found in the everlasting hills of the West." We can't help wondering whether those hills will be everlasting after "the potash or nitrates" have been taken out of them.

The argument as to the relative merits of the Agricultural Department and the Bureau of Mines would not down. Senator Fletcher thought the Department of Agriculture should determine "the source of fertilizer, the elements which enter into plant food, and the way to develop them and make them available to the producers of the food of the country on reasonable terms."

Senator Smoot objected, on the ground that "the scientists in the Department who have been educated to study questions relating to plant life, growth, development and other matters connected with the soil are not the ones to handle it. It takes men who have studied for years and years along a particular line, who have studied the geology of the country, and more than likely who have spent their early lives in the mines of the West. It takes practical men."

That looks like a swat at Dr. Alsberg of the Bureau of Chemistry. How many of his chemists can he point out who have spent their early years in the mines of the West?

Senator Walsh of Montana brought up the Searles

Lake deposits, and said that not only had the Geological Survey made repeated reports on it but that investigations by Congress had also been conducted and that the information so derived was also available.

A congressional investigation into salt brines would be interesting.

Senator Walsh resented the appropriation of \$5,000 to care for the machinery at the experimental kelp plant in California. "Private enterprise," said he, in regard to kelp, "is now engaged in the development of this source of supply of nitrate and it is not necessary for the Government to carry it on any longer."

This, Mr. Editor, is from the Senate of the United States; not the Senate of the Sovereign State of Nevada or of Arkansas. It is "the highest deliberative body in the world." Good Lord!

MARTIN SEYT.

Compensation of Chemists and Salesmen

To the Editor of Chemical & Metallurgical Engineering

SIR:—Mr. Ferguson's letter in your March 16 number headed "Compensation of Chemists and Salesmen" is interesting. Permit me to say, however, that while perhaps there are cases where chemists are insufficiently paid or are seemingly unappreciated, as is true in all walks of life, and that the law of supply and demand affects to some extent chemists' salaries, yet in the vast majority of cases I believe chemists are paid in direct proportion to the delivery they make.

When chemists are paid relatively low salaries it is probably because of their faulty training, their lack of practical horse sense and their inability to sense proportions. I am afraid Mr. Ferguson is not fully informed as to what "the average employer" is paying either his salesmen or his chemists, nor what these salesmen and chemists are *paying* their employer. At any rate, comparisons between chemists and salesmen are scarcely more illuminating than comparisons between chemists and college professors, twelve-dollar-a-day brick masons, or bank presidents. Business is a hard and ceaseless struggle and the employee, be he chemist, salesman or executive, who shows greatest results receives the greatest reward in the long run.

CHEMIST.

Chicago, Ill.

Temperature Conversion Tables

To the Editor of Chemical & Metallurgical Engineering

SIR:—We have had occasion to use almost daily your "Temperature Conversion Tables," as included in the Dec. 1 number of CHEMICAL & METALLURGICAL ENGINEERING, page 1075.

We have found in one small section of the table an error of exactly 1 deg. F. that is carried along for four consecutive temperatures. In converting from degrees Centigrade to degrees Fahrenheit the figures given are correct when converting from 15 deg. and from 20 deg. C. The error comes in the conversion from 16, 17, 18 and 19 deg. C. respectively, and amounts in each case to exactly +1 deg. F. Presumably the calculator of the conversions obtained the 15-deg. and 20-deg. C. values by use of the formula, and the values for the intermediate degrees by successive additions of 1.8. In the section in question the error came in adding 2.8 in one case and 0.8 in the other, instead of 1.8.

We call your attention to this error in the tables, because of their great excellence otherwise.

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Synthesis of Chlorine-Free Benzoic Acid From Benzene—I

An Investigation on the Synthesis of Chlorine-Free Benzoic Acid by Sulphonation of Benzene and Substitution by Carboxyl Group—Formate Fusion Method—Cyanide Fusion and Hydrolysis of Benzotrile Method*

By RALPH H. MCKEE, PH.D., AND FRANK A. STRAUSS

ALTHOUGH a variety of processes for the synthesis of benzoic acid have been proposed, the acid on the market today is made almost exclusively from toluene. The following investigation was undertaken to develop a commercial method for the synthesis of chlorine-free benzoic acid from benzene. An obscure and neglected reaction has been studied, modifications in the reaction conditions whereby a greatly increased yield is obtainable have been worked out, and some of the problems of the commercial application of the process have been touched upon. It is believed that a method is outlined herein for the manufacture of benzoic acid of high purity at a cost which compares favorably with that of the present method of production. The process, moreover, is of especial interest in connection with recent developments in the production of cheap cyanides from atmospheric nitrogen, for which new uses are being sought. It is also of interest in that it makes use of sodium benzene sulphonate, and thus offers a means of employing a part of the extensive idle equipment used in the manufacture of synthetic phenol during the war.

HISTORICAL AND BIBLIOGRAPHICAL REVIEW

Benzoic acid owes its name to its occurrence in gum benzoin. First mentioned in 1608 by Blaise de Vigenère, its preparation was described first by Scheele in 1755. Its structure was established by the classic work of Wöhler¹ and Mitscherlich.²

The processes used or proposed for the manufacture of benzoic acid may conveniently be classified according to the starting material.

MANUFACTURE FROM VEGETABLE AND ANIMAL SOURCES —PRODUCTION FROM GUM BENZOIN.

This was the first source of benzoic acid, and even today is said to furnish a small amount of the pharmaceutical product. The acid may be obtained by sublimation,³ by steam distillation,⁴ by extraction with alcohol⁵ or by digestion with alkali.⁶ A yield equal to 25 per cent of the weight of the gum is obtainable. Other resins, such as Siam, Palembang and gum acroides may be used.

PRODUCTION FROM ANIMAL SOURCES

The urine of herbivora contains small amounts of hippuric acid, $C_6H_5CONHCH_2COOH$, which on hydrolysis gives benzoic acid. About 1870 small amounts of the

acid were made commercially from this source in Germany and Austria,⁷ but the process has long since been abandoned. Benzoic acid has also been prepared from suint (crude wool grease).⁸

MANUFACTURE FROM PRODUCTS OF DISTILLATION OF COAL —FROM BENZENE

Direct synthesis by the Friedel-Crafts reaction from benzene and carbon dioxide in the presence of aluminum chloride is said to have been tried on a commercial scale in France.⁹

During the war, one American manufacturer converted aniline into benzonitrile by the Sandmeyer reaction (diazotization and treatment with cuprous cyanide), and hydrolyzed the nitrile to benzoic acid.

The manufacture of benzonitrile by the action of copper on phenyl isothiocyanate or diphenylthiourea has been proposed.¹⁰

Benzonitrile may also be synthesized by passing chlorobenzene over heated alkali cyanide or ferrocyanide.¹¹ As the best yields reported are 22 per cent, the method seems of little interest. A process has recently been patented¹² in which lower temperatures and the presence of a catalyst are specified.

FROM TOLUENE

Toluene may be oxidized to benzoic acid either directly or by chlorination with subsequent hydrolysis.

Among the agents for direct oxidation which have been proposed are:

- Air in the presence of a heated catalyst, such as: porous carbon or iron oxide;¹³ vanadium or molybdenum oxide;¹⁴ platinum.¹⁵
- Ozone.¹⁶
- Nickel oxide.¹⁷
- Nitric acid.¹⁸ The yields are fair, but the method is expensive. Two American manufacturers are using it in order to obtain a product free from chlorine.
- Potassium permanganate.¹⁹
- Manganese dioxide and acid. A wide range of

¹Hofman, *Wien. Weltausstellungsbericht*, (1877), vol. 3, p. 431; Ullman, *Encyclopaedie der Technische Chemie* (1915), vol. 2, p. 325; Caseneuve, *Zettschr. Oest. Apothek. Ver.* (1879), p. 2. *U. S. Dispensatory*, vol. 17, loc. cit.

²*Chemist and Druggist* (1876), p. 358; *U. S. Dispensatory*, loc. cit.

³Frydlander, *Rev. Prod. Chim.*, vol. 21, p. 24 (1918).

⁴Badische Anilin u. Sodafabrik, Ger. Pats. 259,363, 259,364; Eng. Pat. 28,647 (1912); French Pat. 456,086.

⁵Merz and Schelnberger, *Berichte*, vol. 8, p. 918 (1875); Merz and Weith, *Berichte*, vol. 10, p. 746 (1877).

⁶Akt. Ges. f. Anilinfabrikation, Ger. Pat. 293,094.

⁷Chavy, Delage and Woog, French Pat. 379,715.

⁸Gibbs, U. S. Pat. 1,284,887; Eng. Pat. 119,518 (1917). See also Walter, *J. Prakt. Chem.*, vol. 159, p. 107 (1895); Ger. Pat. 168,291, French Pat. 360,785, Eng. Pat. 21,941 (1905).

⁹Coquillon, *Compt. rend.*, vol. 80, p. 1089 (1875).

¹⁰Heinemann, Eng. Pat. 23,575 (1914).

¹¹Badische Anilin u. Sodafabrik, Ger. Pat. 127,388, U. S. Pat. 698,355, Eng. Pat. 32,887 (1900), French Pat. 306,071.

¹²Fittig, *Annalen*, vol. 120, p. 214 (1861); Grimaux and Lauth, *Bull. Soc. Chim.* (3), vol. 7, p. 100 (1892); Sacchse, Ger. Pat. 216,091; Coblenz and Walker, U. S. Pat. 1,332,028.

¹³Ullman and Uzbachian, *Berichte*, vol. 36, p. 1797 (1903).

*Submitted by one of the authors in partial fulfillment of the requirements for the degree of Doctor of Philosophy, Columbia University, New York, N. Y.

¹*Annalen*, vol. 3, p. 249 (1832).

²*Annalen*, vol. 9, p. 39 (1834).

³Mohr, *Annalen*, vol. 29, p. 177 (1839); Starting, *Archiv. Pharm.*, vol. 231, p. 342 (1893); Loewe, *J. Prakt. Chem.*, vol. 108, p. 257 (1869); *U. S. Pharmacopoeia*, vol. 5 (1870).

⁴Scharling, *Am. J. Pharm.*, vol. 24, p. 236 (1852).

⁵Wöhler, *Annalen*, vol. 49, p. 245 (1844).

⁶*U. S. Dispensatory*, vol. 17, p. 33 (1894). This was Scheele's original method.

conditions has been patented.²⁰ The process is said to have been carried out abroad on a commercial scale.²¹

g. Chromic acid mixture. Toluene is oxidized in vapor form,²² or in the cold in the presence of iron, cerium or manganese compounds.²³

Manufacture by chlorination with subsequent hydrolysis has been the subject of much experimental work, and the literature abounds in references.²⁴ All three of the side-chain substituted compounds have been used.

Benzyl chloride, $C_6H_5CH_2Cl$, seems to be the starting material at present most generally used by American manufacturers. It is usually simultaneously hydrolyzed and oxidized with a warm slurry of bleaching powder. A number of variations of the procedure have been described. Thus Jessnitzer²⁵ heated benzyl chloride or a mixture of benzyl and benzal chlorides with lime and chalk. Savage and the Weston Chemical Co.²⁶ first reflux benzyl chloride with caustic soda or lime of milk and then oxidize with calcium or sodium hypochlorite. Leach²⁷ proposes heating with alkali and then passing in chlorine. Nitric acid may be used as oxidizing agent.²⁸

On hydrolyzing benzal chloride, $C_6H_5CHCl_2$, with alkali some benzoic acid is formed from the benzotrichloride present, and some also is formed secondarily from the simultaneous oxidation and reduction of two molecules of benzaldehyde. Considerable quantities of benzoic acid are obtained in this way as a byproduct in the manufacture of benzaldehyde.

Benzotrichloride, $C_6H_5CCl_3$, appears to be the starting material usually employed in German practice, and until recently in the United States as well; but at present the benzyl chloride method described above seems to be more generally used. The process of Schultze²⁹ has been widely employed. Benzotrichloride is decomposed with milk of lime in the presence of iron powder. Limpricht³⁰ hydrolyzed with water under pressure at 140 to 190 deg. This process was carried on commercially for a time.³¹ Espenscheid³² boiled with alkali containing solid matter to prevent the formation of two liquid layers. Janssen³³ has suggested the use of concentrated sulphuric or phosphoric acid in the cold. Jacobsen³⁴ prepared benzoyl chloride by heating with concentrated acetic acid and zinc chloride.

In the manufacture of saccharin considerable quantities of *m*- and *p*-sulphaminobenzoic acids are sometimes formed as byproducts. It has been proposed³⁵ to convert these compounds into benzoic acid by hydrolysis with superheated steam in acid solution.

FROM BENZONITRILE CONTAINED IN COAL TAR

The carbolic or creosote oil fraction of coal tar has been shown to contain a small amount of benzonitrile.³⁶

²⁰Monnet, Ger. Pats. 101,221, 107,722; Eng. Pat. 22,121 (1897); French Pat. 276,258; U. S. Pat. 613,460; Badische Anilin u. Soda Fabrik, Ger. Pat. 175,295.

²¹Raschig, *Chem. Zeit.*, vol. 24, p. 446 (1900).

²²Chem. Fabrik Buckau, Ger. Pat. 261,775.

²³Dieffenbach and Alefeld, Ger. Pat. 311,051.

²⁴For a description of processes of chlorinating toluene see Cain, "The Manufacture of Intermediate Products for Dyes," 1919, p. 15; Barnett, "Coal-Tar Dyes and Intermediates," 1919, p. 76.

²⁵Ger. Pat. 236,489.

²⁶Eng. Pat. 116,348 (1917).

²⁷Eng. Pat. 132,433 (1919).

²⁸Lunge and Petri, *Berichte*, vol. 10, p. 1275 (1875).

²⁹Ger. Pats. 82,927, 85,493.

³⁰*Annalen*, vol. 139, p. 324 (1866); Lubs and Clark, [*J. Am. Chem. Soc.*, vol. 40, p. 1449 (1918)] obtained complete hydrolysis at 100 deg. with agitation.

³¹Von Rad, *Dingler's Polytechn. J.*, vol. 231, p. 538 (1879).

³²Ger. Pat. Application 47,187.

³³Ger. Pat. 6,685; Eng. Pat. 889 (1879); French Pat. 129,220.

³⁴Ger. Pats. 11,494, 13,127; Eng. Pat. 2,878 (1880); French Pat. 137,419.

³⁵Fahlberg, Ger. Pat. 101,682; Eng. Pat. 10,955 (1895); French Pat. 247,894.

³⁶Kraemer and Spilker, *Berichte*, vol. 23, p. 78 (1890).

The manufacture of benzoic acid from this source by hydrolysis with alkali has been proposed.³⁷ The process was worked for a time at a plant near Vienna.³⁸

FROM NAPHTHALENE DERIVATIVES

Laurent and Castelraz³⁹ prepared benzoic acid commercially by distilling phthalic acid with lime about 1865. Laurent also manufactured benzoic acid from benzonitrile, prepared from phthalimide by heating with lime.⁴⁰ The Basler Chemische Fabrik has patented the production of benzoic acid from nitronaphthalene, nitronaphthols and phthalic acid by heating with alkali under pressure;⁴¹ also by fusing naphthols or other naphthalene derivatives with alkali.⁴² Gibbs and Conover state that benzoic acid is one of the products formed by the catalytic oxidation of naphthalene.⁴³

FROM PHENANTHRENE

The production of benzoic acid from phenanthrene by electrolytic oxidation has been proposed.⁴⁴

DISADVANTAGES OF THE PRESENT PROCESS

Although the details of the manufacture of benzoic acid are in general trade secrets, it is known that the difficulties of large-scale working are considerable. For example, chlorination at elevated temperatures (preferably with chlorine in the vapor phase), or in the presence of phosphorus or sulphur⁴⁵ chlorides, or in direct sunlight or ultra-violet light, must be resorted to in order to obtain the desired side-chain substituted compounds. Even then some compounds with chlorine in the ring are invariably formed.⁴⁶ Chlorination in sunlight or ultra-violet light is apparently the chief method in use in this country at present.

The sunlight process requires small glass units in order that the maximum reacting surface may be exposed to the light. The containers are expensive, fragile and a specially designed building is necessary, and production is dependent on the weather season. If ultra-violet light is used the units are larger, but expensive installations of quartz lamps are required; moreover, the yield is said to be not so good as with sunlight.

The process requires a large amount of chlorine, either in the form of gas or as bleaching powder. Although chlorine is a commodity for which new uses are being sought, its present cost is not low, and its purification, liquefaction, transportation and storage present problems which limit its usefulness. Moreover, this chlorine is largely converted into offensive waste products whose handling and disposition are accompanied by difficulties, particularly if bleaching powder is used.

The crude benzoic acid must be purified by sublimation, a difficult works operation. Even after purification the product is contaminated with appreciable amounts

³⁷Aktienges. f. Teer u. Erdoelindustrie, Ger. Pat. 109,122; French Pat. 287,934; Eng. Pat. 7,867 (1899).

³⁸Goldschmiedt, *Monatshefte f. Chem.*, vol. 28, p. 1091 (1907).

³⁹*Dingler's Polytechn. J.*, vol. 175, p. 455 (1865).

⁴⁰Frydlender, *loc. cit.*

⁴¹Ger. Pat. 136,410; Eng. Pat. 15,527 (1901); French Pat. 313,187; U. S. Pat. 702,171.

⁴²Ger. Pats. 138,790, 139,956, 140,999.

⁴³U. S. Pats. 1,284,888, 1,285,117; Eng. Pat. 119,518 (1917).

⁴⁴Farbwerke vorm. Meister Lucius u. Bruening, Ger. Pat. 152,063; U. S. Pat. 729,502; Eng. Pat. 19,178 (1902); French Pat. 328,069.

⁴⁵Kyrides, U. S. Pat. 1,345,373.

⁴⁶Lubs and Clark (*loc. cit.*) give analyses of commercial chlorinated toluene such as is used in benzoic acid manufacture, origin not stated, but presumably typical. Two samples contained 2.9 per cent and 2.4 per cent ring chlorine respectively, corresponding to a chlorination in the ring of 13.2 per cent and 9.4 per cent of the toluene molecules present.

of chlor-compounds,⁴⁷ which are highly undesirable from a physiological viewpoint. The U. S. Pharmacopœia requirements as to chlorine content are rather indefinite, but it is well known that many lots offered as "U.S.P." contain appreciable amounts of chlorine. Benzoic acid free from chlorine commands a substantial premium on the market.

It is clear that these difficulties are inherent in the chlorination process, and although they may be minimized it is not likely that they can be eliminated entirely. The direct oxidation processes appear attractive because of their simplicity, but in practice they have not proved successful, partly because of the expense of the oxidizing agents and partly because of the poor yields. The other processes enumerated are manifestly of little commercial value, except perhaps under certain unusual conditions.

POSSIBILITIES OF A NEW COMMERCIAL SYNTHESIS

None of the processes starting with benzene hitherto used or proposed show much likelihood of commercial applicability. The Friedel-Crafts reaction offers interesting possibilities, but, like many similar syntheses, must await a cheap supply of anhydrous aluminum chloride. The process using aniline under ordinary conditions is far too expensive. The chlorbenzene reaction would probably not give a chlorine-free product, even if good yields were obtainable, which is doubtful.

The use of sodium benzene sulphonate as the starting material, however, offers more promise. The manufacture of this salt has been the subject of intensive study during the last few years. The details have been worked out with great minuteness, and its production has been carried out on an enormous scale with great success.

There are two known reactions for the synthesis of benzoic acid from alkali benzene sulphonate. They give benzoic acid either (a) directly, on heating alkali benzene sulphonate with alkali formate, or (b) through the intermediate production of benzonitrile, on heating the alkali sulphonate with alkali cyanide.

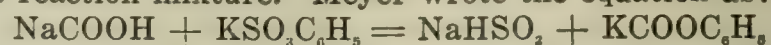
These reactions were first described respectively by Victor Meyer⁴⁸ in 1870 and by Merz⁴⁹ in 1868. Neither author gives many details as to conditions, yields, etc. Neither reaction seems to have received much attention since that date. The yields in both cases were apparently poor. In view, however, of the great improvement in yields resulting from the careful study of reaction conditions in the synthesis of phenol it was believed that a similar study might achieve considerable improvement in these reactions as well. The work which follows constitutes a record of this investigation and of the success obtained.

THE FORMATE FUSION METHOD

Although the reaction between potassium benzene sulphonate and sodium formate was first described by Meyer, the possibility of synthesizing the aromatic acid direct from the alkali sulphonate seems to have oc-

curred first to Merz.⁵⁰ In 1867 he heated a mixture of sodium benzene sulphonate and sodium carbonate to "over 400 deg." and isolated from the resultant charred mass a small quantity of material which exhibited many of the properties of benzoic acid. No later investigator makes any reference to this work of Merz.

Three years later Meyer mixed together equal parts of sodium formate and potassium benzene sulphonate, and heated the mass. Benzoic acid was recovered from the reaction mixture. Meyer wrote the equation as:



The yield was apparently small. He applied the method of synthesis to a number of other aromatic acids and used it to determine the position of the sulphonic acid groups in benzene disulphonic acid.

As a means of synthesizing the aromatic acids this method received some slight attention from later workers.⁵¹ However, because of the poor yields, better and less troublesome methods became generally employed and no reference to this reaction was found in the literature since 1886.

The work of Merz⁵² on fusion with sodium carbonate was repeated, following his directions as closely as possible. A charred mass resulted which contained no more than a possible trace of benzoic acid. Because of its inherent improbability no further attention was paid to this reaction.

Meyer's work⁵³ was next repeated with careful temperature control. A mixture of 50 g. sodium formate and 50 g. dry potassium benzene sulphonate was fused in an iron pot with constant stirring. Temperatures were measured with a base-metal thermocouple. No appreciable reaction took place below 290 deg.

The temperature of the melt was then raised to 300 deg. Vigorous foaming set in, accompanied by clouds of white smoke of pungent, disagreeable odor. The melt became viscous, semi-solid, and finally formed a dark brown cake. Heating was continued for fifteen minutes at 300 to 310 deg. The evolution of fumes having then almost ceased, the mass was cooled, dissolved in water, filtered to free from carbonaceous material, and acidified. A copious yellowish precipitate was formed, which after purification was identified as benzoic acid by the melting point of a sublimed sample, color reaction with ferric chloride, and odor on heating. Yield of crude benzoic acid was 3 g., or about 9 per cent of theory, based on the sodium benzene sulphonate used.

Meyer states in a footnote that sodium benzene sulphonate does not give this reaction. It seemed worth while to investigate this point. A run was made just as before, with the substitution of sodium benzene sulphonate for the potassium salt. At 350 deg. a reaction occurred as before. Benzoic acid was recovered from the reaction mixture. Yield, 2 g., or about 6 per cent of theoretical.

These experiments indicate that benzoate formation takes place only at a high temperature, and is accompanied by a great amount of decomposition. Benzoate formation takes place only at a relatively high temperature and is accompanied by a great amount of charring and the formation of decomposition products. Not only is the sulphonate charred and decomposed, but the sodium formate also breaks down above 290 deg.⁵⁴ It is prob-

⁴⁷Phillips and Gibbs [*J. Ind. Eng. Chem.*, vol. 12, p. 277 (1920)] give some data on crude benzoic acid and the losses accompanying its purification. Crude acid received from the manufacturer contained 7.57 per cent chlorine, calculated to a dry basis, of which 5.45 per cent was in the ring, corresponding to 23.9 per cent chlorobenzoic acid. The sublimed product contained up to 2.53 per cent Cl, although samples described as "very pure" containing 0.34 per cent Cl were obtained. Losses on sublimation ranged from 27 to 57 per cent of the acid originally present. These results were obtained in an investigation of a new method of sublimation and are not necessarily typical, yet they show how large the losses may become.

⁴⁸*Annalen*, vol. 156, p. 273 (1870).

⁴⁹*Zeitschr. f. Chem.*, vol. 11, p. 33 (1868).

⁵⁰*Zeitschr. f. Chem.*, vol. 10, p. 433 (1867).

⁵¹Bibliography of Formate Fusion Method follows.

⁵²*Berichte*, vol. 6, p. 876 (1873).

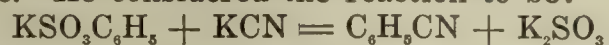
⁵³*Cf. Appendix Bibliography of the Formate Fusion Method.*

⁵⁴Merz and Weith, *Berichte*, vol. 15, p. 1507 (1882); Hoffman and Schibsted, *Berichte*, vol. 51, p. 139 (1918).

able that the disagreeable fumes evolved contain thiophenols and thio-ethers, since these products are readily formed by the interaction of sulphonates and reducing agents.⁵⁵ For these reasons it seems unlikely that the synthesis can have any practical value. The experiments are interesting, however, in that they show Meyer's observations on the behavior of the sodium salt to be in error. There is no appreciable difference in the reactivity of the sodium and the potassium salts other than that due to the higher temperature required to cause the former to react.

SYNTHESIS OF BENZONITRILE

Merz first distilled a mixture of equal parts of potassium benzene sulphonate and potassium cyanide from an iron retort and isolated benzonitrile from the oily distillate. He considered the reaction to be:



In addition to a yellowish red oil, ammonium carbonate and some ammonium cyanide collected in the receiver. The residue in the still contained carbon, potassium sulphide, potassium cyanate and potassium thiocyanate. The yield of benzoic acid formed from the nitrile on hydrolysis is given as 33 per cent, presumably based on the amount of potassium benzene sulphonate used.

Merz also applied this reaction to the synthesis of toluonitrile and naphthonitrile, and others have applied it to the synthesis of various aromatic and heterocyclic nitriles.⁵⁶ The yields in most cases were small, and the method has been quite generally abandoned in favor of the Sandmeyer reaction and others more suited to the organic laboratory. No one seems to have investigated the reaction carefully with a view to improving yields. Merz and Mühlhauser⁵⁷ described rather incompletely a few experiments in which the proportions of the components of the reaction mixture were varied. Witt⁵⁸ proposed the substitution of potassium ferrocyanide for the simple cyanide, claiming an increase in yield. Potassium ferrocyanide was used by a number of later workers in the synthesis of higher members of the series, and at least one laboratory manual⁵⁹ recommends its use. Tingle⁶⁰ in an investigation of various methods of synthesizing benzonitrile repeated Merz' work and obtained a yield of 26 per cent benzonitrile. Beyond these isolated instances the reaction seems to have received no study from its discovery to the present date.

OUTLINE OF EXPERIMENTAL WORK

A brief consideration of the reaction will show that the principal factors susceptible of variation are the temperature of the reaction, the pressure, and the composition of the reaction mixture. A series of runs was carried out in which the influence of each of these factors upon the yield of benzonitrile was determined. In most of these experiments sodium salts were used in place of potassium salts because of their greater importance from an economic point of view.

In addition, a study of the nature and quantity of the products of the reaction other than benzonitrile was made. The results obtained threw much light on the nature of the reaction and were of great practical importance, as they gave a basis for modification of the process whereby the yield was considerably increased.

In order to carry out under control a reaction of this sort an intimate mixing of the constituents and uniform heating of the mixture are essential. A closed steel vessel externally heated and provided with a delivery tube and stirrer was first tried. It was found, however, that the charge did not actually fuse, but only became pasty at the reaction temperature, whereupon the stirrer cut a channel for itself through the mass and became useless.

In the apparatus finally adopted the intimate contact required was obtained by mixing the materials beforehand, no stirring during distillation being attempted. Uniform and rapid heating was obtained by making the container relatively narrow and immersing it in a bath

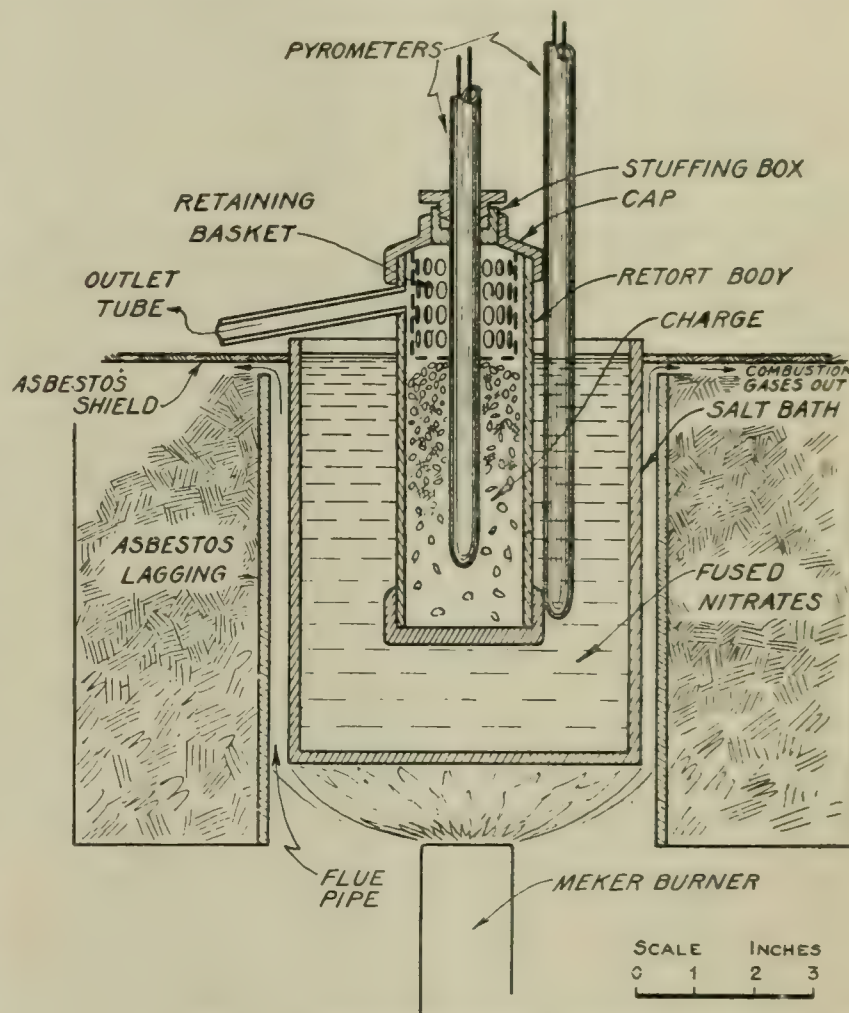


FIG. 1. EXPERIMENTAL RETORT

or fused salts. As the reaction is exothermic, this form of apparatus quite effectually minimized the undesired rise in temperature which would otherwise take place.

The apparatus is shown in Fig. 1. It was made for the most part of pipe fittings. The charge was contained in a vertical steel cylinder 2 in. in diameter and 6 in. long. The chamber was provided with a delivery tube 12 in. long inserted in the side near the top and inclined slightly downward. The chamber was closed by screw caps at top and bottom, a thermocouple passing through a stuffing box in the upper cap.

The salt bath, an equimolecular mixture of sodium and potassium nitrates, was contained in a steel pot 6 in. in diameter and 8 in. deep. The pot was set in a flue formed by a steel cylinder 7 in. in diameter and 9 in. long heavily lagged with asbestos magnesia pipe covering. Gas heating was employed. The temperature could be maintained within 3 to 5 deg. without difficulty, and with careful attention control within 2 deg. was possible, which was the least reading of the pyrometer.

The temperature of the system was measured by base-metal thermocouples and a calibrated millivoltmeter. One couple was immersed in the fused bath in contact with the retort a little below its center. The other was

⁵⁵Capelli, *Gazz. Chim. Ital.*, vol. 48, II, p. 109 (1918).

⁵⁶Bibliography follows. Cf. Appendix.

⁵⁷*Berichte*, vol. 3, p. 709 (1870).

⁵⁸*Berichte*, vol. 6, p. 448 (1873).

⁵⁹Orndorff, *Laboratory Manual of Organic Chemistry*, Exp. 65.

⁶⁰*Am. Chem. J.*, vol. 35, p. 87 (1906).

buried in the charge within the retort, the cold end projecting through the top cap. The cold ends of the thermocouples were maintained at a temperature close to that of the room, frequent measurements showing no variation greater than a degree or two. Hence no correction for this factor was required.

Normally the temperature within the retort during heating lagged behind that of the heating bath. When, however, the exothermic nature of the reaction was pronounced the inner temperature rose above that of the heating bath, as is shown by curves later on. Because of this discrepancy the outer temperature was taken as the criterion in all cases, the inner reading being used only as a check on the progress of the run.

The remainder of the apparatus was very simple. The delivery tube of the retort communicated with a large side-arm test tube in which the major portion of the liquid distillate collected. This receiver in turn was connected with an empty filter flask in which a small amount of distillate sometimes collected. When the evolved gases were examined they were collected over water in an 8-liter bottle. In the runs at reduced pressure the system was evacuated by a suction water pump.

MATERIALS AND GENERAL PROCEDURE

A high grade of commercial sodium cyanide, "sodium cyanide 96 to 98 per cent," was used. It was obtained in lump form, pulverized, and kept in stoppered bottles. Analysis after pulverizing showed a NaCN content of 94.19 per cent (by the Liebig method). This somewhat low figure is due at least in part to absorption of moisture, etc., during grinding.

The sodium benzene sulphonate was prepared from benzene by sulphonation, conversion into the calcium salt and careful conversion of the calcium salt to the sodium salt with sodium carbonate. The salt was powdered and dried at 120 deg. Its sodium benzene sulphonate content by the alcohol extraction method^a was 95.1 per cent.

The course of a run was generally as follows: The requisite amounts of cyanide and sulphonate were weighed out rapidly and transferred to a porcelain jar mill. Usually quantities of materials were chosen such that the total weight of the charge was about 180 g. The charge was then simultaneously ground and mixed by tumbling in the mill. After thorough mixing the contents of the mill was rapidly charged into the retort. The retort was then closed tightly, immersed in the salt bath, which had been brought to the proper temperature, and the pyrometers and collecting train adjusted. As soon as the outside temperature reached the desired point the log of the run was started.

Readings of temperatures, time, etc., were ordinarily taken every ten minutes. The heating flame was carefully adjusted to keep the outside temperature at the desired point. When no more distillate came over heating was discontinued, the distillate removed and treated as described hereafter, and the retort removed and opened. In some runs a portion of the charge was found unchanged in the upper cooler part of the retort, where it had been forced by the evolution of gases. In such cases the charge was removed from the retort, broken up, returned, and the run continued as before.

The experimental work on the formation of benzonitrile may be divided into two main parts:

- I. A detailed study of the products of the reaction.
- II. A study of the effect of variations in reaction conditions on the yield of benzonitrile.

THE PRODUCTS OF THE REACTION

The residue remaining in the retort was black, porous and friable, resembling soft coke. It was hygroscopic and usually had a slight odor of hydrogen sulphide. On treatment with water a black alkaline unfilterable liquid resulted, the color being due to colloidal carbonized material. The colloidal material was precipitated upon acidification or upon adding a salt of a heavy metal. The solution could then be filtered, and the filtrate was clear and colorless, or only slightly yellowish.

The analysis of this material presented many difficulties because of its complexity and because of its colloidal nature. Nevertheless satisfactory methods were finally devised. The results are believed to be quite as accurate as was consistent with the complex nature of the material and the manipulative difficulties of the analytical procedure. A brief description of the methods employed follows. Lack of space prevents discussion of many minor details of technique.

The residues contained, in addition to carbon, sodium carbonate, sulphate, sulphite, sulphide, thiocyanate and benzene sulphonate in varying proportions. Sulphate was determined gravimetrically on a portion after dissolving, acidifying, boiling vigorously and filtering out the insoluble carbonaceous matter. The latter was collected on a Gooch and weighed. To determine thiocyanate, a sample was dissolved in water, an excess of zinc sulphate added to precipitate sulphides, ferrocyanides and colloidal matter, the solution filtered, and the filtrate titrated with standard silver nitrate solution and ferric alum indicator after acidification.

Another portion of the sample was dissolved, treated with ammoniacal zinc sulphate, filtered, and sulphite determined in the filtrate iodometrically. The precipitate, containing the sulphide in the form of insoluble zinc sulphide, was transferred to an evolution flask, treated with hydrochloric acid, and the evolved hydrogen sulphide absorbed in ammoniacal cadmium chloride solution and determined iodometrically.

Cyanate was determined by hydrolyzing a sample with dilute acid (after the precipitation and removal of thiocyanate as the silver salt in acid solution) and determining the ammonia formed by distillation with alkali in the usual manner. To another sample a measured excess of standard acid was added, the solution filtered after an hour's standing, and the filtrate back titrated with alkali and methyl orange. From the data thus obtained the carbonate content was calculated, allowance being made for the acid consumed in hydrolyzing the cyanate and decomposing the sulphide present. Sodium benzene sulphonate was determined by extraction with alcohol after converting sodium cyanate and thiocyanate into the alcohol insoluble copper salts. Ferrocyanide when present was determined by the Williams method.^b

Data showing the composition of the residue under varying conditions are given later on, and an interpretation of these results is reserved for that time. It will be sufficient to point out now that reaction products of such complexity and deviating so widely from the composition expected from theory indicate that extensive side-reactions must occur during heating.

^aBoswell and Dickson, *J. Am. Chem. Soc.*, vol. 40, p. 1787 (1918).

^b*J. Soc. Chem. Ind.*, vol. 31, p. 468 (1912).

The oily distillate, which consisted mainly of benzonitrile, varied in color from a light greenish brown to a very dark brown, becoming darker and cloudy during the course of a run. It was found that a rapid and fairly clean separation of the benzonitrile from the higher boiling constituents of the oil could be effected by steam distillation. The two fractions thus obtained were examined separately.

The fraction volatile with steam accumulated during a number of runs was dried over calcium chloride. It had a pale straw color, the pleasant odor of benzonitrile, and density, $D_{15/15} = 1.021$ (Westphal). A 100-c.c. sample distilled from a 250-c.c. flask gave the distillation curves plotted in Fig. 2, thereby showing the liquid to be substantially benzonitrile.⁶³ In order to determine the nature of the other compounds present, the first and last portions of the distillate were examined separately.

The first few drops distilling over had a disagreeable odor resembling phenyl isocyanide. They were shaken with cold concentrated hydrochloric acid to hydrolyze any isocyanide present. The acid solution was separated from the oil, neutralized, and a few drops added to a bleaching powder solution. An intense violet-red coloration resulted, indicating the presence of aniline, formed by the hydrolysis of phenyl isocyanide.

The presence of phenyl isocyanide (b.p. 165 deg.) is not surprising, as it is known that the normal and isocyanide exist together in equilibrium at elevated temperatures.⁶⁴ Alkyl cyanides prepared by distilling alkyl sulphates with alkali cyanides are always accompanied by a small amount of the isocyanide. Phenyl isocyanate (b.p. 166 deg.) has an odor similar to phenyl isocyanide and on hydrolysis would also give a test for aniline, but the density of the first 10 c.c. distilling (1.000) indicated the presence of phenyl isocyanate ($D_{15/15} 0.9775$) rather than the isocyanate ($D_{15/15} 1.092$).

The last portion was light yellow in color and deposited white crystals in the condenser and receiver. It had the odor and appearance of the first fraction obtained on distilling the oil non-volatile with steam. The crystals were identical with those separating from that fraction (gave same m.p., and m.p. of mixture was not lowered). The oil had the unmistakable odor of diphenylsulphide, the principal component of the fraction non-volatile with steam.

THE FRACTION NON-VOLATILE WITH STEAM

The residues from the steam distillation of the crude distillate were set aside. On standing a quantity of crystalline material separated out. The supernatant oil was poured off and the crystals retained for further examination. The oil was of a reddish brown color and had a rather pleasant sweet odor, density after drying over calcium chloride about 1.12. The upper curve, Fig. 2, was obtained on fractionating 133 g. of the dried oil from a 500-c.c. flask. All fractions of the distillate had the highly unpleasant odor associated with compounds of the thio-ether type.

The first and last portions of the distillate were cooled to -5 deg. and filtered to remove the white crystals which separated out. The crystals were washed with cold alcohol and reserved for further examination. The

filtrates and middle fractions of the distillates were combined and refracted twice. Ten c.c. of a yellow liquid of unpleasant leek-like odor, b.p. 294 to 297, $D_{15/15} = 1.114$, was obtained.⁶⁵ Identification as diphenylsulphide was completed by oxidizing a portion to diphenylsulphone (m.p. 125 deg.) by the method of Stenhouse.⁶⁶

The crystals separating from the crude oil on standing were washed with cold alcohol and recrystallized several times from benzene. From 4 g. of the original residue about 2 g. of a substance having the following properties was finally obtained: difficultly soluble in hot

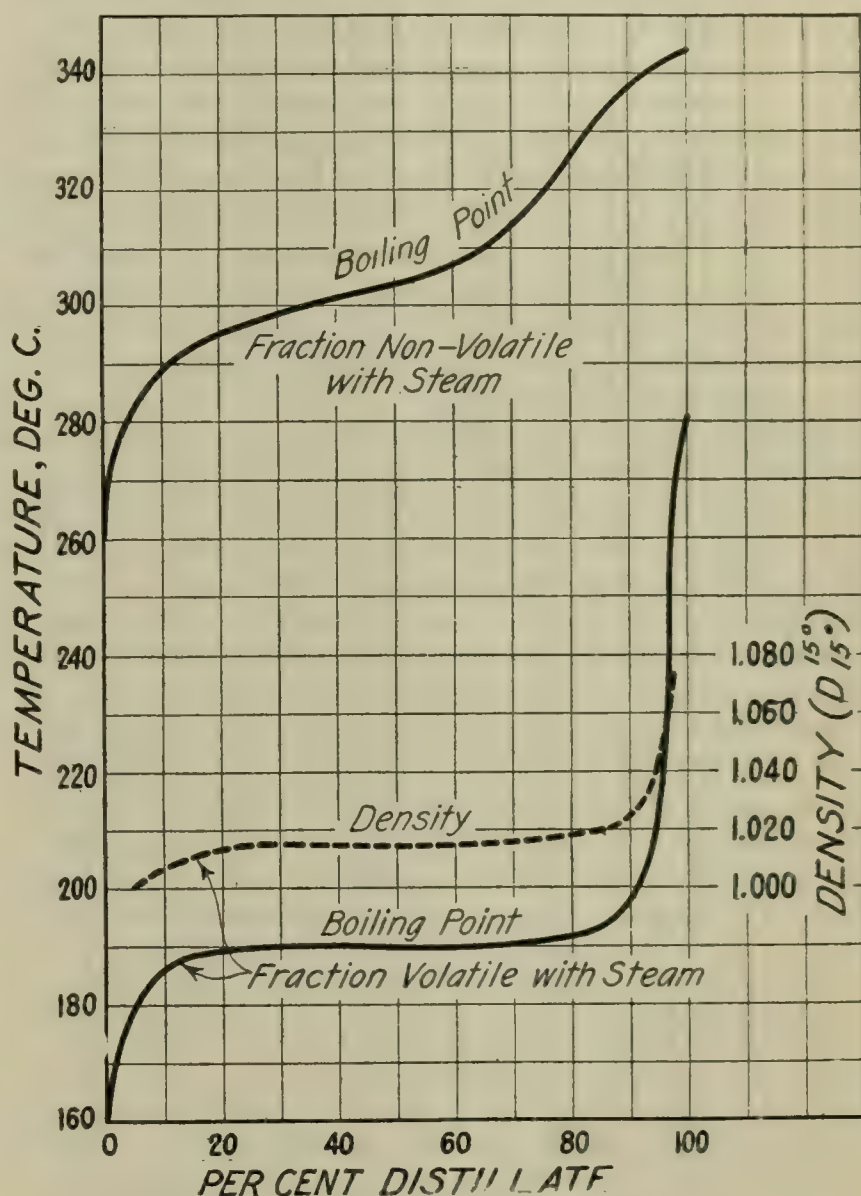


FIG. 2. DISTILLATION CURVES

alcohol, moderately soluble in cold and very soluble in hot benzene, crystallizing in hemispherical masses of white crystals, m.p. 158 deg. These properties⁶⁷ correspond closely to those of diphenylene disulphide ($C_6H_5)_2S_2$. Lack of material prevented more complete identification. The crystals separating from the high-boiling fraction of the oil non-volatile with steam were also found to be diphenylene disulphide.

About 1 g. of crystalline material separated from the low-boiling fraction of the oil non-volatile with steam. After several recrystallizations from alcohol about 0.5 g. of short white needles, sparingly soluble in cold and very soluble in hot alcohol, soluble in benzene, m.p. 177 to 180 deg., was obtained. Lack of material prevented further identification.

To sum up: In addition to benzonitrile the following substances were isolated from the oily distillate: phenyl

⁶³ $D_{15/15}$ for benzonitrile = 1.0102 [Schneider, *Z. Physik. Chem.*, vol. 19, p. 157 (1896)]; b.p. 760 mm.: 190.7 deg. (Schneider); 191.3 deg. [Timmerman, *Bull. Soc. Chim. Belg.*, vol. 24, p. 244 (1910); *Chem. Centralbl.* (1900) II, p. 442].

⁶⁴Hoffman, *Annalen*, vol. 144, p. 114 (1867); Weith, *Berichte*, vol. 6, p. 213 (1873).

⁶⁵B.p. of diphenylsulphide 296.5 deg., $D_{15/15} = 1.1185$ [Perkin, *J. Chem. Soc.*, vol. 69, p. 1243 (1896)].

⁶⁶*Annalen*, vol. 140, p. 290 (1866).

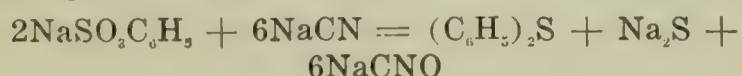
⁶⁷Stenhouse, *Annalen*, vol. 140, p. 284 (1866); vol. 149, p. 247 (1869).

isocyanide; diphenylsulphide; solid, m.p. 177 to 180 deg., slightly volatile with steam; solid, m.p. 158 deg., b.p. over 300 deg., apparently diphenylene disulphide.

It might be well at this point to consider the source of some of these byproducts. The significance of phenyl isocyanide has already been discussed. Compounds of the thio-ether and thiophenol type are common products of the thermal decomposition of aromatic sulphonates. Stenhouse⁶⁸ isolated diphenylsulphide and diphenylene disulphide as well as thiophenol from the products of dry distillation of sodium benzene sulphonate. It is interesting to note, however, that he obtained considerable diphenylsulphide on distilling from a copper vessel, and considerable thiophenol, but little or no diphenylsulphide when an iron container was used. In the present experiments, though an iron vessel was employed, considerable diphenylsulphide was obtained. The isolation of thiophenol from the first fraction of the steam distillate was attempted, a portion being treated with alcoholic mercuric chloride after the usual method.⁶⁹ The result was negative. On applying the color test for thiophenol a few drops of the fraction gave only a faint coloration with concentrated sulphuric acid on long standing. Accordingly it is evident that the mechanism by which diphenylsulphide forms on distilling a mixture of sodium benzene sulphonate and sodium cyanide differs essentially from that by which sodium benzene sulphonate alone decomposes on heating.

This is also indicated by the temperatures at which the two reactions take place. It was found that sodium benzene sulphonate alone can be held at the temperature of these experiments (410 to 440 deg.) indefinitely without decomposition. Only on heating above its melting point (450 deg.) does decomposition take place. The presence of sodium cyanide and of the products of the benzonitrile reaction seems to be responsible, at least in part, for the formation of sulphur compounds. The following are possible, perhaps even probable, reactions by which diphenylsulphide might be formed.

The cyanide might well act as a reducing agent.



More sulphonate might react with the sodium sulphide thus formed:



Although the latter reaction has never been described, it would be in keeping with the behavior of the benzene sulphonates. Thus Spring and Krafft⁷⁰ prepared diphenylsulphide by the distillation of a mixture of sodium benzene sulphonate and phosphorus pentasulphide. Stadler⁷¹ distilled sodium benzene sulphonate with potassium sulphhydrate and obtained thiophenol.

THE GASEOUS PRODUCTS

A large volume of gas was always evolved during distillation, a part of which condensed in the cooler portion of the receiver to form a sublimate of solid ammonium salts. The following compounds were identified in the gases evolved: ammonia, carbon dioxide, hydrogen sulphide, hydrocyanic acid, water.

In order to determine the composition of the gas quantitatively a run was made in which it was collected over a large volume of water, in which the greater

TABLE I. ANALYSIS OF EVOLVED GASES	
Temperature 430°. Ratio cyanide: sulphonate:: 1: 3.00 by weight.	
	Per Cent by Weight
NH ₃	27.4
CO ₂	71.3
H ₂ S	0.2
HCN	1.1
	100.0

part was soluble. The solution thus obtained and the gas over it were then analyzed for NH₃, CO₂, H₂S and HCN. The water content of the gas could not be readily obtained. The results, expressed in per cent by weight, are given in Table I.

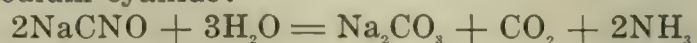
SUMMARY AND DISCUSSION

It is evident from these experimental results that the formation of benzonitrile is accompanied by extensive side-reactions which give rise to a great variety of byproducts. These byproducts give some clue to the processes involved, which are obviously complex, but probably belong to two groups—namely, those due to the reducing action of sodium cyanide, and those due to the thermal decomposition of the organic compounds present.

The reducing power of cyanides at high temperatures is well known. This reducing action would result in the formation of diphenylsulphide according to the reactions already given. In this connection it is interesting to note that no sodium cyanide remained in the residue from the retort, even when a large excess was originally present.

The pyrogenic decomposition of sodium benzene sulphonate would result in the formation of water, hydrogen sulphide, carbon, and sodium carbonate or sulphide. It is true that pure sodium benzene sulphonate does not decompose appreciably at the temperature of the reaction, but Stenhouse has shown that different substances catalyze this decomposition in different ways, and it may well be that some of the other materials present exert a catalytic effect.

If water vapor were formed in this manner it would react immediately with the sodium cyanate formed from the sodium cyanide:



This would account for the fact that large quantities of sodium carbonate, but only small amounts of sodium cyanate, were usually found in residue.

To sum up: In addition to the main reaction in which benzonitrile is formed, side reactions of two general types occur: (a) reduction of the sodium benzene sulphonate by the sodium cyanide, and (b) pyrogenic decomposition with the decomposition of the sodium cyanate formed in (a) and the consequent liberation of ammonia.

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Part II will be published in a subsequent issue.

Peruvian Copper Production for Four Years

The monthly production of copper by the Cerro de Pasco Copper Corporation of Cerro de Pasco, Peru, for the past four years was as follows: 72,675,032 lb. in 1917; 81,906,000 lb. in 1918; 58,124,000 lb. in 1919; 63,128,000 lb. in 1920. According to the foregoing figures, the production of copper in 1920 showed an increase of 5,004,000 lb. as compared with 1919. The production in 1920, however, was 18,778,000 lb. less than in 1918 and 9,547,032 lb. less than in 1917.

⁶⁸Loc. cit. See also Capelli, *Gazz. Chim. Ital.*, vol. 48, II, p. 109 (1918).

⁶⁹Capelli, loc. cit.

⁷⁰Berichte, vol. 7, p. 385 (1874).

⁷¹Berichte, vol. 17, p. 2080 (1884).

The Vapor Compression System of Evaporation

Description of the Autovapor Type of Evaporator Recently Introduced Into Practice in Europe—Comparison With Multiple Effect Evaporators Heated by Primary Heat, in Favor of New Design

By GUSTAV CARLSSON

Chemical Engineer, Brooklyn, N. Y.

BEFORE describing the vapor compression system of evaporation, the first great advance made in the evaporation of liquids might well be mentioned. Pecqueur in 1834 invented the multiple effect system, which resulted in an enormous saving for many industries in concentrating their products from aqueous solutions. The sugar industry adopted it, and as a matter of fact the improvements since that time are very closely connected with the development of that industry. Modern evaporators bear little resemblance to the original apparatus. As time went on other chemical industries have introduced multiple effect evaporators to concentrate the liquors containing valuable products in solutions.

Although multiple effect evaporation in the past has been one of the most important processes in the chemical industries, its weak points from an economical as well as a technical point of view must not be overlooked. In order to produce the necessary steam to operate it, fuel must be consumed. The cost of evaporation depends upon the price of this indispensable fuel. In order to utilize the heat at all economically several units must be put in series. With two units in series, we are able theoretically to evaporate 2 lb. of water per pound of steam, in a triple effect 3 lb. per

Switzerland began manufacturing evaporators which are sold under the trade name of "Autovapor." They have been in use in a great number of plants in Europe. The results of operation indicate that it has some important advantages and that it will probably have continued and successful development in the chemical industry. To a large extent its progress is due to the development of the high-speed compressor, by which the problem of compressing the vapors has been solved in a very satisfactory manner.

In evaporating 1 lb. of water at 212 deg. F. and atmospheric pressure, about 970 B.t.u. is used, or practically one-tenth of the heat obtained from 1 lb. of coal. Instead of conducting the water vapor to the atmosphere, where it will be lost in space, we may compress it to about 3 atm., raising the temperature correspondingly to about 271 deg. F., and have useful energy available. The heat energy of the vapor has the energy of the work of compression added to it and if the compressed vapor is passed through a coil submerged in the liquor being evaporated, the vapor will condense, delivering its latent heat, whereupon more water will be evaporated from the liquor. Continuous evaporation is obtained by the addition of the mechanical energy required for compression.

Lines of Design of Apparatus

The liquid to be evaporated is placed in the evaporator, Fig. 1, and is heated to the boiling point by the steam coil 2. As soon as boiling has begun, the steam feed to the coil is cut down and the water vapor is drawn from 1 by pump 6, driven by the electric motor 15 and compressed through pipe 7 into coil 8. The compressed vapor condenses in the coils and delivers its heat of condensation and superheat, which from that time maintains ebullition in the evaporator. The condensate is discharged through pipe 9 into preheater 10, preheating the liquid charge entering the evaporator through coil 12 and the pipe 13, and then is emptied through pipe 14. The electric motor driving pump 6 consumes but a fractional part of the heat energy equivalent for evaporation. The evaporation of 1 lb. of water at atmospheric pressure requires about 970 B.t.u. To increase the pressure from 1 to 3 atm. and at the same time increase the temperature to about 271 deg. F., an amount of energy equivalent to 106 B.t.u. is required, measured at the shaft of the pump with the efficiency taken into account. This 106 B.t.u. is equivalent to slightly more than 10 per cent of the heat energy flowing through the pump and used in the evaporation. The best results are obtained with dilute solutions. When dealing with concentrated solutions, conditions are not so favorable, because the boiling points of the solutions are higher than those of the solvents.

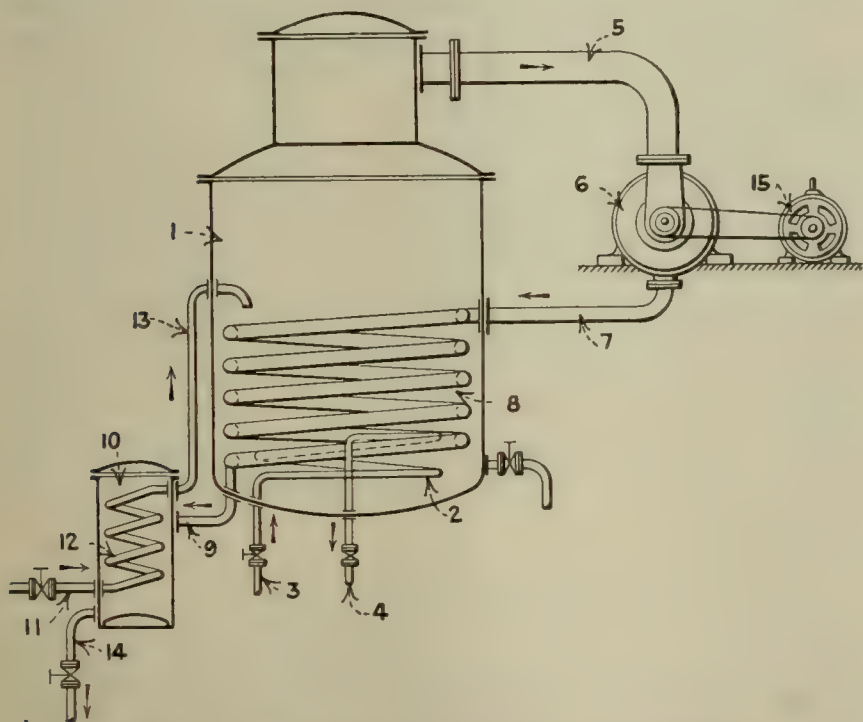


FIG. 1. SKETCH OF AUTOVAPOR SYSTEM

pound of steam, and so forth. In practice these figures of course do not hold, being 1.2 and 2 instead of 2 and 3, with apparatus having a capacity of 2,200 lb. of water evaporated per hour.

Many suggestions on new evaporation methods have been made and tried during recent years, but all of them have failed until quite recently. In 1918 a firm in

One of the earliest types of Simplex-Autovapors—i.e., with single boiling pan and used in concentrating sodium hydroxide liquor—was thoroughly controlled by Prof. Stodola at the Institute of Technology in Zürich, Switzerland. The apparatus had been running for 1½ months and had not been cleaned prior to the test. The capacity was 2,200 lb. of water evaporated per hour. He stated the efficiency to be 36.2 to 37.7 lb. of water evaporated per kw.-hr., the liquid being concentrated from 7 deg. to 23 deg. Bé. This means that although the concentration was considerable, the evaporation is from 11.2 to 11.7 times that obtained by direct conversion of the electric current consumed into heat.

This result is particularly interesting because the apparatus was not thoroughly insulated against heat losses. The temperature of the feed liquor was about 68 deg. F. and the temperature of the condensate when leaving the system was 176 deg. F. Using a preheater, much better results should be obtained. The capacity of the apparatus was about 2,200 lb. of water evaporated per hour, consuming about 50 kw.-hr. In spite of the high concentration of the liquor, the condensate was very pure, containing but 0.002 g. NaOH per liter. This indicates that with this type of equipment distilled water is obtained with a degree of purity which an ordinary evaporator cannot deliver.

The arrangement of a small installation with a capacity of 2,200 lb. of water evaporated per hour is shown in Fig. 2.

In order to reduce heat losses, the different units

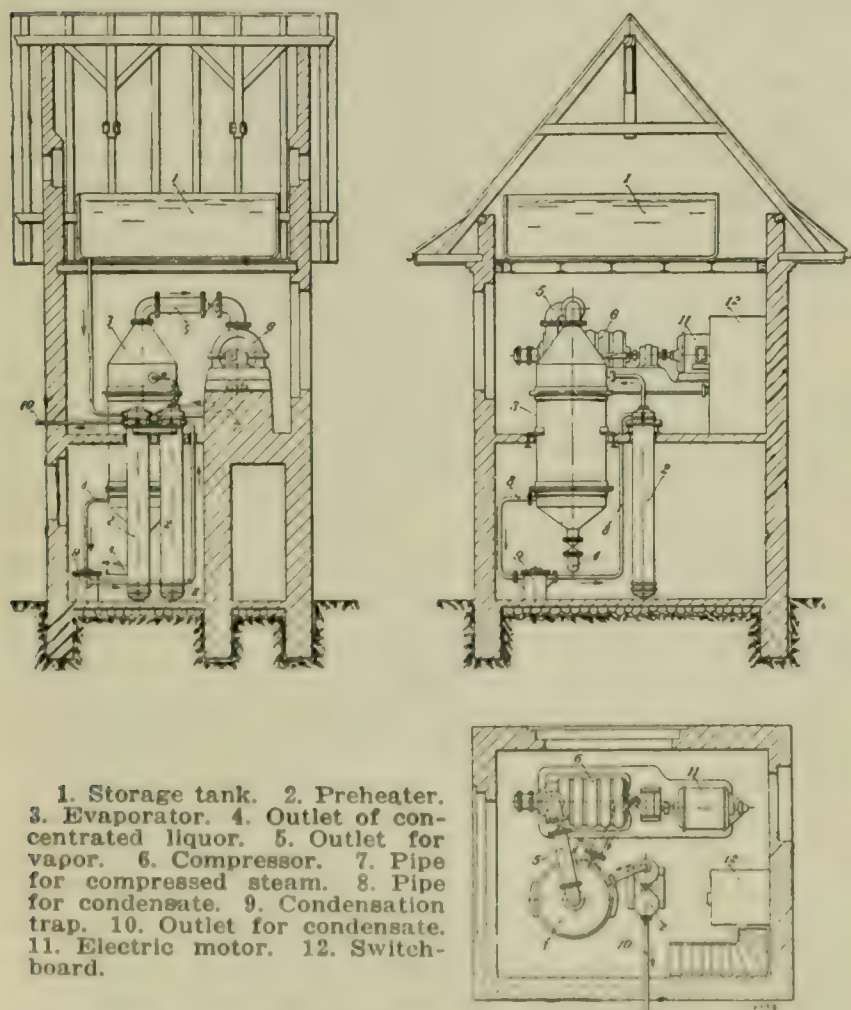


FIG. 2. SKETCH OF A PLANT INSTALLATION

of the apparatus are built closely together and the compressor and the motor are in the same room, because no corroding fumes were evolved there.

Among installations that have been erected for chemical purposes, some are used for concentrating sodium sulphite liquor containing more than 80 per cent water. The concentrated liquor is used as a binder for coal

briquets, as a leather-filling substance, in producing alcohol, and so forth. This liquor is particularly adaptable, as the rise of the boiling point is small with increase of concentration, amounting to only from 5 to 8 deg. F. due to the high molecular weight of the dissolved substances. Most liquids that are evaporated, however, have much higher increments in their boil-

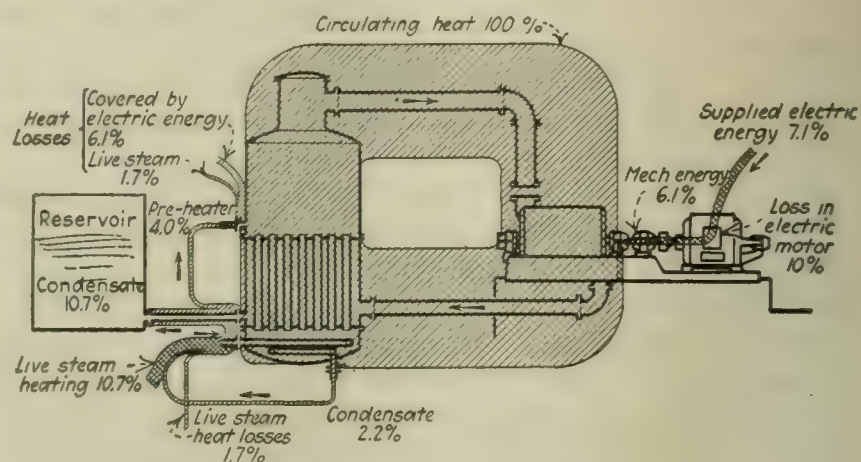


FIG. 3. ENERGY DIAGRAM

ing point upon concentration, sodium hydroxide liquor being about 32 deg. F., saturated common salt solutions 16 deg. F. These increments of boiling temperature upon concentration must be taken into account when calculating the degree of compression of the vapor so that the increase in the temperature of the compressed vapor under the operation will compensate for the rise of the boiling point. In addition a temperature difference has to be established between the compressed vapor in the coil and the liquid to obtain a sufficient rate of heat transmission.

In the dye industry also apparatus mostly of the Simplex type have been installed, evaporating from 35.3 to 38.6 lb. of water per kw.-hr. continuously and they have in long runs produced liquor of 34 deg. Bé. It was necessary due to acid fumes to install the motor and the compressor in separate rooms. The capacity is about 2,760 lb. and the efficiency 35.3 to 39.8 lb. of water evaporated per kw.-hr. The liquid is evaporated to the same viscosity as sirup.

Returning to the test made by Prof. Stodola, the following data were obtained:

The rise in the boiling point was from 3.6 deg. to 12.6 deg. F. During a 5-hr. run 11,590 lb. of water was evaporated from the liquor, using 271.41 kw.-hr. to run the compressor and in addition 1,598 lb. of steam. The rate per hour gives: 2,320 lb. of water evaporated, using 54.28 kw.-hr. and 320 lb. of steam, or 42.6 lb. of water, evaporated per hour, neglecting the steam, and 37.7 lb., considering the steam used, respectively.

ENERGY CONSUMPTION

Fig. 3 shows the results diagrammatically. As a matter of fact, in the preheater only 4.0 per cent of the heat was recovered, while at the same time 10.7 per cent was removed by the condensate. In this case, however, the preheater was not enlarged, as the 10.7 per cent of heat in the hot condensate available could be used in other departments of the plant. As a result we might see that of the 12.4 per cent of steam added only 1.7 per cent has to be considered as a real loss due to insufficient heat insulation. We may now state that the test gave the following results: Using 271.41 kw.-hr. and 1,598 lb. of steam, 11,590 lb. of water was

evaporated from the liquor and in addition 13,235 lb. of distilled water was obtained at a temperature of 176 deg. F.

How to utilize the heat of the condensate has to be determined in each particular case. Being very pure, it may be used directly in the manufacturing process. In other cases an efficient preheater may be installed, and no doubt will pay for its investment. Summarily it may be seen that even such a small apparatus can be run economically.

Regarding the construction details of this evaporator, the following is quoted from the English patent: "The evaporator has vertical heating channels formed by annular hollow heating bodies, arranged concentrically one within the other. The channels are provided with scrapers, which extend from above and operate in a resilient manner on the vertical walls. The scrapers are of clamp shape, removable and mounted on a horizontal beam, which is rotated about a vertical axis."

COMPARISON WITH EFFECT TYPES

The following figures are given for purposes of comparison of this method with a multiple effect system, based upon the results stated above and with a capacity of 2,200 lb. per hour. With a triple effect evaporator of this capacity 2 lb. of water may be evaporated per lb. of steam:

a. Using a vapor compression system evaporator, driven by electrical energy: Evaporating 2,200 of water, 51.6 kw.-hr. is necessary. Referring to previously stated results to cover heat losses: $\frac{1.7 \times 305}{12.4} = 41.7$ lb. of steam is necessary. Assuming 8.5 lb. of steam per pound of coal, this corresponds to $\frac{41.7}{8.5} = 4.92$ lb. of coal.

b. Using a triple effect evaporator: The following quantity of coal will be necessary: $\frac{2200}{2 \times 8.5} = 129.8$ lb. Assuming the running of the condensate pump requires 8 hp., the efficiency of which is 70 per cent, we get $\frac{8 \times 2545}{0.7 \times 9800} = 2.92$ lb. of coal. Total, 132.73 lb. of coal. On the one hand we have 51.6 kw.-hr. and 4.92 lb. of coal. On the other hand 132.73 lb. of coal.

The significance of these figures for one year's run for plants having access to water power may be realized upon the following calculation, assuming coal cost at \$10 per 2,000 lb. and the price per kw.-yr. at \$30:

		Total Cost
a.	51.6 kw.-yr. @ \$30.....	\$1,548
	21.5 tons of coal @ \$10.....	215
		\$1,763
b.	580 tons of coal @ \$10.....	5,800
	Saving by a vs. b.....	\$4,037

Using coal to produce the electrical energy, the vapor compression evaporator will prove its superiority to a triple-effect apparatus where byproduct steam is not available. Assuming a large steam turbine power station 1 kw.-hr. may be obtained with 10 lb. of steam and we get:

a. Compression Evaporator:

$$\frac{51.6 \times 10}{8.5} = 60.8 \text{ lb. of coal to run the compressor.}$$

$$\text{Total: } \frac{4.92 \text{ lb. of coal for addition steam}}{65.72 \text{ lb. of coal}}$$

In other words, 33.6 lb. of water evaporated per lb. of coal.

b. 1. Triple effect evaporator:

$$2 \times 8.5 = 17 \text{ lb. of water evaporated per lb. of coal.}$$

2. Quadruple effect evaporator:

$$3 \times 8.5 = 25.5 \text{ lb. of water evaporated per lb. of coal.}$$

The new system is thus superior even to a quadruple effect evaporator. In other words, the coals might in this case be better utilized in a power station than in direct heating.

More important, however, is the case when coal is used to produce high-pressure steam utilized in a power station, the exhaust steam being used for heating purposes. In this case we may substitute the necessary power for the corresponding heat energy, the mechanical efficiency of the motor taken into account. The thermal losses in compression increase the heat of vapors and are utilized in the system.

1. For 2,200 lb. of water evaporated per hour and requiring 51.6 kw.-hr. we use:

$$\frac{51.6 \times 3420}{9800} = 18.2 \text{ lb. of coal}$$

$$4.95 \text{ lb. of coal}$$

$$\text{Total: } 23.15 \text{ lb. of coal}$$

This gives an evaporation of 95 lb. of water per lb. of coal, being a very high efficiency.

2. On the other hand, using a high-pressure quadruple-effect evaporator, the efficiency of which is 3 lb. of water evaporated per pound of steam, we have:

$$\frac{2200}{8.5 \times 3} = 86.5 \text{ lb. of coal minus about 442 lb. of}$$

exhaust steam, corresponding to $\frac{442}{8.5} = 51.8$ lb. of coal, the difference being 34.7 lb. of coal per 2,200 lb. of water evaporated, or $\frac{2200}{34.7} = 63.7$ lb. of water evaporated per pound of coal.

From these calculations it is seen that the vapor compression system of evaporation is an economical one. In addition it has the advantage that the boiling point of the liquor may be regulated as is best in each particular case, although the high-pressure steam status is utilized, the evaporators running either under vacuum or high pressure.

It might be emphasized that all calculations given herewith are based upon the investigations by Prof. Stodola and are performed with a small installation. At greater capacities the efficiency of the compression should be greatly increased. Evaporating 2,200 lb. of water per hour, the efficiency was shown to be 19.3 lb. per kw.-hr., but having a capacity of 40,000 lb. per hour, the efficiency has proved to be 59.2 lb. of water evaporated per kw.-hr. As a matter of fact, dealing with solutions similar to water, the efficiency has proved to be 84 lb.

The construction of the vapor compression system evaporator may be varied according to the cost of the available electrical energy so as to get the most economical operation. Power being cheap, the compression may be high in order to decrease the heating surfaces. On the other hand, with high-priced electricity, it is possible to diminish the necessary power by using evaporators having larger heating surfaces.

Dr. C. L. Alsberg Director of Stanford University Food Research Institute

DESPITE the fact that an adequate food supply for armies and for civilian populations always has been recognized as one of the vital factors in war, the Allied nations and the United States plunged into the late struggle without a vestige of preparation in that particular. There were no data, either statistical or historical. The food administrators had to work under the greatest handicaps, because no one ever had studied or had gathered information as to mass feeding. When Herbert Hoover met with the Allied food administrators during the war they each agreed to do all possible toward securing a systematic study of this problem so that it might be available in case of another emergency. Millions had been spent in studying ordnance, tactics and transportation, but Germany was the only country which had given any attention to the equally important matter of using food resources in a way that would help win a war.

When the war was over Mr. Hoover did not forget his promise to the other food administrators. He found that there was no prospect for the Government to take up at that time a work of that character, so he went to the Carnegie Corporation and interested it in financing such an undertaking. Then he went to the trustees of Stanford University and secured their promise of co-operation. As a result the Food Research Institute of Stanford University has been created and Dr. Carl Lucas Alsberg has been selected as one of its directors. There are to be two other directors. Pains-taking care is being taken in the selection of these men. Mr. Hoover regards the work as essential to the national defense as is the furnishing of munitions to the Army or fuel to the Navy. Armies travel on their bellies, and doubly so do the civilian populations which stand behind those armies. The excitement at the front may relegate to a secondary importance an irregular or an inadequate food supply. In a battle-swept area or in a center of mobilization all are aware of the difficulties attendant upon food supply and irregularities are discounted. Not so in industrial centers far from the fighting line. With nothing spectacular or exciting to vary the monotony of the day's drudgery, irregularities in food have even a more important bearing on morale.

To produce food in sufficient quantities and to distribute it in a manner insuring the maximum of effective use was one of the great war problems which

brought strikingly to the attention of the various nations the necessity for a study of the food problem as a whole. America is taking the initial step in this direction with the establishment of the Food Research Institute, none of the Allied countries having found the time as yet to start work along these lines. Holland, having seen the necessity, already has acted and has a study of this character well under headway.

The study in the United States is to be divided into three groups, each under the immediate charge of a director. One of the directors will be chosen for his qualifications to handle the economic and statistical features of the work. Another will supervise the activities pertaining to human nutrition, while the third will look after the industrial side of the question. It is this last angle of the work to which Dr. Alsberg

has been assigned. No announcement has been made as to those who are being considered for the remaining directorships.

The Carnegie Corporation has agreed to finance the work for a period of from seven to ten years. The scale on which it is to be undertaken will be determined after three years. Great care will be exercised not to duplicate either work or equipment. Very general co-operation with existing laboratories is expected.

Dr. Alsberg plans to continue his work as chief of the Bureau of Chemistry of the United States Department of Agriculture until July 1. It probably will be Oct. 1 before he will be able to give his full time to his new duties.

Dr. Alsberg was born in New York City April 2, 1877. He was prepared for college by tutors and at preparatory schools, and entered Columbia College in 1892, receiving his A.B. in

1896. He then entered the medical department of Columbia University and received the degree of M.D. in 1900. In the same year he received his A.M. from Columbia University. While studying medicine he devoted considerable time to research with Dr. P. A. Levene, now chief of the chemical department of the Rockefeller Institute for Medical Research. In 1900 he did advanced work at the University of Strassburg in physiological chemistry, medicine and pharmacology. Later he worked in Berlin with Emil Fischer.

Late in 1902 Dr. Alsberg was appointed assistant in physiological chemistry at the Harvard Medical School. In 1905 he was made the head of the department. In 1908 he resigned to accept the position of chemical biologist in charge of the poisonous plant laboratory of the Bureau of Plant Industry. On Dec. 16, 1912, he succeeded Dr. Harvey W. Wiley as Chief of the Bureau of Chemistry.



Photo by Edmonston, Washington, D. C.

DR. CARL L. ALSBERG

Miscellaneous Alloys of Nickel

Principal Data on Binary Alloy Systems With Nickel as One Constituent — Use of Nickel in Bronzes and Light Aluminum Alloys—Composition and Electrical Characteristics of Many Special Resistance Alloys—Analyses of Complex Alloys for Various Minor Uses

By PAUL D. MERICA
Superintendent of Research, International Nickel Co.

EQUILIBRIUM OF BINARY ALLOYS OF NICKEL

THE constitution of most of the important binary alloy series with nickel has been investigated fairly completely and the principal results of the investigations of the systems forming one or more compounds are given in tabular form in Table I. It is observed that nickel has a strong tendency to form solid solutions with other metals, either of limited compositions or in all proportions. Structurally speaking, it is perhaps mainly for this reason that the metal forms a constituent of so many commercially useful ferrous and non-ferrous alloys. Thus nickel and any one of the following metals are soluble in all proportions in the solid state: Chromium, cobalt, copper, iron, manganese, palladium and platinum. A 60:40 nickel:chromium alloy has the minimum melting point of that series at 1,290 deg. C.; a 70:30 nickel:iron alloy melts at 1,425 deg. C., the minimum for that series, and correspondingly, a 44:56 nickel:manganese alloy melts at 1,000 deg. C.

Gold and nickel form a simple eutectiferous series; the eutectic analyzes 27 per cent Ni and melts at 950 deg. C., and is composed of two conjugate solid solutions containing approximately 16 per cent gold and 6 per cent nickel respectively.

Table II gives the principal data concerning three binary systems having limited solubility in the liquid state.

ACID-RESISTING ALLOYS

Many nickel alloys display an even greater resistance to acid corrosion than nickel itself. The acid-resisting properties of Monel metal have already been noted by the author in CHEMICAL AND METALLURGICAL ENGINEERING, vol. 24, p. 291 (Feb. 16, 1921). It may be re-

membered that Monel metal does not resist the action of nitric acid.

Chromium:nickel alloys are acid-resisting and are used for dipping baskets and other articles exposed to acid corrosion. The following results of tests communicated by the Driver-Harris Co. indicate the degree of

TABLE II. BINARY ALLOYS OF NICKEL HAVING LIMITED MISCIBILITY IN THE LIQUID STATE

Nickel and	Temperature of Beginning Melting		Solubility in Solid State	
	Temperature Deg. C.	Composition per Cent Ni	Second Constituent in Nickel per Cent	Ni in Second Constituent per Cent
Lead.....	326	97-0	3	0.7
Silver.....	961	100-0	..	..
Thallium.....	320	97-0	3	0

resistance to acid corrosion afforded by the composition used for Ni-chrome castings. The samples, of 125 g. weight, were immersed in 300 c.c. cold acid for 200 hours.

Acid	Loss in Weight in per Cent of Weight (125 g.) per Day			
	20% Acid	30% Acid	50% Acid	60% Acid
Sulphuric.....	0.009	0.005	0.005	0.005
Hydrochloric.....	0.14	0.34	..	..
Nitric.....	0.08	0.13	0.22	0.30

Prof. S. W. Parr¹ has developed an alloy, which he calls Ilium, of the following composition:

Copper.....	6.42	Tungsten....	2.13	Iron.....	0.76
Manganese...	0.98	Nickel.....	60.65	Chromium...	21.07
Silicon.....	1.04	Aluminum...	1.09	Molybdenum.	4.67

This alloy has been applied by him with success in the construction of combustion chambers of calorim-

¹Trans., Am. Inst. Metals, vol. 9, p. 211 (1915).

TABLE I. BINARY ALLOYS OF NICKEL IN WHICH THE TWO METALS FORM ONE OR MORE COMPOUNDS

Nickel and	Compounds Formed	Compound	Nickel-Rich Alloys			Nickel-Poor Alloys			
			Solubility of compound*	Temperature, Deg. C	Composition	Compound	Solubility of compound at eutectic temperature†	Temperature, Deg. C	Composition†
Aluminum.....	NiAl; NiAl ₂ ; NiAl ₃	NiAl	14	(p) 1,370	13	NiAl ₃	0(?)	630	7
Antimony.....	SbNi ₃ ; Sb ₂ Ni ₅ ; SbNi.....	Sb ₂ Ni ₅	7.5	1,100	35	SbNi	0	612	4
Arsenic.....	NiAs ₂ ; Ni ₅ As ₂ ; Ni ₃ As ₂ ; NiAs	Ni ₅ As ₂	5.5	898	28	.....	.....	.....	.....
Bismuth.....	NiBi; NiBi ₃	NiBi	2	(p) 655	.....	NiBi ₃	0	272	0
Boron.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Cadmium.....	NiCd ₄.....	.....	.....	.....	.....	NiCd ₄	0	321	0
Carbon.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Magnesium.....	Ni ₂ Mg; NiMg ₂	Ni ₂ Mg	0	1,082	12	NiMg ₂	0	512	32
Molybdenum.....	MoNi.....	MoNi	33	1300	49	.....	.....	.....	.....
Phosphorus.....	Ni ₃ P; Ni ₅ P ₂ ; Ni ₂ P.....	Ni ₅ P ₂	0	880	12	.....	.....	.....	.....
Selenium.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Silicon.....	Ni ₃ Si; Ni ₂ Si; Ni ₃ Si ₂ ; NiSi.....	Ni ₃ Si	6	1,153	10.6	.....	.....	.....	.....
Sulphur.....	Ni ₃ S ₂ ; NiS.....	Ni ₃ S ₂	0.5	644	23	.....	.....	.....	.....
Tellurium.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
Tin.....	Ni ₄ Sn; Ni ₃ Sn; Ni ₃ Sn ₂	Ni ₃ Sn	15	1,135	33	Ni ₃ Sn ₂	0	229	1(?)
Zinc.....	NiZn; NiZn ₃	NiZn	30(?)	(p) 1,035	.....	NiZn ₃	0	419	0

(p) Peritectic.

* In per cent of second metal forming system of alloys with nickel.

† In per cent of nickel.

(p) Peritectic. * In per cent of second metal forming system of alloys with nickel. † In per cent of nickel.

eters, as it is practically unattacked by 25 per cent nitric acid. The alloy may be cast and machined, although with some difficulty; it has a tensile strength of about 50,000 lb. per sq.in.

Tungsten:nickel alloys have been prepared by Irmann² and their resistance to the action of sulphuric acid studied. He discovered that the resistance of nickel to the action of 65 per cent acid, which itself is considerable, is increased fourfold by the addition of 5 per cent of tungsten and twelvefold by the addition of 10 per cent. Alloys containing under 18 per cent have sufficient ductility that they may be formed into sheets.

Fairlie³ has reported some tests of nickel:lead alloys for acid-resisting purposes. Alloys containing from 1 to 3 per cent of nickel and remainder lead were more resistant to the action of 50 to 60 deg. Bé. sulphuric acid, both hot and cold, than pure lead, and had a tensile strength of about 3,000 lb. per sq.in., about 30 per cent greater than that of lead. The antimony:lead alloys were much harder and stronger and although resistant to the action of cold were not resistant to the action of hot acid.

Some of his results are reproduced in Table III.

TABLE III. ACID RESISTANCE OF NICKEL:LEAD ALLOYS						
Composition	Elongation in 0.5 In., per Cent	Tensile Strength in Lb. per Sq.In.	Loss in Weight in 50 Bé. H ₂ SO ₄		Loss in Weight in 50 Bé. H ₂ SO ₄	
			Cold Loss in One Week, per Cent	Hot (184°C.) Loss in One Week, per Cent	Cold Loss in One Week, per Cent	Hot (184°C.) Loss in One Week, per Cent
100% Pb.....	110	2,360	0.014	0.357	0.078	0.419
80% Pb, 20% Sb..	5	7,540	0.015	2.425	0.091	5.817
99% Pb, 1% Ni..	74	3,170	0.009	0.190	0.035	0.391
96½% Pb, 3½% Ni	32	3,260	0.021	0.134	0.057	0.199

The disadvantages of the nickel:lead alloys are their low strength and difficulty of preparation, due to the great difference between the melting points of the components.

Clamer has patented ferronickel alloys for production on non-corrodible sheets, rods, etc. These contain approximately 25 to 50 per cent nickel, 5 to 20 per cent copper, remainder iron.

An alloy⁴ of 30 per cent tantalum and 70 per cent nickel is reported to be resistant to the action of boiling aqua regia. Siemens-Halske has patented similar compositions for this purpose.

NICKEL IN BRONZES

Nickel is used to some extent, particularly abroad, as a component of brasses⁵ and of aluminum bronzes, to which it appears to impart desirable properties. Parker⁶ has pointed out the desirability of studying the possibilities of these alloys for the construction of high-speed turbine blading for superheated steam, and mentions several compositions which are in commercial use in Great Britain. These are as follows:

	A	B	C
Copper.....	82.07	79.63	79.0
Aluminum.....	2.54	9.77	11.5
Nickel.....	14.64	4.13	5.0
Manganese.....	nil	0.94	nil
Zinc.....	0.68	nil	nil
Iron.....	trace	4.80	4.5
Silicon.....	0.04	0.14	....

Bronzes of similar composition containing aluminum and nickel have also been produced commercially as substitutes for nickel silver under such names as aluminum silver and minargent. They have a fine white color and will take a good polish.

Read and Greaves⁷ have contributed results of extensive tests of aluminum:nickel bronzes of this type. These alloys were found to forge and roll satisfactorily and to have good mechanical properties, the hardness increasing with the nickel content. Table IV contains the results of some of their tensile tests on annealed

TABLE IV. TENSILE PROPERTIES OF NICKEL:ALUMINUM COPPER ALLOYS						
Chemical Composition			Tensile Properties			
Per Cent Cu	Per Cent Ni	Per Cent Al	Yield Point	Tensile Strength, Lb. per Sq.In.	Elongation in 2 In., per Cent	Reduction of Area, per Cent
89.94	....	10.06	32,200	57,500	9.0	10.4
87.66	2.46	9.88	40,500	71,500	12.3	13.0
85.11	4.95	9.94	40,400	77,400	16.2	17.4
82.82	7.48	9.70	42,100	87,000	13.1	15.1
94.98	....	5.02	11,600	49,600	82.5	78.9
93.96	0.94	5.10	11,800	51,000	94.6	76.1
92.68	2.38	4.94	12,300	51,300	90.2	71.0
89.84	4.84	5.32	21,100	57,200	70.0	60.2
87.48	7.31	5.21	53,700	87,400	25.6	26.8

alloys rolled from 2½-in. ingots. Corrosion tests in fresh and sea water carried out by these investigators indicated that the presence of nickel in aluminum bronzes decreases markedly the corrosion in sea water; it does not seem to affect corrosion in fresh water in any definite manner, as shown in Table V.

The properties of light aluminum alloys containing nickel have been studied by Read and Greaves⁷, Merica, Waltenberg and Finn⁸ and Merica and Karr,⁹ and it seems to have been demonstrated that nickel in aluminum up to 4 per cent will produce an alloy which will roll and work very readily and have quite satisfactory mechanical properties. Thus an alloy containing 3.9

TABLE V. CORROSION TESTS OF ROLLED AND ANNEALED NICKEL:ALUMINUM:COPPER ALLOYS					
Chemical Composition			Corrosion Loss in Weight in Lb. per Sq.Ft. per Month		
Per Cent Cu	Per Cent Ni	Per Cent Al	Sea Water	Fresh Water	
89.94	....	10.06	0.00091	0.00009	
89.55	0.97	9.48	0.00022	0.00006	
85.15	4.94	9.91	0.00012	0.00011	
80.13	9.98	9.81	0.00009	0.00009	
94.98	....	5.02	0.00031	0.00006	
94.04	0.92	5.04	0.00031	0.00008	
90.09	4.90	5.01	0.00012	0.00007	
85.08	10.07	4.85	0.00002	0.00012	

per cent of nickel in the form of rolled and annealed sheet possessed the following tensile properties:

Tensile strength.....	20,200 lb. per sq.in.
Elongation in 2 in.....	24 per cent

It does not appear that light alloys containing nickel are as strong, hard and resistant to corrosion as those which have been hardened with copper, manganese or zinc in similar amounts and would therefore not give much promise of replacing present commercial wrought light alloys of the copper:aluminum, copper:magnesium:aluminum or zinc:aluminum type.

Promising results have been obtained, however, with the addition of from 1 to 2 per cent of nickel in aluminum casting-alloys containing also from 2 to 3 per cent of copper, and there seem to be some possibilities of development in this direction. Thus Merica and Karr have obtained the following tensile test results with a

²*Metall u. Erz*, vol. 5, p. 21, (1917).
³*Metal Ind.*, vol. 3, p. 64, (1911).
⁴*Metall u. Erz* (1918), p. 22.
⁵Guillet, *CHEM. & MET. ENG.*, vol. 24, p. 261 (Feb. 9, 1921).
⁶*J. Inst. Metals*, vol. 14, p. 25 (1915).

⁷*J. Inst. Metals*, vol. 13, p. 100 (1915); vol. 11, p. 169 (1914).
⁸*Bu. Standards Tech. Paper* 132.
⁹*Bu. Standards Tech. Paper* 139.

TABLE VI. THERMO-ELECTROMOTIVE FORCE OF REPRESENTATIVE COUPLES. COLD-JUNCTION TEMPERATURE, 0 DEG. C.

Copper-Constantan		Iron-Constantan		Chromel-Alumel	
Emf., Millivolts	Temp., Deg. C.	Emf., Millivolts	Temp., Deg. C.	Emf., Millivolts	Temp., Deg. C.
0	0	0	0	0	0
1	25	5	95	5	122
2	49	10	186	10	243
3	72	15	277	15	363
4	94	20	367	20	482
5	115	25	457	25	601
6	136	30	546	30	721
7	156	35	632	35	844
8	175	40	713	40	970
9	194	45	792	45	1,100
10	213	50	871	..	..
11	232	55	950	..	..
12	250	60	1,030	..	..
13	268	..	..	..	..
14	285	..	..	..	..
15	302	..	..	..	..
16	319	..	..	..	..
17	336	..	..	..	..
18	353	..	..	..	..

sand-cast alloy containing 3 per cent copper, 0.8 per cent manganese and 1.5 per cent nickel:

Tensile strength..... 24,000 to 25,000 lb. per sq.in.
Proportional limit..... 6,000 to 7,000 lb. per sq.in.
Elongation in 2 in..... 8.5 per cent

In this connection it might be noted that nickel is used in the casting alloy called magnalite, and in certain varieties of magnalium produced abroad; these will contain from 1 to 2 per cent of nickel.

Nickel has been substituted for a portion of the tin in government bronzes with attractive results (Burgess and Woodward¹⁰); these investigators give the following results of tensile tests of castings:

	Tensile Strength	Yield Point	Elonga- tion	Reduc- tion of Area
88 Cu, 5 Sn, 5 Ni, 2 Zn...	40,700	13,100	31.8	28.0
89 Cu, 4 Sn, 4 Ni, 3 Zn...	39,700	11,500	31.2	31.2

These results may be compared with advantage to the American Society for Testing Materials specifications for government bronze (88 Cu, 10 Sn, 2 Zn) as follows:

Tensile strength..... 30,000 lb. per sq. in.
Elongation in 2 in..... 14 per cent

The proposal has also been made by McKinney¹¹ to substitute nickel for a portion of the copper in 88:10:2 by using some cupronickel scrap in making the alloy.

ALLOYS FOR ELECTRICAL PURPOSES

The chief electrical uses for alloys containing nickel for the construction of pyrometer thermocouples and the construction of rheostats and electrical heating devices. The use of an alloy containing from 3 to 5 per

¹⁰Trans., Am. Inst. Mining Eng., vol. 58, p. 175 (1919).
¹¹Bull., Am. Inst. Mining Eng., December, 1919, p. 3185.

TABLE VII. COMPOSITION AND PROPERTIES OF ELECTRICAL ALLOYS

Name of Alloy	Form in Which Produced	Chemical Composition					Resistivity in Microhm, Cm.	Electrical Resistivity		Tensile Strength, Lb. per Sq. In.	Density	Melting Point or Range, Deg. C	Recommended Max. Working Temp., Deg. C	Thermal Expansivity, Deg. C	
		Ni	Cr	Cu	Fe	Mn		Temperature Co-efficient, per Deg. C.	Resistivity in Ohm, Mil-Ft. at 75 Deg. F.						
A—Nickel:Chromium Alloys															
Nichrome (a)...	Wire, ribbon.....	60	12	.....	26	2	109.5	0.00017	660	100,000	8.15	.....	1,000	0.000164	
Nichrome (a)...	Castings (f).....	.....	.....	.....	.....	.....	.....	.....	.....	50,000 to 55,000	8.15	.....	1,100	0.000121	
Nichrome 2(a)...	Wire, ribbon.....	66	22	.....	10	2	110 to 113	0.00017	660 to 680	.....	8.02	.....	1,100	.....	
Kromore (a)...	Wire, ribbon.....	85	15	.....	.....	.....	96.4-101.5	0.00024	580 to 610	.....	8.3	.....	1,100	.....	
Chromel A (c)...	Wire, ribbon, catgs	80	20	.....	.....	.....	103	0.00011	620	.....	8.46	.....	1,100	.....	
Chromel B (c)...	Wire, ribbon.....	85	15	.....	.....	.....	89	0.00011	535	.....	8.16	.....	.....	.....	
Chromel C (c)...	Wire, ribbon.....	64	11	.....	25	.....	108	0.00018	650	.....	.....	.....	.....	.....	
Calorite.....	.....	65	12	.....	15	8	110	.....	662	.....	.....	.....	.....	.....	
Calido (b).....	Wire, ribbon.....	65	12	.....	23	.....	103	0.00036	620	{ Hard, 160,000 Soft, 80,000	8.15	1,530	1,000	0.000016	
Excello.....	.....	85	14	..	0.5	0.5	92	.....	554	.....	.....	.....	.....	.....	
Rayo (b).....	Wire, ribbon.....	85	15	.....	.....	.....	95.7	0.00018	575	{ Hard, 160,000 Soft, 80,000	8.05	1,530	1,100	0.000015	
Tophet.....	.....	61	10	.....	26	3	107	.....	644	.....	.....	.....	.....	.....	
Chromel (c).....	.....	89	10	.....	1	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Nichroloy 1 (d).....	.....	75	16	.....	7 to 9	3	.....	.....	.....	.....	.....	.....	.....	.....	
Nichroloy 2 (d).....	.....	40	7	.....	50	3	.....	.....	.....	.....	.....	.....	.....	.....	
Nichroloy (d)...	Castings (g).....	23	20	.....	50	1	.....	.....	.....	.....	.....	.....	1,100	.....	
Kromax.....	.....	80	20	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
B—Ferro-nickel Alloys															
Climax (a).....	Wire, ribbon.....	25	.....	.....	75	.....	83.1	0.00098	500	.....	8.14	.....	.....	0.0000171	
No. 193 (a).....	Wire, ribbon.....	30	2	.....	68	.....	87.2	0.0007	525	.....	8.14	.....	.....	0.0000171	
Comet (b).....	Wire, ribbon.....	32	3	.....	bal.	.....	87.0	0.0007	525	Hard, 150,000	8.15	1,510	600	0.000016	
Phenix (b).....	Wire, ribbon.....	25	.....	.....	bal.	.....	83.1	0.0011	500	Soft, 70,000	8.10	1,510	600	0.000017	
Ferrozoid (e).....	.....	.....	.....	.....	.....	.....	84.0	.....	506	Hard, 140 000	.....	.....	.....	.....	
Kruppin (e).....	.....	28	.....	.....	bal.	.....	85.0	.....	512	Soft, 70,000	.....	.....	.....	.....	
Vestalin (e).....	.....	.....	.....	.....	.....	.....	85.1	.....	512	.....	.....	.....	.....	.....	
C—Nickel: Copper Alloys															
Advance (a)...	.....	44 to 46	.....	bal.	.....	0.75 to 1.25	48.9	nil	294	.....	8.9	.....	.....	0.0000144	
Ideal (b).....	Wire, ribbon.....	45	.....	55	.....	.....	49.2	0.000005	296	{ Hard, 115,000 Soft, 60,000	8.9	1,210	500	0.000014	
Lucero (b).....	Wire, ribbon.....	65	.....	30	.....	bal.	46.5	0.0007	280	{ Hard, 140,000 Soft, 65,000	8.9	1,350	600	0.000014	
Nickelin (e).....	.....	31 to 32	.....	55 to 68	Zn 6 to 13	.....	43.0	.....	258	.....	.....	.....	.....	.....	
Ferry (e).....	.....	.....	.....	.....	.....	.....	47.2	.....	284	.....	.....	.....	.....	.....	
Constantan.....	.....	40 to 55	.....	bal.	.....	.....	48 to 50	.....	295 to 300	.....	.....	.....	.....	.....	
Eureka (e).....	Similar to Constantan.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	.....	
Monel.....	.....	67	.....	28	—balance—	.....	50.2	.....	302	.....	.....	.....	.....	.....	
.....	.....	.....	.....	.....	.....	.....	42.5	0.0019	256	.....	.....	.....	.....	.....	
D—Nickel: Silver Alloys															
18% (a).....	.....	.....	.....	.....	.....	.....	36.3	0.00030	218	.....	8.5	.....	.....	.....	
7% (e).....	.....	.....	.....	.....	.....	.....	18.0	.....	108	.....	.....	.....	.....	.....	
10% (e).....	.....	.....	.....	.....	.....	.....	21.0	.....	126	.....	.....	.....	.....	.....	
20% (e).....	.....	.....	.....	.....	.....	.....	29.0	.....	174	.....	.....	.....	.....	.....	
30% (e).....	.....	.....	.....	.....	.....	.....	40.2	.....	241	.....	.....	.....	.....	.....	
Platinoid.....	.....	.....	.....	.....	.....	.....	41.0	.....	246	.....	.....	.....	.....	.....	
Rheotan II.....	.....	25	.....	52.5	5	18 Zn	.....	.....	.....	.....	.....	.....	.....	.....	
E—Miscellaneous Alloys															
Alumel.....	.....	94 Si1	Al2	.....	0.5	2.5	.....	.....	.....	.....	.....	.....	.....	.....	
Manganin.....	.....	2 to 16	.....	50 to 85	.....	12 to 30	42 to 48	0.00001	250 to 290	.....	.....	.....	.....	.....	
Tarnac (e).....	Cupro-manganese	.....	.....	.....	.....	.....	41.0	.....	246	.....	.....	.....	.....	.....	
Resistin (e).....	Cupro-manganese	.....	.....	84 to 86	2	11 to 13	50.2	.....	302	.....	.....	.....	.....	.....	
Magno (b).....	Wire, ribbon.....	95	.....	.....	.....	5	86.4	.....	520	{ Hard, 140,000 Soft, 65,000	.....	1,400	800	0.000014	

(a) Data from Driver-Harris Co. (b) Data from Electrical Alloys Co. (c) Data from Hoskins Manufacturing Co. (d) Data from Hiram Walker & Sons Co. (e) Law "Alloys and Their Industrial Application." (f) Brinell hardness 179. Specific heat, 0.111 cal., per g. at 100 deg. C. Thermal conductivity, 0.0341 cal. per sec. per cm. (g) Also contains 0.5 Si, 0.5 Al, 1.0 C, 1.0 V.

TABLE VIII. MISCELLANEOUS ALLOYS CONTAINING NICKEL

Name of Alloy	Chemical Compositions								Remarks
	Ni	Cu	Fe	Zn	Mn	Al	Pb	Sn	
Aphtit.....	20-21	70-75		5.2-2.2					Cd 4.5-1.8.
Ajax metal.....	25-50	5-20	30-70						Bearing metal, gun mountings.
Aluminum—nickel.....	76.4					23.6		20	Ag 10.
Aluminum—silver.....	20	57	20			3			
Aluminum—wire (B).....	1.3	1				97.7			
Argozie.....	14	54		28			2	2	Castings.
Ashberry metal.....	1-3	2-3		1-3				78-80	Sb 14-20. Tableware.
Aterite.....	12-18	55-60	6-10	13-20			1-2.5		Valves and valve parts.
Bario metal.....	90					W 1.22	Si 0.2	9 Cr	4.25 Heat and acid-resisting alloy.
Bearing metal.....	10.4							83.3	W 6.3. For high speeds.
Bismuth brass.....	31	47		21			1		Bi 1.
Bismuth bronze.....	24	25							Sb 50, Bi 1.
Bismuth bronze.....	10	53		20		1		15	Bi 1.
Bismuth bronze.....	32.5	45		21.5				16	Bi 1.
Chromax bronze.....	15.2	66.7		12.1		3.0			Cr 3.0. Can be rolled. T.S. 79,000 lbs. per sq.in. 3% elongation.
Cooperite.....	80								W 14, Zr 6. Cutting tools.
Cuniloy.....	65	25			3½		1		Resistance to corrosion and alkalis.
Cufenium.....	22	72	6						Knives, forks, spoons.
English nickel (complex).....	2	2			1			87	Bi 0.5, W 1.5, Sb 6.
Illum.....	60.6	6.4							Mo 4.6, Cr 21, Acid resistance.
Invar.....	37		63						37% nickel steel.
Machine bronze.....	25	50-90		0.30			0-8	0-30	
Machine bronze.....	25	50						25	
Manganin.....	8-10	80			10-12				See p. 651.
Minargent.....	39.77	56.82				0.57			W 2.84.
Minargent.....	32	46					22		
Mira metal.....	0.24	74.7	0.43	0.62			16.3	0.91	Sb 6.8. For cocks, pipes, etc., to resist acid corrosion.
Neogen.....	12	58		27		0.5		2	
Nickel aluminum bronze.....	10	88				2			
Nickel aluminum bronze.....	40	10				30		20	
Nickel bronze.....	30	86						11	
Nickel bronze.....	20	60		12				8	
Nickel bronze.....	25	50						25	
Nickeloy.....	1.41	4.15				93.8			Cast gives 20,000 lbs./sq.in. tensile strength, 4.5% elongation.
Nickel manganese bronze.....	2.5	53.4		39	1.7	0.2	0.3	2.6	
Nickel-tungsten.....	25-50								W 50-75. Alloy for mixing.
Nickel-zirconium.....	86.4					6			Si 6, Zr 1.5, C 0.1. High speed cutting tools
Plastic bronze.....	1	64					30	5	
Platinite.....	46		54						46% nickel.
Platinum substitute.....	72					23.6			Bi 3.7, Ar 0.7.
Platnam.....	58.8	32.55	0.48			0.32	12.72		Used for valve seating.
Rosein.....	40					30		20	Ag 10. Used for jewellers' work.
Sea water bronze.....	32.5	45		5.5				16	Bi 1. Resistant to sea water.
Sheathing bronze.....	32.5	45		5.5				16	Bi 1.5.
Sidiraphite.....	23	5	65						W 4, Sb 3.
Speculum.....	4	64						32	For telescope mirrors. Does not always contain nickel.
Stanniol.....	0.3	1	0.1				2.4	96.2	
Stellite.....	1		2						Co 75, Cr 16.5, Si 3-4, C 2. Pocket and table knives, surgical instruments, machine tools.
Stuffing box alloy.....	15.5	61.5		11			10	2	For turbines.
Toncas metal.....	28.6	35	7	7			7	7	Sb 7. Ornamental work.
Trabuk.....	5.5							87.5	Sb 5, Bi 2. Substitute for nickel silver; resistant to vegetable acids.
Tungsten brass.....									See wolfram brass.
Turbadium bronze.....	2	48		46					
Turbiston bronze.....	2	55	0.84	41	0.16	1			Resistant to salt water.
Typewriter metal.....	20	57		20		3			Used for typewriter parts.
Unmagnetizable watch wheels.....	18	18							Pt 62.75, Cd 1.25. Used for watch wheels.
Warnes metal.....	26							37	Bi 26, Co 11.
White gold.....	59								Au 41. Substitute for platinum.
White gold.....	15								Au 80. Substitute for platinum.
White solder.....	10	45		45					Soldering.
Wolfram brass.....	14	60		22					W 4.
Zamium.....	60	bal. Cr, Mn, W.							A nickel-chromium alloy, resistant to corrosion.

cent manganese for sparkplug terminals has been mentioned. The characteristic which renders this group of nickel alloys of value for these purposes is their resistance to oxidation and alteration at the higher temperatures (up to 2,000 deg. F.) at which they are used, in conjunction with their high electrical resistivity, low temperature coefficient of electrical resistivity and either high or low thermal electromotive force against iron or copper.

The principal base metal thermocouples are copper against constantan, iron against constantan (Leeds and Northrup, Bristol, Brown pyrometers) and Chromel against alumel (the Hoskins thermocouple). The temperature-electromotive force relations of these three elements are given in Table VI, quoted from Foote, Harrison and Fairchild,¹² the values being average or standard ones. Adams¹³ has shown how to apply deviation curves based on one temperature-electromotive force measurement to lots of such wire having slightly different relations.

The alloys used for electrical heating and for the construction of rheostats or electrical resistances may be

divided into several groups: (1) The nickel:chromium alloys having a high electrical resistivity, low temperature coefficient together with maximum resistance to oxidation and alteration at higher temperatures; (2) the ferronickel alloys with lower resistivity and resistance to oxidation but considerably cheaper; (3) copper:nickel alloys having lower resistivity and inferior heat-resisting properties than the first class, but with practically negligible temperature coefficient of resistivity at ordinary temperatures, a very necessary property in the construction of precise electrical resistances for measuring instruments, and (4) the alloys similar to nickel silver, which are the oldest alloys used for electrical purposes and are being displaced by the others.

The compositions of alloys manufactured commercially today are listed in Table VII, together with approximate compositions and physical properties, principally as described by the manufacturers owning the patents. Most of these alloys are furnished in wire and in ribbon form and are manufactured by melting either in crucibles or electric furnace, pouring into small ingots which are first hot-rolled, annealed, and then cold-drawn with annealing into the finished form.

¹²Bulletin 153, Am. Inst. Mining Eng.

The alloy constantan, or copper:nickel, which also is sold under a number of trade names, is chiefly used for pyrometer and electrical resistance wire. It may be rolled at the temperatures (1,175 to 1,200 deg. C.) used for Monel metal and annealed at a slightly lower temperature—i.e., 850 deg. C. The tensile properties of copper:nickel alloys containing approximately 45 per cent of nickel will average as follows:

	$\frac{1}{4}$ -in. Hot-Rolled Wire Rod	Annealed Wire	Hard-Drawn Wire
Tensile strength, lb. per sq.in. . .	65-85,000	60,000 to 65,000	110,000 to 140,000
Elongation in 2 in., per cent.	25-40	.....	.....

The general subject of electrical resistance has received much attention by Hunter and Sebast,¹³ and Sebast and Gray.¹⁴ An alloy of very high resistivity (113 microm-cm.) and of negligible temperature coefficient (0.000078 per deg. C.) was found containing 17 per cent chromium, 71 per cent nickel and 12 per cent copper which would appear to have commercial possibilities; it resists oxidation at higher temperatures to a remarkable degree and is easily manipulated in drawing. An alloy was found containing 48 per cent copper, 39 per cent nickel and 10 per cent manganese which has a resistivity of 70 microhm-cm. and zero temperature coefficient at 20 deg. C.; this is superior to manganin in its higher resistivity. The highest values of the resistivity were found in the binary nickel:manganese and nickel:chromium and in the ternary ferronickel:manganese, ferronickel:chromium and copper:nickel:chromium alloys. The ternary alloys have a higher value of the resistivity than the binary alloys. Alloys of low temperature coefficient were found chiefly among the copper:nickel:manganese alloys.

An interesting corollary of the development of electrical resistance alloys for rheostats and heaters has been that of heat-resisting alloys, and many compositions used at first because of their electrical- and heat- or high temperature-resisting properties are now used because of the latter alone. Nickel:chromium alloys in the form of castings are now much used for furnace muffles, carbonizing and annealing boxes and pyrometer protection tubes. These alloys (see Table VII) withstand very well the action of gas and oil flames as well as that of molten lead, cyanide or of carbonizing mixtures at temperatures up to 2,000 deg. F. (1,100 deg. C.).

MISCELLANEOUS ALLOYS

Besides its use as a principal alloying element in the well-known alloys just considered, nickel enters into the composition of a great variety of other commercial and experimental alloys, in which it acts perhaps principally to increase the hardness without an appreciable loss of ductility. However, it is also considered to exercise other functions. In Table VIII are assembled data on the chemical composition and use of a number of miscellaneous alloys in commercial use or mentioned in the literature which contain nickel; this table does not include alloys which have been listed in former tables covering nickel:silver alloys and those for electrical purposes.

Nickel is a powerful decolorizing agent for metals such as copper and gold. Several jewelers' white alloys are produced today as substitutes for platinum under the name of white gold; they contain from 20 to 50 per cent of nickel, with the remainder gold.

An alloy of 90 per cent nickel and 10 per cent tin is used to some extent for valve seats and rings.

Nickel in small amounts has been found to exert a beneficial effect on copper:lead-bearing bronzes in preventing the segregation of the lead. Thus, a much-used railway bearing bronze for heavy bearings contains:

	Per Cent		Per Cent
Copper.....	64	Lead.....	30
Tin.....	5	Nickel.....	1

An alloy of nickel and zirconium called Cooperite (see Table VIII) after its discoverer has been patented for machine tools and appears to have shown some very interesting test results in comparison with ordinary high-speed steel.

Legal Notes

BY WELLINGTON GUSTIN

General Rules of Water Purification Board of Rhode Island Do Not Aggrieve Corporations or Persons

Appeals of the Standard Oil Co. of New York and the Mexican Petroleum Corporation from orders of the Board of Purification of Waters of the State of Rhode Island have been dismissed in the Rhode Island Supreme Court.

The board was established under an act to prohibit and regulate the pollution of waters of the state and thereafter made an order establishing certain rules and regulations to prevent the discharge or escape of any petroleum, gasoline, kerosene, tar, oil or any product or mixture thereof into the public waters, as it was empowered to do under section 8 of the act. The corporations claimed that they were aggrieved by this order and were entitled to appeal from such order to the Supreme Court. They set up about twenty grounds upon which they contended that the order was unlawful and unreasonable.

To illustrate these rules the second regulation is here stated: "(2) No person shall discharge, or cause, suffer or procure to be discharged, or cause or suffer to escape into any of the public waters of the state any petroleum, gasoline, kerosene, tar, oil, or any product or mixture thereof."

It was charged that such rule and regulation is unlawful because the escape of such products is prohibited irrespective of whether or not such escape causes pollution of the waters; that on the same ground it is unreasonable; and that it is unlawful and unreasonable on the further ground that the escape of the above-mentioned products is prohibited irrespective of the circumstances, reason or cause for the same.

PROPERTY RIGHTS DETERMINE RIGHT TO APPEAL

However, the court said the right to appeal from such order is given only to those who are aggrieved by the finding of an inferior tribunal, and the party is "aggrieved" where the judgment or decree operates on his rights of property or bears directly on his interest. Neither of the corporations had been made the subject of proceedings under the act, but they feared some act or omission in the future might be complained of under some provision of chapter 1,914, and that such provision as applied to the circumstances of a case which might arise would be unlawful or unreasonable.

¹³J. Am. Inst. Metals, vol. 11, p. 115 (1917).

¹⁴Trans., Am. Electrochem. Soc., vol. 29, p. 569 (1916).

However, the court pointed out that the law requires the board, after it finds any person polluting the water, to order such person to prevent such pollution, and section 7 of the act prohibits prosecution without an order finding a violation, and section 10 prohibits conviction except for violation of the order of the board. It said the adoption of rules of the board under the authority of section 8 does not affect any person's property, but such rules are admonitory in character, and therefore do not "aggrieve" any person so as to authorize an appeal therefrom.

There was a strong dissenting opinion filed.

Rule Laid Down Where Defendant May Examine Plaintiff Before Trial

In the case of R. M. Jones against the Union Guano Co., Jones appealed to the Supreme Court of North Carolina from an order of the Superior Court of Rockingham County permitting the company to proceed with an examination of plaintiff before trial.

This case is one of nineteen actions in the Rockingham Supreme Court by nineteen farmers against the Union Guano Co. for damages for alleged breach of warranty in certain fertilizers causing them losses in their crops. After the complaint in this case was filed, the defendant filed a petition to examine the plaintiffs to obtain information on which to file its answer. The plaintiffs were directed to appear for examination on April 19, 1920, on which date they filed an answer to the petition and order, and asked that the order be set aside. The trial judge directed that the defendant should proceed with the examination of the plaintiffs and Jones appealed, the eighteen cases to await and abide the decision in this case.

This proceeding for the examination of the opposite party before trial may be permitted to the plaintiffs to procure information to frame the complaint (116 N. C., 480). Or after answer is filed the plaintiff may cause the defendant to be examined to procure evidence (18 Am. State Rep., 893). And likewise the rule extends to the defendant so to examine the plaintiff. But the Supreme Court said this right does not lie where, as in this case, the grounds of action are fully set out in the complaint, and the defendant can deny the same, or if so disposed it may answer on information or belief.

CANNOT SPREAD DRAGNET FOR ADVERSARY

As to both parties to a suit the court said in the case of Bailey vs. Matthews (156 N. C., 78): "The law will not permit a party to spread a dragnet for his adversary in the suit, in order to gather facts upon which he may be sued; nor will he countenance any attempt, under the guise of a fair examination, to harass or to oppress his opponent. It is a very rare case that requires the exercise of this function of the court, and the order should not be made without careful consideration and scrutiny."

The complaint filed by Jones and his eighteen associates, the court said, was a clear, specific statement as to the purpose for which the fertilizer was bought and the constituent elements which it was represented to contain by the Guano company, and allegations of the falsity of such representations and of the damage. It was said that the defendant did not need any examination of the plaintiff to enable it to answer these allegations.

It was laid down as the rule that an application for

an order for an examination be under oath, stating facts showing the nature of the action, is such that the testimony desired is relevant and that the examination is material and necessary and the information desired is not already accessible and that the application is made honestly and in good faith, and not maliciously. These requirements had not been met, the court said.

Guarantee of Product by Another Is a Direct Obligation and Need Not Be in Writing

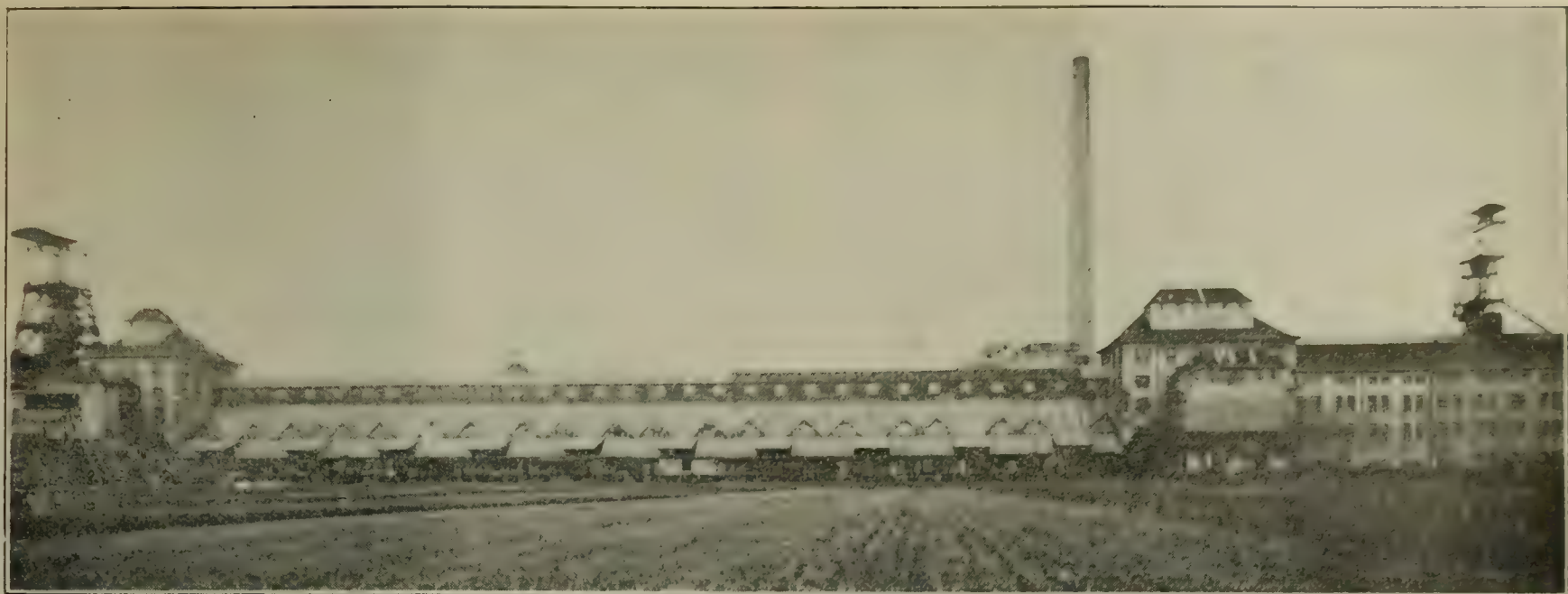
In a recent case the proposition of guaranty was considered by the Supreme Court of California. It appears that the Simons Brick Co. employed the Interstate Vaccine Co. to vaccinate hogs with anti-cholera serum on the personal warranty or guarantee of one Wiglesworth that such vaccination would render the hogs immune from cholera, and that he would pay for any hog vaccinated which subsequently died. Afterward the Simons Brick Co. brought action against Wiglesworth and recovered judgment for \$5,637.20. Two questions were presented on appeal from this judgment. The first was as to whether there was a contract, and the second was as to whether such contract, if it did exist, was one which had to be in writing under the statute of frauds.

In passing on the question the court said that defendant's statement, that if the Brick company would employ a particular company and its product he would personally warrant or guarantee the results, was a proposal which had to be accepted within such time as the parties contemplated it would remain open, and, in the absence of express understanding, within such time as they reasonably had in mind under the circumstances. The facts showed that the offer of warranty was to remain open and that the employment of the company some months afterward was on an understanding of which the guaranty was a part.

NOT EVERY GUARANTEE MUST BE IN WRITING

As to the point made that the promise of guarantee was not in writing, the court said not every promise which may be aptly termed a "guarantee" is required to be in writing. It is only where the guarantee is a promise to answer for the debt, default or miscarriage of another that it must be in writing under the universal statute of frauds.

The question presented is: Was the promise of defendant one to answer for the obligation of another? The only other for which it could be considered that he intended to assume responsibility was the serum manufacturer. But it was not shown that any obligation of guaranty existed on the part of the manufacturer. There being no contract of warranty between the plaintiff and the manufacturer, the law implies a warranty or agreement that reasonable skill and care will be exercised in the selection and application of the vaccine, but that is all, nor were there any facts in the case from which an express warranty could be inferred between them. Since no warranty as sued upon existed between plaintiff and the manufacturer of the product, the agreement of defendant to pay for any hogs vaccinated which subsequently died was not a contract to answer for the debt or default of another—all of such contracts being required to be in writing under the statute of frauds. Such a guarantee of a product is a direct and separate contract, obligating the guarantor alone, and is enforceable, although not in writing.



GENERAL VIEW OF REICHSLAND PLANT

The Alsatian Potash Industry

Location and Extent of Alsatian Sylvinite Deposits—Physical Characteristics—Mining Methods—Surface Treatment: Crushing and Refining—Status of the Mines Before and After the War—Improved Operating Methods—Distribution of Products

By HENRI VIGNERON

Consulting Engineer, Société Commerciale des Potasses d'Alsace.

AS FAR back as 1869 borings were made in the vicinity of Mulhouse in search of petroleum and oil. Only the presence of common salt was discovered. More recently, in 1904, other searches were made; the first borings, near Wittelsheim, showed common salt at a depth of 1,100 ft. At a depth of 1,900 ft. the first layer of potash was found, and a second layer at a depth of 1,950 ft. It is interesting to note that the presence of potash would probably not have been discovered had it not been for the curiosity of Joseph Vogt, Sr., an Alsatian, who, noticing the red color of the salts, had them analyzed.

EXTENT OF THE DEPOSITS

Encouraged by the results, a company was formed to determine the limits of the basin. One hundred and sixty-five borings were made, varying from 750 to 3,000 ft. in depth. These proved the existence of a very large deposit of potash salts (sylvinite) over an area of about 68 square miles. It was also shown that there were two layers, or strata, of potash; the top layer containing a high percentage salt, 20 to 25 per cent K_2O , the lower layer containing potash salts varying from 15 to 18 per cent K_2O . The limits of the basin and the upper and lower deposits are shown on the map, Fig. 1.

During the war the battle front was very near the mines. L'Hartmannswillerkopf, or "Old Armand," that mountain of the Vosges where the "Blue Devils" (Alpins Chasseurs) resisted the attacks of the German army for three years, is only two miles from the shafts of the mine Marie-Louise.

The French did not destroy the mines, as they believed they would be restored to France some day; therefore the Germans continued to operate them with-

in range of the French guns. Unfortunately, when the French took possession of Alsace they found that the enemy, in retreating, had left the mines in a deplorable condition. All the shafts in process of construction were flooded. Those mines that were in active exploitation were left in such a state that it took many

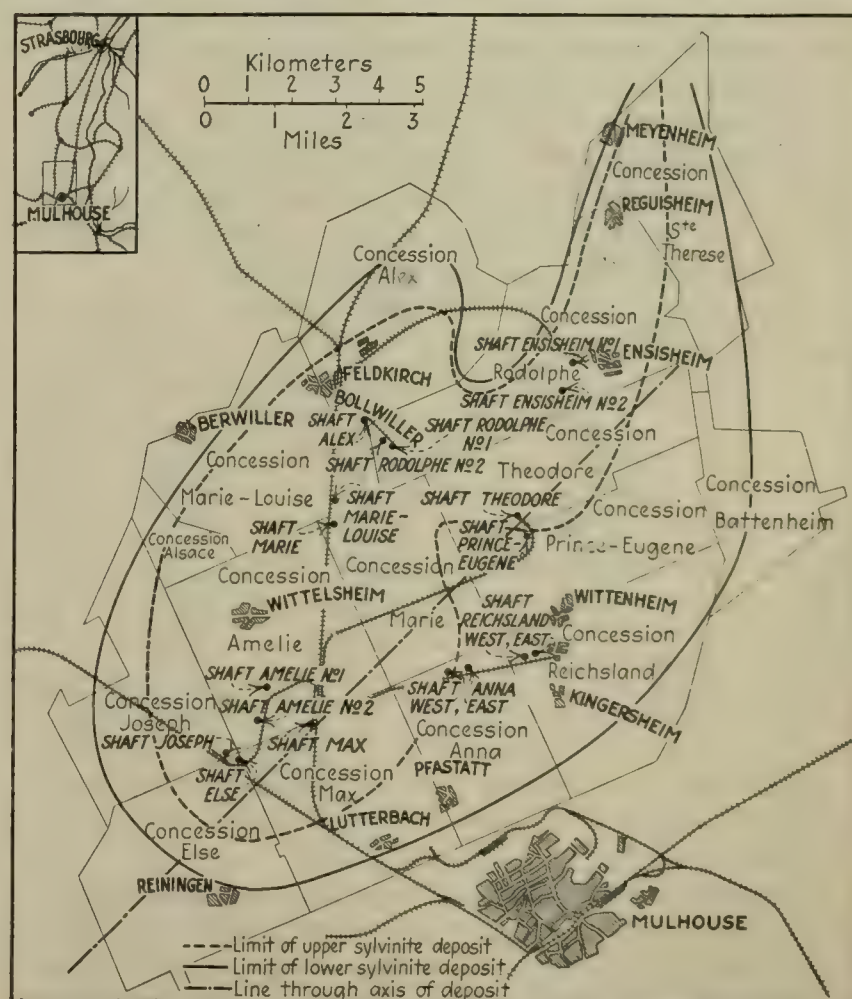


FIG. 1. LOCATION OF ALSATIAN POTASH DEPOSITS

months and great expense to put them in working order. In spite of the difficulties, notwithstanding labor troubles and depression among workmen due to under-nutrition, in spite of the absence of a technical personnel, the reconstruction of the mines was immediately commenced. Since that time, thanks to the unceasing work of the French engineers, the Alsatian mines have

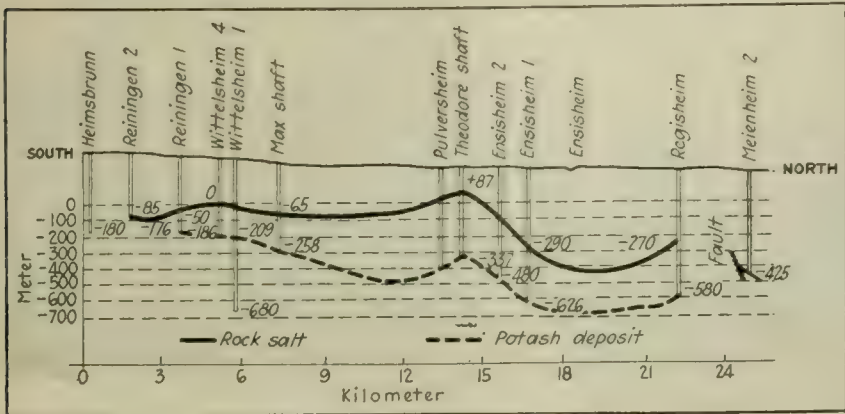


FIG. 2. SECTION ALONG AXIS OF DEPOSITS

reached a production power which the reader will be able to appreciate from the following discussion. It has already been stated that the deposit consists of two layers. These differ in grade and are about 60 ft. apart. The upper layer, 3.8 ft. in thickness, contains from 35 to 40 per cent of potassium chloride, or 22 to 25 per cent K_2O . This layer is found at a depth of 1,500 ft. at Amelie, 1,650 ft. at Theodore, 1,900 ft. at Alex, 2,500 ft. at Ensisheim. The lower layer is 7.5 ft. in thickness at Reichsland; 13.5 ft. at the mines Marie and Marie-Louise, and 16 ft. at the mine Amelie. Its nature varies from 23.5 to 32 per cent KCl , or 15 to 20 per cent K_2O .

The borings, which were made at various points, prove that the basin assumes the form of an ellipse, the axis of which passes through Ensisheim, running northeast to southwest. The northern end of this ellipse is prolonged by an additional strip which extends as far as Oberentzen. The western boundaries are formed by the Vosges and Harz Mountains, where the strata become thinner.

A cross-section (Fig. 2) following the axis of the ellipse as indicated by the dot-and-dash line in Fig. 1, shows that the deposit of potash salts, at a depth of 550 ft. at Reinigen, sinks to approximately 1,900 ft. at Ensisheim, only to rise again later.

The average analysis of Alsatian potash salts is as follows:

	Crushed Sylvinites, 14 to 16 per Cent	Raw Salts Rich Sylvinites, 20 to 22 per Cent	Refined Salts KCl, 50 to 60 per Cent	Refined Salts KCl, 60 to 62 per Cent
K_2O	14-16	20-22	50-60	60-62
KCl	21-25	32-35	79-95	95-98
$NaCl$	55-67	50-55	4-5	4-0.7
$MgCl_2$	0.1-0.7	0.1-0.5	0.1-0.5	0.05-0.1
$MgSO_4$	none	none	none	none
$CaSO_4$	2-5	2-4	0.3-0.4	0.1-0.3
H_2O	0.7-1.2	0.5-1.2	0.3-1.5	0.1-0.3
Insoluble:				
Clay, Fe_2O_3 ..	10-14	9-12	0.5-5	trace

Fig. 3 shows the cross-section of the shaft Theodore, which is situated in the center of the basin at Wittensheim. The shafts are from 15 to 18 ft. in diameter. At the opening, the casing, which continues to a depth of about 300 ft., is of cast iron and from this level to the bottom the shaft is lined with a casing of concrete from 1 to 1½ ft. in thickness.

The following table gives the composition of the successive layers encountered in sinking the shafts:

Strata	Depth m.	Thickness m.	Depth ft.	Thickness ft.
Soil	0	0.3	0	1
Sand and gravel	0.30	21.95	1	72
Fossiliferous blue clay	22.25	58.57	73	193
Gray, brown and blue clay	81	60.5	266	198
Rock salt with alternate clay strata	141.5	404.3	464	1327
Upper sylvinitic deposit	545.8	1.25	1791	4
Slate, etc.	547.05	18.0	1795	59
Lower sylvinitic deposit	565.05	4.10	1854	13
Rock salt	569.15	6.85	1867	23
Slate	576	4	1890	....

PHYSICAL CHARACTERISTICS OF THE POTASH BEDS

In the descent into one of the potash mines nothing can be seen of the deposits passed in the shaft, because they are covered by the concrete lining of the shaft, or, near the top, by a metal collar. The first sight of any of the underground deposits is obtained as one steps from the mine cage into the mine workings. Here broad entries, well lighted by electricity, have been excavated in the thicker of the two potash beds. The galleries branch in various directions and are closed here and there by doors (brattices), which are needed to direct the circulation of the air that is forced through the mine for ventilation. Figs. 4 to 7 are typical views of the mine workings.

The sight of the potash salts in place is striking. High walls of sparkling crystalline salts are banded in approximately horizontal stripes of red and white, more or less wavy, giving the impression of a portion of

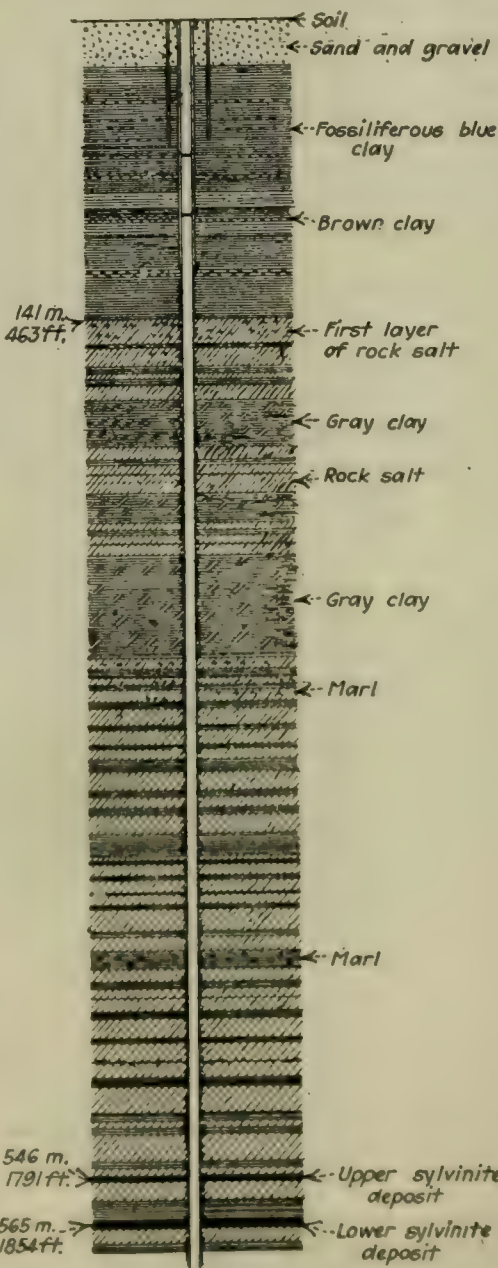
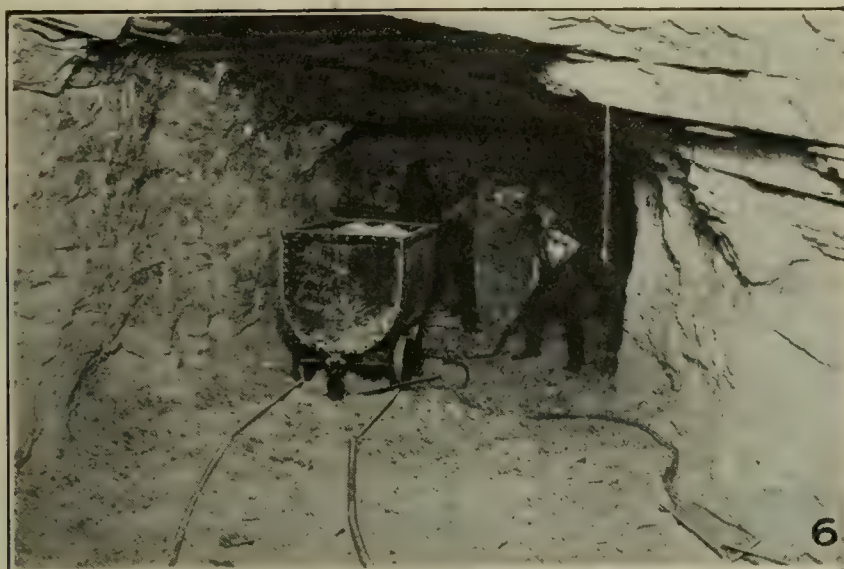
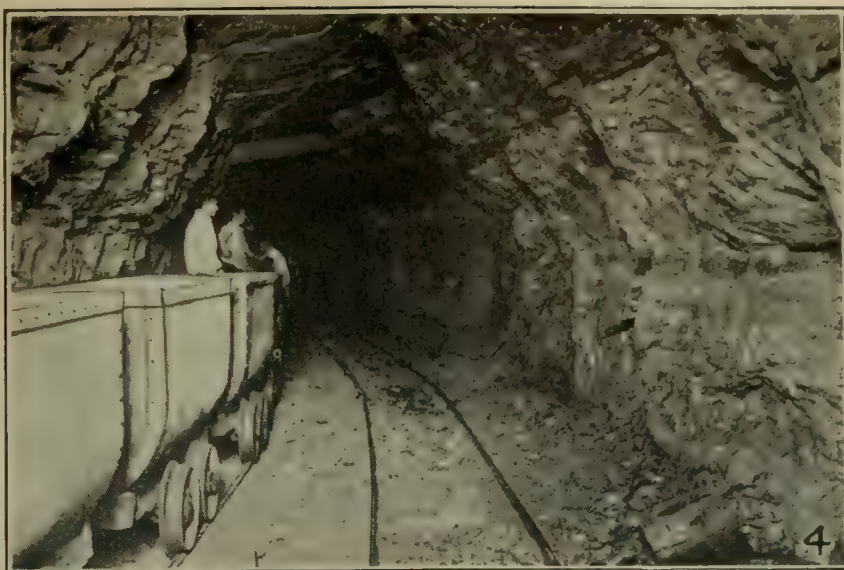


FIG. 3. STRATA AT SHAFT THEODORE

an immense flag. (See Fig. 7.) On clean mine faces the colors are beautifully clear. Some of the bands are a deep, rusty red or brick red. Other portions are delicately pink, and there is much white and gray granular crystalline material. The belief that the red and some of the pink salts are directly associated with the richer potash portions of the bed is so generally expressed throughout the field that it must have some foundation in fact, although perfectly white or transparent crystals of almost pure potassium chloride have been found. Examination in detail shows that the coarse crystals, both red and white, are much intermixed, and it is not usually possible to trace a distinct boundary



TYPICAL VIEWS OF THE MINE WORKINGS

Fig. 4. One of the main galleries.
Fig. 6. Loading cars at the end of a gallery.

Fig. 5. Drilling at the end of a gallery.
Fig. 7. Present method of mining.

between them, but in general aspect the banding is very distinct.

The top and bottom of the potash beds, where the salts rest against adjacent clay or shale seams, are very clearly defined. The shale leaves a very clean surface in the roof of the mine, marked by some irregular pits or patches, but usually breaking clean from the salts. This is also true of the clearly defined shale seams that occur within the potash bed.

The two beds preserve their individual characteristics, including general thickness and relation to each other, as well as details of the shale partings and chemical character of the constituent members, with remarkable constancy throughout the field. The upper bed, containing a richer grade than the lower bed, is the thinner.

MINING METHODS

The room-and-pillar method of mining was employed by the Germans. Long parallel evacuation galleries from 475 to 650 ft. in length and from 140 to 200 ft. in width were used to remove salt from the minor galleries. The large wall separating these parallel galleries was removed during the process of mining. Inasmuch as no shoring or timbering was used, pillars or columns 6 ft. square and 12 ft. apart were left as supports. A map or plan of the galleries gives one the impression of a large checkerboard. These pillars were too weak to support the great weight of the roof and very often would break under the enormous overhead pressure. The Germans tried to reinforce them, filling in spaces with hollow wooden columns, the centers of which were filled with common salt (the waste byprod-

uct obtained in the manufacture of muriate). This method gave no security either against cave-ins, which frequently occurred without warning, or against fire-damp, caused by the bituminous slate forming the roof of the strata.

Electric and compressed air drills are used, and from 500 to 600 g. of explosive materials are required for each ton of crude salt extracted. The temperature in the galleries is about 95 deg. F., but the ventilation system employed reduces this to a temperature of about 80 deg. in the working galleries.

SURFACE TREATMENT

Some idea of the extent and arrangement of the crushing and refining plants can be gained from Figs. 8 to 10. The salts are brought to the surface by electric or steam hoists (Fig. 11). Rotary dumps (Fig. 12) discharge the contents of the cars into storage bins. From these the salts pass to a jaw crusher, where the coarser lumps are broken to about the size of a man's fist, and the material is then spread on a revolving table, where it is sorted hurriedly by one or several workers, who remove the larger lumps of waste that happen to come to the surface with the rest. From this table it is fed to a lower level into grinding mills, which are of several types. From these the material either passes into storage for shipment as crude salts or goes into the refinery. The arrangement of the crushing machinery is shown in Fig. 13.

If the material is to be refined, it is elevated and passed through a screen. The fines, relatively cleaner and purer, go directly to boiling vats, and the coarse material, which includes more shale, is returned to the

mills for regrinding. It is then transferred, usually by belt, into hoppers, from which at intervals it is fed into boiling vats fitted with agitators.

REFINING

The refining is based on the difference in solubility of the mixture of chloride of potassium and chloride of sodium in hot or in cold water. As shown by the solubility curves, Fig. 14, one hundred c.c. of water can dissolve:

	KCl	NaCl
	g.	g.
at 100 deg. C.....	35.9	25.7
at 10 deg. C.....	12.5	29

A warm saturated solution of potassium chloride and of sodium chloride deposits 23.4 g. of potassium chloride on cooling, but as the solution is not saturated in sodium chloride this latter does not precipitate. Actually, due to loss by evaporation, a little of the sodium chloride is also precipitated.

The raw salts are heated with mother liquor derived from previous crystallizations, at about 225 deg. F. The liquors and salts from these solution vats are discharged periodically, and the residue is drawn into draining vats which have perforated bottoms and revolving rakes, the latter assisting the draining of the residue while it is still hot (at about 195 deg. F.). When the free liquor is practically all run off, the residue is thrown out at the edge by means of the revolving rakes and goes to waste, usually being returned to the mine to fill old workings. The moist residue still contains several per cent of potash.



FIG. 8. GENERAL VIEW OF AMELIE MINE



FIG. 9. ANOTHER VIEW OF AMELIE MINE

The liquor then goes to settling vats, where it stays about fifteen minutes, beginning to crystallize on the surface almost at once. A long glass tube thrust into the solution, then closed at the top and withdrawn, shows the progress of settlement of the muddy slime, and a hinged drainage pipe is let down into the vat, so that its outlet end follows the rather distinct limit of the clear liquid. The mud and salt left in the bottom of the tank are again washed with hot mother liquor.

The liquor, which is still distinctly muddy and with a temperature of about 195 deg. F., is drawn from the settling tanks through troughs to a battery of iron crystallizing vats of the ordinary type (Fig. 15), where as it cools it deposits the crop of muriate (potassium chloride) of varying degrees of purity, the quantity and quality of the product obtained depending somewhat on the care with which the various steps of the process are conducted, the length of time allowed for crystallizing and the amount of chilling. After the mother liquor has stood for several days it is withdrawn and returned to the process. The crust that forms with each cooling is from 2 to 5 in. thick on the sides of the tanks and somewhat thicker at the bottom. The salt is dug out of the crystallizers by hand and loaded over the sides into tramcars, whence it is taken to a rotary drier, where any surplus moisture is removed before bagging.

The coal consumption is about 600 lb. for 1 ton of muriate of potash, and 3 tons of crude salts are used to produce 1 ton of muriate.

STATUS OF THE MINES DURING AND AFTER THE WAR

The following table gives the quantities of crude salts extracted from various mines during the war:

	1913 Tons	1914 Tons	1915 Tons	1916 Tons	1917 Tons	1918 Tons
Reichsland	15,103	38,847	41,364	50,335	81,787	79,674
Amelie I.....	137,876	53,335	14,434	.....	.....	3,290
Amelie II.....	.....	30,550	.....	.....	.....	.....
Max	35,656	23,048	2,250	37,086	43,378	34,818
Joseph	21,875	23,197	.....	.....	.....	.....
Else	23,665	23,826	.....	.....	.....	.....
Theodore	47,608	39,244	22,698	90,623	159,044	173,706
Prince Eugene ..	47,608	39,243	22,698			
Marie	9,634	15,143	5,457	12,910	4,344	27,151
Marie-Louise ...	7,080	15,143	5,457	13,220	27,701	
Alex	1,600	24,310	.....	300	3,877	14,860
Rudolph	2,636					
Total	355,341	325,886	114,358	204,474	320,131	333,499

From this is noted the very large quantity extracted from the mines Theodore, Prince Eugene and Reichsland during the year 1917-1918. This intensive extraction left the galleries in such a deplorable condition

that it took many months' labor and much expense to get them in working order. The elevator of the Alex mine, which was undermined by water when the shaft was flooded, was repaired during the war by the German management, but it is only since the French regained possession of the mines that pumping out and reparation has been undertaken in the other flooded shafts. The shafts Marie and Else have been repaired. The shaft Rudolph has been pumped out, but about 600 ft. of masonry must be repaired and a new elevator installed. The shaft Ensisheim I has been pumped dry and entirely repaired. Sinking, which must go down to approximately 2,600 ft., has been continued. The shaft Ensisheim II is in a similar state. As soon as the shaft has been pumped dry, it is necessary to repair at once the concrete lining in order to prevent further seepage of water. Seepage commences in most of the mines, especially in Anna I, at about 600 ft. below the surface.

When one takes into consideration the wasteful methods employed by the Germans and the deplorable con-



FIG. 10. HEADFRAME AT AMELIE SHAFT

dition in which they left the mines, some conception can be obtained of the enormous difficulties encountered and successfully overcome by the French engineers.

It has been stated above that the Alsatian potash deposit consists of two layers: One from 9 to 12 ft. in thickness; the other from 3 to 4½ ft. in thickness, the latter lying only 60 ft. above the former. The Germans, with their usual lack of foresight and wasteful methods, commenced operations on the lower layer first, and inasmuch as no supports or timbering were

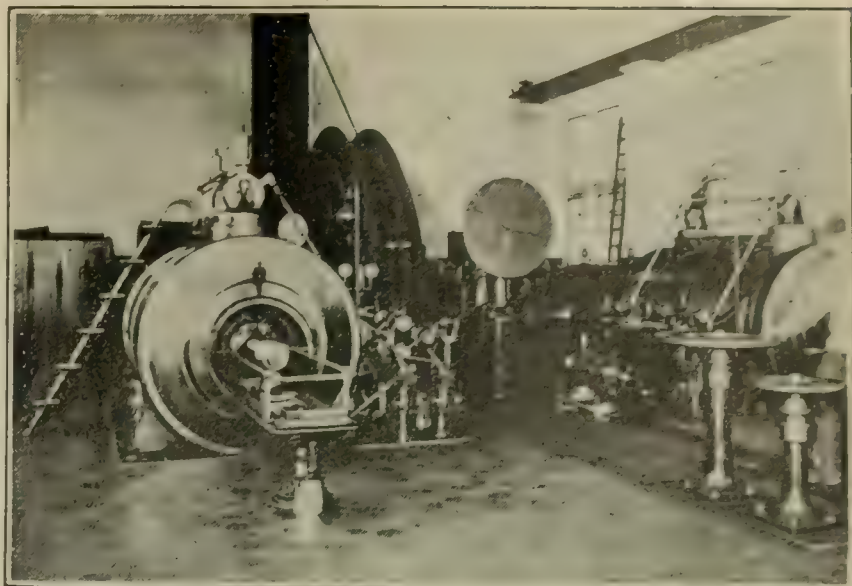


FIG. 11. STEAM HOISTING-ENGINE

used, this rendered exploitation of the upper layer very difficult, if not dangerous. In some parts this upper layer, which contains the richest salt, may be considered as lost.

In order to protect the shafts, the working galleries are begun only beyond a circle whose radius depends on the depth of the shaft, leaving shaft pillars which prevent the weakening of the strata surrounding the pits. Otherwise the concrete lining of the shafts would crack and break, rendering them unfit for future use. The Germans started their working galleries within a radius of 150 ft. Had this method been continued, cave-ins would have been inevitable and in a short time the mines would have been completely ruined. This practice has been stopped and measures have been taken to insure both the safety of the shafts and the machinery. Therefore the shaft pillars have been extended from 150 ft. to 600 ft. by French engineers.

PRECAUTIONS AGAINST FIREDAMP

The Germans were fully aware of the presence of firedamp, yet they did nothing to guard against this enemy of the miner. Firedamp in the potash mines comes from the slate beds located either in the roof or walls in the vicinity of the layer. It exudes from the slate beds only when the latter are reached by drilling or are dislocated by sinkings. Otherwise, the slate beds contain a very small amount of firedamp, since notwithstanding the experiments made with air currents in the old unembanked work, where the roof sinks by degrees, its presence is not revealed. Firedamp in the Alsatian mines is dangerous only when

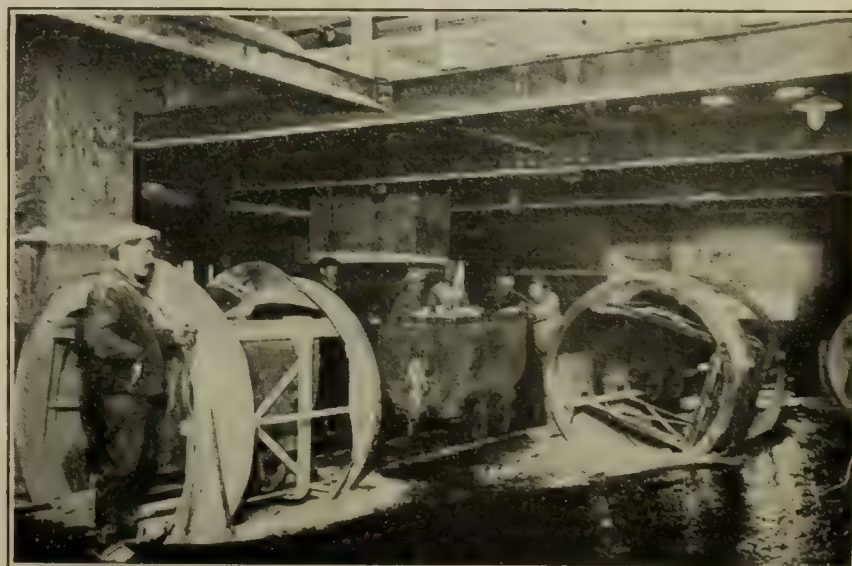


FIG. 12. ROTARY DUMPS

sudden landslides occur in the parts worked by the room-and-pillar method. In this event the small amount contained in the slate is quickly freed and produces a sufficient amount of gas to form a flammable mixture with the surrounding air.

The principal precautions to be taken in the avoidance of accidents due to firedamp are known, and are as follows: The use of safety lamps; good ventilation; the suppression of instantaneous liberations of firedamp by use of modern mining methods.

None of these precautions was taken by the German exploiters. The lamps used were ordinary acetylene or flame lamps. The ventilation was the natural one created between the connecting shafts of each working. There were ventilators in some of the mines, but none were in working order. No preventive measures were taken against instantaneous emissions of firedamp. At the shafts Theodore and Marie-Louise the work was done by the room-and-pillar method, which left square pillars 12 to 15 ft. with unshored spaces.

At the shaft Amelie long chambers 15 to 19 ft. wide were worked, leaving 15 ft. of salt between the chambers. This pillar-and-chamber method was somewhat better than the one employed at the shafts Theodore and Marie-Louise, in the sense that the long walls are more resistant to cave-ins than the pillars, in that they allow only a slow sinking of the roof and a slow influx of firedamp. However, this method is no guarantee against sudden possible sinkings. In addition, 25 per cent of the salts at Theodore and Marie-Louise was lost by the use of this method, and 40 to 45 per cent at Amelie.

Various precautions have been adopted in order to lessen this danger of coal gas. Flame lamps have been

present time to prevent all sudden cave-ins and thus reduce to a minimum the dangers of firedamp. This will have, among other advantages, that of allowing the removal of all the salt, whereas by the German method, 25 to 50 per cent was lost. Thanks to the new arrangements of the galleries and improved ventilation, the work has been facilitated. In this manner, cave-ins of the roof of the galleries will be prevented. Nevertheless, the danger from firedamp is extremely small. There is no continuous emission of gas, as it is never detected in the air coming from the mine.

STORING EXPLOSIVES IN THE MINES

The removal of the salt is done by the use of explosives, generally compressed black powder. Since the

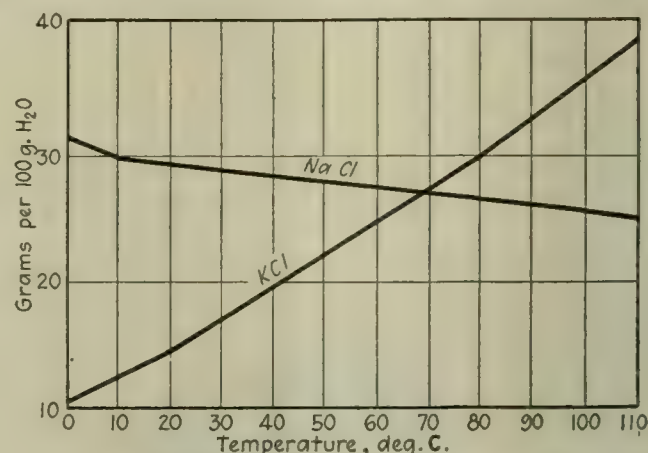


FIG. 14. SOLUBILITY CURVES

consumption for each ton of crude salt is a little over a pound, the total consumption for a shaft which has a daily output of 500 tons will be from 550 to 600 lb. Thus it is necessary to have a large quantity of explosives in the mine proper. Fulminate of mercury detonators are used, and these are very sensitive to shock.

The Germans, regardless of the danger to life as well as to the safety of the mines, stored large quantities of explosives and detonators together. The correct procedure is to distribute the explosives to the miners in separate rooms far from the main storerooms, so that if an explosion occurs during the handling of the cartridges, it will not be communicated to the whole supply. At present, detonators are in separate rooms and the distribution rooms are at some distance from the supply rooms.

WEIGHING APPARATUS

It is absolutely necessary that in a plant which sells only a fraction of its product in the crude state and

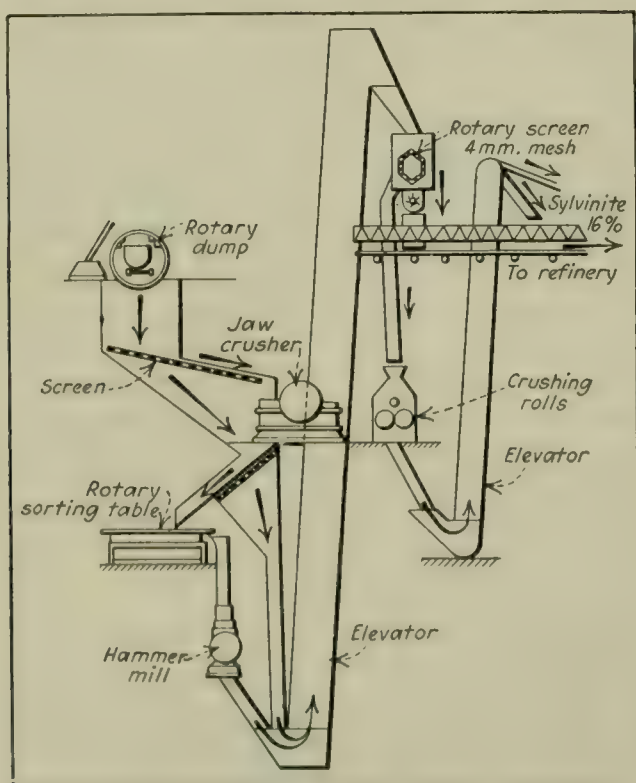


FIG. 13. CRUSHING AND GRINDING MACHINERY

replaced by safety lamps. The new directors, who were formerly directors of coal mines, use natural ventilation, which, by a system of deflectors or doors, forces the air through all the working galleries. These are used wherever they were formerly installed. The possibility of the formation of firedamp has been lessened by abandoning the room-and-pillar method of mining and by using instead the pillar-and-chamber method in those parts where bracing is still impossible.

Another method of mining is being tried at the



FIG. 15. CRYSTALLIZING TANKS

the remainder as refined, there should be weighing apparatus in order to know exactly the quantity delivered to the plant, and therefore to know exactly the yield. The Germans had no scales and there were weighing machines for the cars only, and no attempt was made to increase production.

DIFFICULTIES OVERCOME BY NEW MANAGEMENT

Other instances of the peculiarities in the German methods of working the mines are: The exaggerated length of the research galleries, which run in directions without any rhyme or reason; the floor level of the main galleries is irregular; in the mine Amelie, for example, the width of the tracks is not the same for the two communicating parts of the mine, so that the cars of one part cannot go to the other shaft.

All these numerous errors committed by the Germans imperiled not only the future of the mines but also constituted a permanent danger to the safety of the miners. In all cases the less important mistakes only occasioned heavy operating expenses and prevented the mines from reaching their highest state of development. These errors are so numerous that one is led to believe that they were made intentionally to hinder the future development of the basin.

It is not only these obstacles that the French have overcome but it is also necessary to repair and install new machinery, mobilize an entirely new and efficient executive staff, capable of meeting all conditions and of rendering, by modern methods, a highly developed organization, capable of supplying the potash needs of the entire world.

FACILITIES FOR DISTRIBUTION OF PRODUCTS

Alsace-Lorraine has ample transportation facilities to insure quick delivery to all parts of the work, either by water or by rail. When the Rhine is navigable, the potash is shipped by rail to Strasbourg, where it is loaded on barges which proceed directly to Antwerp, at which point it is loaded on steamers. When the Rhine is too low to permit navigation, the potash is shipped directly from the Alsatian mines to Dunkirk or Antwerp, and from there by steamer to the various markets of the world.

In order to facilitate the sale and distribution of Alsatian potash salts, the Société Commerciale des Potasses d'Alsace was formed with one end in view—i.e., giving service and satisfaction to its buyers in order to come into more direct touch and intimate relations with the largest market of the world, namely, the American. As an indication of ability to supply the American market, the following tonnages are announced as available for export to the United States between May 1, 1921, and March 31, 1922:

	Tons	K ₂ O Tons
Kainite (sylvinite), 14 per cent.	420,000	60,000
Manure salts (rich sylvinite), 20 per cent.	500,000	100,000
Muriate of potash, 50 per cent.	100,000	50,000
High grade muriate of potash, 60 per cent.	12,000	6,000
	1,032,000	216,000

For sales purposes, the lower grades are referred to as kainite and manure salts because these terms have become firmly established in the trade.

The Société has recently opened its United States bureau in New York at 25 West 43rd St. The object of this bureau is to come into direct touch with the American fertilizer manufacturer and to increase the good feeling which has always existed in the past between the American consumer and the Alsatian potash industry.

Some Synthetic Resins From Furfural

BY GERALD H. MAINS AND MAX PHILLIPS

A PRACTICAL method for the cheap production of furfural, 2-furfuraldehyde, $C_5H_4O_2CHO$, has recently been developed in the Bureau of Chemistry,¹ and furfural promises to become one of the cheap organic chemicals. Relatively few commercial uses have as yet been developed for this product, and the bureau is now carrying on an investigation for the development and extension of this field. The present paper is a preliminary report on one phase of the work.

RESULTS REPORTED IN THE LITERATURE

That furfural reacts with various compounds, especially phenols and amines, to form products of a tarry or resinous character more or less indefinite in composition has long been recognized in the literature.² The scarcity and very high cost of furfural made these reactions, however, of very little importance. During the past four or five years furfural has been produced on a small scale in France from wood and kapok waste. The recent work of Roger Adams at the University of Illinois,³ and of LaForge,⁴ Monroe⁵ and the authors at this bureau has further demonstrated the practicability of securing in this country furfural in large quantities and at a reasonable cost from corncobs. Thus the possibility of producing synthetic resins from furfural is brought within the realm of economic importance.

A good foundation has been laid for the study of the formation of the hard or infusible type of resin by the condensation of furfural with phenols in the rather extensive investigation of Beckmann and Dehn.⁶ Meunier⁷ has made some resins of the soft, fusible and soluble type by the action of furfural with sodium hydroxide, ammonia, acetone and aniline. The present paper will be limited to a consideration of this latter type, which is suitable as a varnish resin. We have made a more extended study of the conditions under which the resins described by Meunier are formed, and have studied the formation of soluble resins by the condensation of furfural with a number of other compounds.

EXPERIMENTAL

The method of attack was to determine first the optimum concentrations of amine (or other compound under test) and furfural for the formation of a resin at room temperature, approximately 25 deg. C. Five-gram portions of furfural were used and from one-fifth to three times that weight of the other compound. Where no resins at all were obtainable at room temperature the optimum concentrations were determined at 100 deg. C. Using the concentrations which gave the best results in the previous experiments, resins were made at certain readily obtainable laboratory temperatures: room temperature, 25 deg. C.; the temperature of boiling water, 100 deg. C., and that of a paraffine

¹The work on the production of furfural was suggested by Dr. F. B. La Forge of this bureau, and is an outgrowth of the general corncob utilization project which he is developing. Cf. *J. Ind. Eng. Chem.*, vol. 10, p. 925 (1918), *Chem. Age*, vol. 28, p. 332 (1920).

²Cf. J. Persoz, *Wagner's Jahres-Bericht der Chem. Technologie* (1860), p. 487; J. Stenhouse, *Proc. Roy. Soc.*, vol. 18, p. 537 (1870).

³Roger Adams, O. Kamm and C. S. Marvel, *Univ. Ill. Bull.* 16, No. 43, p. 5 (1919).

⁴*Loc. cit.*

⁵K. P. Monroe: U. S. Pat. 1,357,467; *J. Ind. Eng. Chem.*, vol. 13, p. 133 (1921).

⁶E. Beckmann and E. Dehn, *Sitzb. kgl. preuss. Akad.* (1918), p. 1,201; *Chem. Abs.*, vol. 14, p. 642 (1920).

⁷George Meunier, *Mat. Grasses*, vol. 9, p. 4,516 (1916).

bath, 150 to 200 deg. C. Having determined the optimum temperature, the length of time necessary under the given conditions to form the most satisfactory resin was similarly investigated.

It might appear that the temperature could have been more finely adjusted than in our experiments, but in view of the fact that the resins are not pure compounds, but products of an indefinite and varying composition, and that the same consistency of resin can be produced over a rather broad range of temperature by varying the length of heating period, it was felt that in this work we should hold to certain readily obtainable temperatures and let the time be the variant. Our criterion of the quality of the resin was simply that it should be hard and fairly brittle when cooled to room temperature and yet not noticeably carbonized.

In some cases no resins were formed without the addition of a catalyst. Beckmann and Dehn⁸ used hydrochloric acid as a catalyst in their work on making infusible resins by condensation of furfural with phenols. We have found that hydrochloric acid is an exceedingly effective catalyst in producing resins from furfural. It not only effectively catalyzes the formation of both fusible and infusible types of resins from furfural and other compounds, but added to furfural alone causes the formation of an infusible resin. Its salts are also catalysts, but not quite as effective.

The results obtained with each compound follow, the reactions being carried on in an open flask unless otherwise stated, and all proportions being given by weight.

CONDENSATION WITH AMINES

Aniline. Equal parts of furfural and aniline heated for one hour at 200 deg. C. in an open flask or for three hours at 170 deg. C. in a flask attached to a reflux condenser give a black resin, hard and brittle at 25 deg. C.

Aniline Hydrochloride. Equal parts of furfural and aniline hydrochloride heated at 100 deg. C. for one hour produce a black resin, hard and brittle at 25 deg. C.

Aniline plus Hydrochloric Acid. Five parts each of furfural and aniline and one part of concentrated hydrochloric acid, sp.gr. 1.19, give a resin similar in characteristics to the above in ten minutes at 90 deg. C.

m-Nitraniline. By heating one part of furfural and two parts of *m*-nitraniline at 150 deg. C. for one hour and fifteen minutes a black resin becoming hard and brittle at 25 deg. C. may be obtained. If the temperature exceeds 175 deg. C. a violent reaction occurs giving off voluminous clouds of dense brown smoke.

Cymidine plus Hydrochloric Acid. Five parts of furfural, five parts of cymidine (1-CH₃,2-NH₂,4-isopropyl benzene) and one part of hydrochloric acid (sp.gr. 1.19) heated at 150 deg. C. for ten minutes give a dark reddish brown resin very hard and brittle at 25 deg. C. Without the presence of hydrochloric acid no resin is formed even after heating for three hours at 200 deg. C.

α-Naphthylamine. When heated for three hours at 200 deg. C. one part furfural and two parts α-naphthylamine condense to form a black resin, hard and brittle at 25 deg. C.

β-Naphthylamine. One part of furfural and two parts of β-naphthylamine mixed at room temperature, 25 deg. C., give the immediate formation of a reddish-brown hard, brittle resin.

o-Toluidine plus Hydrochloric Acid. By heating five

parts of furfural, ten parts of *o*-toluidine and one part of hydrochloric acid (sp.gr. 1.19), for one hour at 150 deg. C., a black resin is produced which is very hard and brittle at 25 deg. C. Without the addition of the hydrochloric acid no appreciable thickening of the liquid is found even after heating for three hours at 200 deg. C.

p-Toluidine. One part of furfural and two parts of *p*-toluidine heated for two and one-half hours at 150 deg. C. produce a black resin becoming hard and brittle when cooled at 25 deg. C.

m-Toluylenediamine. Equal parts of furfural and *m*-toluylenediamine, upon standing over night at room temperature, 25 deg. C., give a dark brown, hard, brittle resin.

Xylidine plus Hydrochloric Acid. By heating five parts of furfural, five parts of xylidine (crude mixed) and one part of hydrochloric acid (sp.gr. 1.19) together for fifteen minutes at 150 deg. C., a very thick, dark red, almost black, resin is formed, very hard and brittle at 25 deg. C.

Other Amines. No resins were formed by the action of furfural on amylamine, dimethylaniline, diphenylamine and *m*-phenylenediamine even after heating at 200 deg. C. for three hours. Furfural condensed with the following at room temperature to form crystalline compounds: *p*-nitraniline, benzidine and toluidine.

CONDENSATION WITH KETONES

Acetone plus Sodium Hydroxide. One part of furfural, one part of acetone and two parts of 50 per cent sodium hydroxide solution when heated in flask attached to a reflux condenser for thirty minutes at 100 deg. C. condense to give a dark brown solid mass. By washing out the excess alkali with dilute acid, drying at 100 deg. C. and cooling to room temperature a hard, brittle, brown resin is formed.

Methyl Ethyl Ketone plus Sodium Hydroxide. Five parts of furfural, two parts of methyl ethyl ketone and five parts of 50 per cent sodium hydroxide solution give almost immediately at room temperature, 25 deg. C., a dark brown gum. By washing out the excess alkali with dilute acid, drying at 100 deg. C. and cooling to room temperature, a hard brown resin is obtained.

MISCELLANEOUS CONDENSATION REAGENTS

Ammonium Hydroxide (Furfuramide Resin). To an aqueous solution of furfural an excess of ammonium hydroxide is added. The furfuramide formed, partially dried and heated for one hour at 100 deg. C., gives a reddish brown resin hard at room temperature.

Sodium Hydroxide followed by Hydrochloric Acid. One part of furfural and seven parts by weight of a 25 per cent sodium hydroxide solution are heated together for one hour in a flask attached to a reflux condenser. Concentrated hydrochloric acid (sp.gr. 1.19) is then added in excess and a black resin is formed, the excess of acid is washed out and a medium hard tar is formed which gradually becomes brittle upon standing.⁹

GENERAL PROPERTIES OF RESINS PRODUCED

The resins do not have sharp fusion points, softening gradually till fluid. The softening temperature of the resins made as described lie between 25 and 100

⁹The conditions for forming this resin are satisfactory only within a narrow range. If more dilute acid than the above is used a poor resin or none at all is formed. If the excess hydrochloric acid is not thoroughly removed the resin will change to the insoluble and infusible type.

deg. C., but have not been carefully determined, since the softening point can be raised to almost any reasonable temperature desired by simply heating the resins at higher temperatures or for a longer period of time.

All of the above resins are practically insoluble in water. They are somewhat soluble in turpentine, quite soluble in benzene, acetone and alcohol, and very soluble in furfural. The acetone, benzene and furfural solutions of these resins form varnish stains which when applied to wood give shades ranging from golden brown to black, depending upon the resin, the concentration of the solution and the number of coats applied. The surfaces thus coated have a glossy appearance.

APPLICATIONS

Of the furfural resins described those which are produced from cheap enough materials to be of possible practical importance at the present time are: furfur-aniline, furfur- α -naphthylamine, furfur-*o*-toluidine, furfur-xylylidine, furfur-acetone, furfur-methyl ethyl ketone, furfur-amide, and furfur-sodium hydroxide resins.

The appearance of the varnish stains on white oak when the resins are applied in a single coat from the saturated benzene and furfural solutions is given in Table I.

TABLE I. APPEARANCE OF FURFURAL VARNISH STAINS ON WHITE OAK

Resin	Shades Given by One Coat of Resin	
	Applied in Saturated Benzene Solution	Applied in Saturated Furfural Solution
Furfur-aniline.....	Light brown	Dark brown
Furfur- α -naphthylamine.....	Dark brown	Nearly black
Furfur- <i>o</i> -toluidine.....	Medium brown	Dark brown
Furfur-xylylidine.....	Dark reddish brown	Dark reddish brown
Furfur-acetone.....	Golden brown	Dark brown
Furfur-methyl ethyl ketone....	Golden brown	Golden brown
Furfur-amide.....	Reddish brown	Reddish brown
Furfur-sodium hydroxide.....	Medium brown	Dark brown

By allowing the furfural solutions to evaporate somewhat and applying several coats, furfur-aniline, furfur- α -naphthylamine, furfur-*o*-toluidine and furfur-xylylidine resins give beautiful black enamels. The furfur-sodium hydroxide resin also gives a black enamel, not quite as good as the others.

The resins are all derived from furfural, and furfural is an excellent solvent for them. The source of furfural, corncobs, is practically unlimited, and with a large demand the price will be very low.¹⁰

CONCLUSIONS

With the improvement by the Bureau of Chemistry of the processes for the production of furfural cheaply and on a large scale, resins made from it become of economic importance. The optimum conditions for the production of fusible resins suitable for use in varnishes by the condensation of furfural with amines, ketones and other compounds are given. It is shown that eight of these resins—namely, furfur-aniline, furfur- α -naphthylamine, furfur-*o*-toluidine, furfur-xylylidine, furfur-acetone, furfur-methyl ethyl ketone, furfur-amide and furfur-sodium hydroxide resins—can be produced from cheap enough materials to be of practical importance under present conditions. The varnish stains given by these resins in benzene and furfural solutions and their appearance when applied to oak are described.

Color Laboratory,
U. S. Bureau of Chemistry,
Washington, D. C.

¹⁰Furfural was quoted in this country at \$65 per lb. in 1917, \$30 in July, 1920, \$20 in December, 1920, and \$10 in January, 1921, is being produced in this laboratory (even with a very small apparatus) at a cost of less than \$3 per lb., and we estimate can, on a large scale, be produced for less than 10c. per lb.

Synopsis of Recent Chemical & Metallurgical Literature

Growing Uses of Magnesium.—The late war has contributed to a better appreciation of the important properties of magnesium metal, and its industry is now growing steadily. Its most useful properties are the low specific gravity (1.75), the great affinity for oxygen, and the very high heat of combustion. These last two properties make it one of the best reducing agents in metallurgy. As a deoxidizing agent it is utilized for the purification of aluminum, copper, nickel, brasses, bronzes and alloys of copper and nickel. When introduced in a galvanized material it gives a thinner and more brilliant coating. It is to be expected that it will be used as a deoxidizer in the steel industry as soon as means are found to slow down the intensity of its oxidizing action.

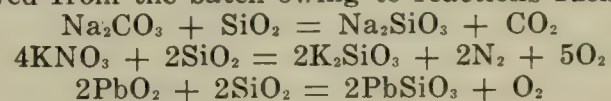
The alloys of magnesium, especially the magnesium:aluminum alloys, are bound to be used more extensively, due to their being very light. During the war the Germans made extensive use of a 90Mg:10Al alloy known under the name of elektron. Alloys known as magnalium, with 30 per cent Mg, have their resistance greatly improved by mechanical work such as forging, hammering and drawing. Other important magnesium alloys are known under the names of zimalium and duralumin. The demand for light and at the same time resistant alloys in the aeronautics industry especially is growing fast.

The electric and thermic properties of magnesium are also very important. Its electric conductivity is about 30 per cent of that of copper and, taking its thermic conductivity as 100, that of aluminum and of iron would be respectively 86.5 and 9.8.

The Société d'Electrochimie et d'Electrometallurgie of Clavaux (Isère) is now working extensively on the development of the magnesium industry.—*J. du Four Electrique*, March 1, 1921, p. 23.

Dissolved Gases in Glass.—All varieties of glass, even at ordinary temperatures, are in the liquid state of aggregation. They are liquids which have been cooled through their normal crystallization interval so rapidly that there has not been time for crystallization ("devitrification") to occur. In principle any liquid can by supercooling be brought into the condition of a glass, but since it still remains a liquid, it should possess the characteristic properties of liquids, including the power to hold gases in a state of solution.

During the process of manufacturing glass, large quantities of gas, mainly carbon dioxide, oxygen and nitrogen, are evolved from the batch owing to reactions such as:



On cooling the glass these gases should remain in solution and glass in the finished state may therefore be expected to contain appreciable quantities of these dissolved gases. Since no data concerning the nature or amounts of such dissolved gases were available, experiments were undertaken by E. W. WASHBURN, F. F. FOOTITT and E. N. BUNTING. The preliminary results have been published in Bulletin 118 of the Engineering Experiment Station, University of Illinois.

The existence of dissolved gases was demonstrated by melting a piece of perfectly clean homogeneous glass under atmospheric pressure in a vacuum furnace connected through a valve to a large evacuated tank. When the temperature reached about 1,200 deg. C. the valve was opened quickly, thus causing a sudden drop of pressure within the furnace. On opening the furnace (after cooling) most of the glass was found outside the pot, standing above it in the form of a large white mass of foam about six times the size of the original piece.

By the use of specially designed apparatus, analyses were made of the gas content of three types of commercial glass:

A barium flint optical glass; a light flint bulb glass; a borosilicate laboratory glass. Carbon dioxide, oxygen and nitrogen were found in varying amounts, the total volume (measured under standard conditions) being from 0.2 to 2 times that of the glass itself.

Evolution of dissolved gas tends to occur in the form of bubbles or "seed" whenever the pressure on glass, while in the fluid state, is decreased. Such a condition is met with in cases where the glass is "gathered" by suction, as in the case of the Owens machine. If the glass when it reaches the gathering machine is supersaturated with dissolved gases, the operation of gathering will evidently result in the formation of seed, some of which will not disappear again when the suction is released.

Results thus far attained indicate that a vacuum furnace process for the manufacture of certain types of glass is entirely feasible on an industrial scale, and that it offers a number of pronounced advantages over current methods. It eliminates entirely the fining operation as ordinarily understood, materially reduces the high finishing temperatures required with some glasses, produces in all cases a product absolutely free from even the smallest seeds, and these results suggest the possibility of considerably increasing the yield of perfect glass. Its main field of usefulness will probably be in the manufacture of certain types of optical glasses and in the manufacture of glass for high-vacuum apparatus.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Ammonium Sulphate.—Ammoniacal gas from coke ovens is led through coolers to a gas exhauster followed by a tar extractor. From the tar extractor the gas, moist and cooled, passes into the cracker pipes of the first two of three saturator compartments, which are separated by partitions but provided with connecting ducts for the overflow and interchange of portions of the saturation bath. The moist gas gives up its ammonia with relatively limited formation of ammonium sulphate and without appreciable incrustation within the saturator or salting up of the cracker pipes through which the gas enters. The ammonia-freed gas is passed through an acid separator and a heater and is then returned to the third compartment of the saturator, where it supplies the heat required for evaporation and consequent deposition of ammonium sulphate from the saturation bath. By means of an elaborate system of pipes, valves and bypasses, the order of the three saturator compartments may be changed at will. Separation of tar and ammonia liquor and recovery of the latter by distillation are accomplished in the usual manner. (1,366,111; JOSEPH BECKER, of Pittsburgh, Pa., assignor to the Koppers Co.; Jan. 18, 1921.)

Diaphragm for Electrolytic White Lead Cell.—In carrying out the Harrington process for the electrolytic manufacture of white lead considerable difficulty was experienced in obtaining diaphragms possessing the necessary mechanical strength, durability and the proper degree of porosity. It was practically impossible to maintain a cell in uninterrupted operation for more than a few days. An improved diaphragm has been designed by ELMER A. SPERRY, of New York, which permits of continuous operation for many weeks. One method of making such a diaphragm is as follows: A piece of duck canvas of suitable size and preferably of comparatively fine weave is first freed of grease by treating it with a caustic solution. The fabric is then subjected to a strong sulphuric acid bath (1.750 sp.gr.) for a length of time depending on the osmotic and

impervious qualities desired, say 30 to 45 min. Excess acid is washed off and finally neutralized in a bath containing about 5 per cent of sodium or ammonium hydroxide. Such diaphragms swell when moist and tend to crack and tear when allowed to dry on frames. It is necessary therefore, that they be kept moist before and after they are mounted on the frames. The chief difficulty in accomplishing this is to prevent the drying of that portion of the diaphragm which is unsubmerged in the electrolyte. This area is best covered by strips of treated cloth large enough to dip in the electrolyte and sufficiently absorbent to draw up electrolyte by capillary action and thus keep the diaphragm moist. (1,368,227, assigned to Anaconda Lead Products Co.; Feb. 8, 1921.)

Ammonium Perchlorate Blasting Powder.—Ammonium perchlorate explosives of relatively low strength are desirable for use in many operations but, as ordinarily made, they cannot be used in wet work; they harden and set during storage, and they are relatively insensitive. ARTHUR LANGMEIER of Dover, N. J., has found that a coating of trinitrotoluene on the particles of ammonium perchlorate and sodium nitrate used in this class of explosives not only renders the powder waterproof but facilitates storage and makes it possible to explode the charge with a No. 6 standard detonator. It is essential that the trinitrotoluene should form a protective film and not be present simply as an ingredient of a mixture. The ammonium perchlorate and sodium nitrate are placed in a steam-jacketed crystallizing and agitating kettle maintained at a temperature above the melting point of trinitrotoluene. After adding the trinitrotoluene the mixture is cooled with constant agitation. A preferred composition is as follows: 20 per cent ammonium perchlorate coated with TNT; 49 per cent sodium nitrate coated with TNT; 20 per cent trinitrotoluene; 10 per cent sulphur; 1 per cent wood pulp. (1,367,608; assigned to Hercules Powder Co.; Feb. 8, 1921.)

Fused Silica.—Fused silica articles may be made by reducing silica to plasticity in an electric resistance furnace and then blowing the plastic mass into molds. However, at the temperature required for this purpose gas is given off from the carbon or graphite core. This gas diffuses through the plastic mass and the finished article is therefore not homogeneous. By surrounding the resistance core with a thin graphite tube somewhat larger than the core, a space is formed through which the gases may escape. The space between this thin tube and a larger two-part graphite jacket is filled with the silica to be fused. After current has been passed through the core for a sufficient time, a plastic cylinder of fused silica is formed. This is then removed from the furnace and placed in a mold. A graphite nozzle is inserted in the hole through the center of the mass and superheated steam admitted under pressure so as to cause the mass to take the shape of the molds. (1,368,990; JOHN SCHARL, of New York, assignor to General Ceramics Co.; Feb. 15, 1921.)

Coke-Oven Construction.—A more uniform coke is obtained in an oven constructed so that the distillate can be drawn off in the usual way until the peak temperature is reached and can then be drawn off in the opposite direction. Steam is also admitted during the latter phase of the operation and the upper parts of the coking chambers are interconnected. The vapors and gases in passing downwardly through the charge have a cooling effect on the hotter portions of the charge and a local circulation is induced which causes heat to pass from the hotter portions to the relatively cooler portions of the charge, thereby preventing over-coking in the hotter zones but accelerating the coking of the under-done portions of the charge in the cooler zones. In addition, the steam acts according to the water gas reaction (which is endothermic), thereby absorbing much heat which would otherwise effect over-coking. In order to insure an efficient reversal of flow a channel-forming rod is forced into the bottom of the chamber by the pusher and left there until the charge has hardened enough to permit of its withdrawal without disturbing the channel. (1,369,673; HEINRICH KOPPERS, of Essen-Ruhr, Germany, assignor to Koppers Development Corp.; Feb. 22, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Chemical Warfare Service Dinner

What is expected to be a highly representative gathering of those interested in chemical warfare will take place in Washington April 16 at the annual dinner of the Chemical Warfare Service. At this dinner it is expected that a chemical warfare association will be launched.

The program has been arranged so that the chemical, as well as the military, side of the service will be brought out. Brigadier-General William Mitchell, of the air service of the Army, will discuss plans and possibilities of aerial offenses against battleships, which involve the use of smoke screens and gases. Brigadier-General Amos A. Fries will present some of the problems with which the Chemical Warfare Service now is wrestling and will outline the present character of the work being done under his direction.

General Pershing and Admiral Sims have been invited to attend and to reply to toasts.

More than 1,000 invitations have been sent out. Every effort has been made to reach all former Chemical Warfare Service officers and all reserve officers attached to that service. Arrangements are in charge of Major F. R. Maddux, of General Fries' staff. The dinner is a subscription affair and will be held at the Army and Navy Club.

Federated American Engineering Societies Activities

Permanent headquarters of the Federated American Engineering Societies have been established in Washington. A desirable location has been secured on the third floor of 719 Fifteenth St., N. W. (National Savings and Trust Building). Sufficient space has been obtained to accommodate the staff of the F.A.E.S. and at the same time provide a large lounging room or conference room for those who may desire to use the headquarters as a meeting place. It will be the purpose of the headquarters at all times to render as much personal service as possible to engineers who visit Washington. A special plan will be developed to the end that engineers visiting Washington may be able to transact business with the minimum amount of effort on their part. Engineers, therefore, are asked to notify it of an intended visit to Washington so that arrangements may be made to care for them. The executive secretary, L. W. Wallace, will be permanently located in Washington in the near future.

There is great activity in a number of states regarding the licensing of engineers. The F.A.E.S. has in every instance taken a part in such legislation. It has made an effort to have a representative at every meeting. It is not the desire of the F.A.E.S. to initiate such legislation nor to urge its passage, but it does take the position that it desires to be instrumental so far as possible toward securing the passage of a bill that will not be detrimental to public interests and to the engineering profession.

A very careful study is being made by the Employment Service conducted under the auspices of the F.A.E.S. This study purposes determining what policies should be adopted that will enhance the value and usefulness of the service to the individual members of the member-societies. This report will be submitted to the executive board at its meeting on April 16.

WORK OF COMMITTEE ON ELIMINATION OF WASTE IN INDUSTRY PROGRESSING FAVORABLY

The work of the Committee on Elimination of Waste in Industry is progressing according to schedule. It is now assured that all the field work will be completed on or before April 15. The publication of the final report of the committee will be undertaken immediately upon the com-

pletion of the field work. A definite program has been evolved for this phase of the work. Since the field investigation is going according to schedule, it is expected that the final report will also do so. The report will be published some time in June. The findings of the committee thus far are very significant and it has every reason to believe that the publication of this report will create a great deal of interest. The finest of co-operation has been obtained from all agencies approached. This has greatly aided the committee in its work.

There is a large interest on the part of engineering societies that have not yet become affiliated with the F.A.E.S. In recent weeks two have joined—namely, the Boston Society of Civil Engineers and the Engineering Society of Milwaukee. There are a number of other societies that are either voting upon it at the present time or have it under consideration by the executive board. It is reasonably sure that a number of other societies will become affiliated with the F.A.E.S. before July 1, at which time the opportunity of coming in as a charter member will expire.

The next meeting of the executive board is to be held in Philadelphia on April 16. The executive board will be the guests of the Philadelphia Engineering Club and the sessions will be held at the Engineers Club. The club is making preparations to have a large and interesting attendance. There is to be a dinner at the Bellevue-Stratford on the evening of April 16 which is to be addressed by the president, Mr. Hoover. A very large attendance of engineers is being arranged for. It is expected that this will be one of the most important meetings that the board has ever held.

American Engineering Standards

About a year ago the American Engineering Standards Committee was organized, and much of the time and effort of the committee has since been spent in laying a basis for an extended program. Considerable progress has already been made in the unification of the more important standards and in overcoming the confusion that was being produced by the numerous organizations (more than 100) that hitherto published engineering standards without systematic co-operation among themselves.

The committee itself is composed of forty-seven members representing seventeen bodies or groups of bodies, including six national engineering societies, five governmental departments and thirteen national industrial associations. Its function is merely to see that each body or group concerned in a standard shall have opportunity to participate in its formulation, which is in the hands of a working committee, technically called a "sectional committee." Each sectional committee is organized by and under the leadership of one or more of the principal bodies interested, such bodies being known as "sponsors." Sponsorships have been arranged for thirty-eight projects which were under way by the beginning of 1921.

An important part of the committee's work relates to safety codes. On Dec. 8, 1920, at a conference at which more than 100 organizations were represented it was unanimously voted that a comprehensive program of safety codes should be undertaken, to be carried out under the auspices of the American Engineering Standards Committee, to insure proper co-ordination and elimination of overlap, etc. Active work is now in progress on twenty-four such codes including "Foundries," "Gases," "Paper and Pulp Mills," "Refrigeration," "Presses," with hearty co-operation among the state commissions, associations of insurance companies, national engineering societies, manufacturers' and industrial associations, labor and civic organizations and technical bureaus of the Federal Government.

Organization of Petroleum Section, A.C.S.

The organization of a Petroleum Section has been authorized by the officers of the American Chemical Society, and it is proposed to hold the initial meeting of this section at the general meeting of the Society at Rochester, April 26 to 29.

For the Rochester meeting Dr. Thomas G. Dolbridge, Atlantic Refining Co., Philadelphia, has been appointed chairman and Dr. W. A. Gruse, Mellon Institute, Pittsburgh, secretary.

The purposes which this organization is expected to fulfill may be expressed as follows:

(1) To enable chemists and technologists engaged in the petroleum, shale-oil and natural gas industries to meet and to correspond, and to accumulate trustworthy information regarding the geochemistry of petroleum, oil-shale and natural gas, the conversion of the raw materials into manufactured products, and the characteristics and usages of these products, together with their transport and storage.

(2) To promote the better education of persons desirous of becoming petroleum engineers, refinery engineers or hydrocarbon chemists, and to elevate the professional status of those employed in the industries mentioned by establishing a high standard of scientific and practical proficiency.

(3) To encourage hydrocarbon chemistry.

(4) To co-operate with the American Petroleum Institute and with the National Research Council, and to collaborate with the American Society for Testing Materials in its work on the standardization of bituminous and petroleum products.

Fifty chemists and chemical engineers actively engaged in the petroleum industry have pledged their support and co-operation, and fifteen papers on the chemistry of petroleum have been promised for the first meeting. At this meeting it is desired also to take up such questions as that of the degree and scope of the activities of the section, the form of co-operation with other technical and scientific societies, the exact name of the section, and other interesting points. If time permits, it is planned to hold an informal symposium on the problems of the petroleum and allied industries.

All persons who desire to become members of the section are requested to send their names to the secretary. A full attendance at this organization meeting is urged and the submission of papers is solicited.

The secretary will be glad to have any suggestions which this announcement may call forth.

Chemical Problems in Cottonseed Oil and Jelly Manufacture

Monday evening, April 4, before the Rochester Section of the American Chemical Society and guests, Donald Howe, chief chemist of the Beechnut Packing Co., gave a talk on cottonseed oil and its products.

The byproducts of the vast cotton industry enter into the manufacture of many and various materials and articles of common use, such as lacquers, soap, salad oil, celluloid, etc. As in most other industries, the last few years have seen attention turned to use of heretofore waste products. It has been largely through the work of the chemist that these waste products have been converted into useful and marketable materials, and very often, as in the case of the cotton industry, the byproducts have a money value nearly equal to the main product.

For many years salad oil meant only olive oil. With the increasing cost of this oil a search was made for a desirable substitute. At first there was a good deal of popular opposition to the use of anything but olive oil for salads. The nutritive value of both peanut and cottonseed oil is practically the same as for the more expensive olive oil, and as for the taste, as Mr. Howe said, you really cannot tell the difference.

Cotton is raised in the Southern States, where the climate is semi-tropical. After picking, the cotton is taken to the gin and the seeds are removed. The seeds are graded according to moisture and quality, the latter depending on the amount of decay, size and other points. The moisture

should be lower than 10 per cent, otherwise the seeds may ferment and spoil.

The seeds are cleaned and the hulls cracked just enough to break the hulls but not to crush the seed. They are then screened to remove the hulls. The meats are then taken to the presses, where the oil is removed from the seed. The material left after removing the oil is called oil cake, which is a desirable cattle feed, having a high protein and fat content. When oil cake was first tried as a cattle feed the thinnest, poorest looking cattle were fattened, meanwhile being periodically weighed, the occasion being marked by a parade to the village scales. This practical method was one of the most effective pieces of advertising.

The oil as it is pressed from the seed is neutralized and refined. It contains some stearine, a fat having a high melting point. This is easily removed by simply cooling the oil, and as stearine solidifies it can be filtered off. The oil is bleached by fuller's earth.

With the increasing cost of lard the industrial food chemists made every effort to find a less expensive desirable substitute. They turned to cottonseed oil, but to get the oil to a solid at ordinary temperature was the problem. This was finally accomplished by the use of nascent hydrogen, which will convert the oleic acid of the oil into stearic acid of the fat having a higher melting point and being a solid at ordinary temperatures. Nickel is used as a catalyst in the hydrogenation which solidifies the oil.

This lard substitute, coming under various trade names, is a desirable and satisfactory shortening agent for all kinds of cooking. It is also well to note that its food value is about the same as lard.

MANUFACTURE OF JELLY

Mr. Howe told something about commercial jelly making and its corresponding laboratory problems. It is only within a few years that jellies have been made on a commercial scale. The old family cook book gives directions to the effect that not more than six glasses should be made at one time to be certain of the best results. But the making of jelly has been commercialized, even as most other household duties have. Jelly is made from the juice of fruits boiled down with sugar. The ability of the fruit juice to "jell" is determined by the proper combination of pectin, acid in the fruit, and sugar. Pectin is a complex carbohydrate present in certain fruits, such as apples, currants, oranges and lemons, and when boiled is converted into pectic acid, which forms calcium pectate with the calcium salts always found in the fruit.

Pectic acid and calcium pectate set to a jelly when certain fruits are boiled with water and the juice allowed to cool. When certain fruits, such as strawberries, which contain very little pectin, are desired for jelly pectin must be added. So much water should not be added to fruits that it will be necessary to boil the juice for a long time, because the acid present will so change the pectin that it will lose its ability to "jell."

At the close of his talk Mr. Howe treated the Section to Beechnut molasses popcorn bars, salad dressing and jelly.

Harry A. Carpenter, chairman of the registration committee for the National Convention, received the registration fees of those present and announced that the badges would be given out at the next meeting.

Prof. Ernest J. Woodland, president of the Section, announced that the speaker for the next regular meeting, April 18, would be Dr. Alsberg, chief chemist of the United States Bureau of Chemistry.

Civil Service Examinations

Vacancies in the Chemical Warfare Service, Edgewood Arsenal, Edgewood, Md., will be filled from the following open competitive examinations announced recently by the Civil Service Commission:

Chemist, \$3,000 to \$5,000 a year. Apply on Form 2118.

Associate chemist, \$2,000 to \$3,000 a year. Apply on Form 2118.

Junior chemist, \$1,400 to \$2,000 a year. Apply on Form 1312.

Science News Agency Founded

The establishment of an organization for the purpose of familiarizing the general reading public with the progress of scientific research has been announced at the offices of the National Research Council.

The new organization, to be known as "Science Service," has been substantially endowed and is chartered as a non-profit-making corporation. Its control is vested in a board of trustees composed of ten scientists and five journalists. The National Academy of Sciences, the American Association for the Advancement of Science and the National Research Council each elects three trustees. The personnel of the first board of trustees is announced as follows:

A. A. Noyes, director of chemical research, California Institute of Technology, Pasadena; R. A. Millikan, professor of physics, University of Chicago; John C. Merriam, president of the Carnegie Institution of Washington; D. T. MacDougal, director of the Desert Laboratory of the Carnegie Institution of Washington, Tucson, Ariz.; George I. Moore, director of the Missouri Botanical Gardens, St. Louis; J. McKeen Cattell, editor of *Science*, Garrison, N. Y.; George E. Hale, director of the Mount Wilson Observatory, Pasadena, Cal.; Vernon Kellogg, secretary of the National Research Council, Washington; R. M. Yerkes, chairman of the Research Information Service, National Research Council, Washington; E. W. Scripps, Miramar, Cal.; R. P. Scripps, Cleveland, Ohio; W. E. Ritter, director of the Scripps Institution for Biological Research of the University of California, La Jolla, Cal.; William Allen White, editor of the *Gazette*, Emporia, Kan.; Chester H. Rowell, Berkeley, Cal.; Edwin F. Gay, editor of the *New York Evening Post*.

The charter of the new organization is a wide one, authorizing Science Service to employ newspapers, periodicals, books, lectures, conferences, motion pictures and any similar educational agencies in the distribution of scientific information.

Edwin E. Slosson, for twelve years professor of chemistry at the University of Wyoming, for seventeen years literary editor of the *Independent* and author of "Creative Chemistry," "Easy Lessons in Einstein" and other popular science works, is to be the editor of Science Service. The manager is to be Howard Wheeler, formerly editor of the *San Francisco Daily News*, Pacific Coast manager of the Newspaper Enterprise Association, managing editor of *Harper's Weekly* and for five years editor of *Everybody's Magazine*.

The policy of the Service is to be one of co-operation rather than competition with existing press associations, news agencies and syndicates. It will aim to supply accurate and interesting articles on all branches of science and technology at the lowest possible cost.

Offices have been opened in the National Research Council Building, 1701 Massachusetts Ave., Washington.

Chicago Chemists Club Annual Meeting

The members and friends of the Chicago Chemists Club gathered on the night of April 1 for the informal dinner, second annual business meeting and social evening at the quarters, 315 Plymouth Court. Besides being one of the many meetings which are doing so much to weld the professional men of Chicago through close personal friendships to the advancement of chemistry in this community, it was also the occasion of the second election of officers for the coming year.

The retiring president, dean and father of Chicago chemists, William Hoskins, gave a characteristic address on club affairs. He spoke about the quiet demonstration of the success of the club launched under difficulties over a year ago, touching briefly on the benefits of the weekly meetings and the momentum gathered over the period to be taken up and augmented by the incoming administration. The club in one short year has passed through the stage of infancy and grown to full young manhood. It must become more closely linked to the affairs of the community. While the membership is small, it is made up of professional men of the better type and the organization may well take a larger part in civic activities, to become eventually a power

for better conditions in the Chicago district. There is great hope for the future and the support of all is needed in upholding the hands of the new officers to this end.

Paul Nicholas Leech, who was termed "the keystone of the arch," was called upon to describe the excellent work he had carried forward as chairman of the arrangements committee. A large part of the development of the club's progress is directly attributable to the tireless activity of Dr. Leech.

Reports by Messrs. Dunlap and Kawin showed the club to be shipshape as regards finances.

The officers for the coming year were next elected. Otto Eisenschiml, popular among chemists for his straightforward character and original wit, was unanimously elected president. L. W. Spring and W. Lee Lewis were chosen for first and second vice-presidents respectively. Paul Van Cleef was the unanimous choice for secretary, and Glenn H. Picard for treasurer. Carl S. Miner and J. R. Powell, staunch supporters of the better things for chemists, were made trustees.

The social feature of the evening was a profusely illustrated talk by Dr. Arthur J. Cramp of the American Medical Association on "The Dunes of Northern Indiana." Having been a dune fan for the past fifteen years, his description of this most remarkable territory held the deepest interest of the audience. A sea of sand covered with vegetation varying in kind from the tropical to the northern flora, these dunes merit the study of scientists and nature lovers.

State-Owned Cement Plant in Dakota

South Dakota passed a law in 1919 authorizing a commission to survey the state for suitable raw materials for cement manufacture, and—in case it found that the state can successfully engage in the business—to locate, construct and operate a cement plant. A report to the Governor has recently been printed, signed by the commissioners, Paul E. Bellamy, W. J. Sharwood and C. M. Harrison, in which they note that the best and most acceptable cement materials are found in the Black Hills and that owing to cheap fuel and available water power cement can be manufactured at Rapid City and delivered to consumers in the state much cheaper than from any other point. A plant site and quarry land have accordingly been contracted for. On the basis of August, 1920, costs a plant of 2,000 bbl. daily capacity will cost approximately \$2,000,000, in which first-quality cement can be manufactured for \$1.48 per barrel, exclusive of interest on investment, amortization, and apparently of taxes and depreciation.

The commission's estimates follow:

Cost of shale quarry equipment	\$47,000
Cost of limestone quarry equipment.....	40,000
Cost of cement mill.....	1,570,000
Cost of 200,000 bags.....	70,000
Cost of repair parts carried in stock.....	50,000
Operating capital	223,000
Total	\$2,000,000

Daily operating costs:	
Stripping in quarries	None
Shale quarry	\$69.63
Limestone quarry.....	131.75
Mill operating*.....	2,462.14
Charge against bags.....	49.86
Repair parts	215.07
Interest on operating capital.....	36.61

Total operating cost.....	\$2,965.06
Cost per barrel, f.o.b. plant.....	\$1.48

*Electric power purchased at 1½c. per kw.-hr.

In December, 1920, the date of the report, the commission was of the opinion that there would be a 50 per cent underproduction of cement during the next five years, and in view of the fact that no cement plant exists within 175 miles of the state boundaries the building of roads and other structures will undoubtedly be badly hampered. On Nov. 1, 1919, the price of cement was from \$3 to \$5 per barrel; the average wholesale rate delivered at each county seat on the basis of 1 barrel per capita was \$3.53, without sacks. Adding the average freight rate to the above-itemized cost leads the commission to believe that a like service can be performed by a state-operated plant for \$2.38 per barrel. The latter figure includes depreciation, amortization and interest.

Lenroot Impressed at Edgewood

That the United States should maintain the lead it has obtained in the application of chemistry to war is the opinion of Senator Lenroot of Wisconsin. On returning from a recent visit to the Edgewood Arsenal Senator Lenroot made the following statement to the Washington correspondent of *CHEMICAL & METALLURGICAL ENGINEERING*:

"While chemical warfare is abhorrent to the minds of everyone, it ought to be realized that it constitutes a kind of warfare which cannot be insured against by treaty or other agreement. Its possibilities are limitless. It is absolutely necessary, as a matter of defense, that we not only keep abreast with other nations but that we stay in advance of them with respect to the use of chemicals in warfare. The best protection against such warfare is to be better prepared in its use than is any other nation. If we are thus prepared there probably never will be occasion to employ it.

"I was very much impressed with Edgewood Arsenal, especially with the laboratory and the work going on there. I shall favor the continuance of research and development work in this branch of the military service."

In addition, Senator Lenroot had the following to say about the Muscle Shoals development:

"I do not think anything should be done at Muscle Shoals for the next two or three years. I never have taken the position that we should adopt the policy of complete abandonment. It may be that when costs come down it would be well to take up the development again. If it is done, however, it should be only upon the assurance that it would be a good business proposition for the Government. As a military precaution I think the nitrate plants and the big steam power plant should be kept in standby condition. This can be done at comparatively little cost."

New Jersey Clay Workers Hold Dinner in Honor of Ceramic School Designers

As a result of a contest recently held for a suitable design for the new ceramic building to be erected at Rutgers College, New Brunswick, N. J., the New Jersey Clay Workers' Association and Eastern Section of the American Ceramic Society gave a dinner to all contestants at the New Packer House, Perth Amboy, N. J., on Friday evening, April 1.

The prize contest was carried out under the auspices of the National Terra Cotta Society, which offered \$300 in prizes for a suitable design for the facade of the new structure, divided into a first prize of \$200 and second prize of \$100. Fourteen persons entered the competition, the winners being E. W. Moell, Rocky Hill, N. J., and S. R. Audsley, Perth Amboy, both employees of the Atlantic Terra Cotta Co., who received the first and second prizes respectively.

Charles Howell Cook, president of the Cook Pottery Co., Trenton, N. J., acted as toastmaster at the dinner. The speeches dealt with the work connected with the new ceramic school building, for which a state appropriation has been secured, and the broad possibilities for development in the ceramic industry in the state. Among the speakers were: Abel Hansen, head of the Fords Porcelain Works, Perth Amboy; State Senator Thomas Brown; E. V. Eskesen, president New Jersey Terra Cotta Co.; Charles A. Bloomfield, head of the Bloomfield Clay Co.; George H. Brown, director department of ceramics, Rutgers College; Charles W. Crane, the Crossman Co., South Amboy; Roy H. Minton, General Ceramics Co.; Leslie Brown, Lenox, Inc.; D. P. Forst, Robertson Art Tile Co.; Andrew Faltz, Lambertville Pottery Co., and Charles T. H. Phillips, head of the Sneyd Enamelled Brick Co., Trenton.

Prince of Monaco to Receive Agassiz Medal

An address on his oceanic researches by the Prince of Monaco will be one of the features of the meeting of the National Academy of Sciences which will be held in Washington April 25 to 27. On that occasion the Prince is to receive the Alexander Agassiz medal. The only previous award of this prize was to Dr. Johan Hjort.

Domestic Potash Producers Discouraged

Despite the fact that there is reason to believe the Ways and Means Committee will approve an import duty of 50c. a unit on potash, representatives in Washington of the domestic potash industry take a gloomy view of the situation. As a result of the intense competition which has sprung up between the French and the Germans it now appears that 50c. a unit will not afford adequate protection.

In their efforts to capture the American market, representatives of the French and of the German producers are said to be making heavy concessions in price. This is especially the case when a five-year contract can be arranged. The French are now in a position to produce on a large scale. Despite the fact that stocks of potash in this country already are large, the French are continuing to build up their reserves here. German stocks have reached the point where little additional potash is being imported from that country.

It is believed that genuine competition between the Germans and French will continue as long as the French properties are under the direct control of the government. It now seems certain, it is stated, that the government will buy in the properties and then will lease them to private companies for operation. Once this takes place it is regarded as almost certain that the present ruinous type of competition will end, if there is not an understanding as to prices.

Dr. F. G. Hopkins to Receive Chandler Medal

At a meeting to be held in Havemeyer Hall, Columbia University, at 8:15 p.m. Monday, April 18, the Chandler Medal will be presented to Frederick Gowland Hopkins, F.R.C.P., F.R.S., F.I.C., F.C.S., professor of biological chemistry, Cambridge University, in order to recognize publicly his pioneer and very valuable work in the study of food accessories, such as vitamins. Dr. Hopkins will speak on "Newer Aspects of the Nutrition Problem."

Co-operative Work in Ceramics

Plans are being developed for intensive co-operative work between the Bureau of Mines and the Bureau of Standards, Washington, D. C., and the national brick and tile associations relative to investigations and experiments in the manufacture of burned clay building products. A fund is to be provided for carrying out the work, which for the most part will embody improved methods of production and the solution of fundamental problems encountered in this branch of manufacture. The associations interested in the movement include the Face Brick Manufacturers' Association, the American Common Brick Manufacturers' Association, the National Paving Brick Manufacturers' Association and the Hollow Building Tile Manufacturers' Association.

Book Reviews

RAPID METHODS FOR THE CHEMICAL ANALYSIS OF SPECIAL STEELS, STEEL-MAKING ALLOYS, THEIR ORES AND GRAPHITES. By *Charles Morris Johnson*, Ph.M., Chief Chemist of the Park Works of the Crucible Steel Co. of America. Third edition, revised and enlarged. xi + 552 pp. New York: John Wiley & Sons, Inc., 1920. Price \$6.

The new edition of this well-known text will be welcomed by all who are interested in the analysis of steel and steel-making materials. At the present time it is necessary for the steel analyst to be prepared to determine or guard against the interferences of about one-half of the elements of the periodic table. And who would say the end is yet? The present book provides for nearly all the probable cases of today. New material not found in either of the previous editions includes the analysis of chrome-vanadium and chromium steels; the complete analysis of tungsten ore;

tantalum and tungsten in ores, alloys and steels; arsenic in steel; zirconium in steel; the complete analysis of crude zirconia; oxygen and arsenic in copper; boron in iron; a new modification for the determination of phosphorus in the presence of vanadium using a faintly ammoniacal water solution of ammonium molybdate; the analysis of clays; a chapter on the micrographic examination of steel; notes on electrical laboratory furnaces and special refractories; the analysis of ferrocerium and cerium steel. A further addition of interest is the facsimile of the certificate of the new British standard chrome-vanadium steel and a comparison of the results on this steel from three American laboratories.

In addition to methods for analysis the book contains much information on the design and equipment of a steel-works laboratory and on grinding, sampling and the annealing and microscopic examination of steel. Tables of typical analyses of ores, slags, refractories and special alloys given throughout the book are convenient. The text is well illustrated.

There is a very noticeable opportunity to arrange the material given in this book according to some more simple or more evident scheme; the analytical methods arranged either on the basis of the elements being determined or according to the class of material being analyzed and the scattered portions on other subjects gathered together. While the author does not state that the methods described are confined to those in use at the Park Works of the Crucible Steel Co., yet it is so implied. Certainly in many instances references to recently published papers along lines related to the context are lacking—e.g., methods for oxygen in steel, nitrogen in steel, zirconium in steels and ores, electrometric methods. Complete details of the method for determining phosphorus in the presence of vanadium of pages 41 to 45 are needlessly duplicated in pages 318 to 323.

LOUIS JORDAN.

* * *

THE THERMIONIC VACUUM TUBE AND ITS APPLICATIONS. By *H. J. Van der Bijl*, M.A., Ph.D. 392 pp., illustrated. Price \$5. New York: McGraw-Hill Book Co.

The publication of this book fills a need, experienced for a number of years by those not specialists in the field of conduction of electricity through gases, of a complete treatise on the theory and use of the vacuum tube as an amplifier and a detector of high-frequency electric currents. Although the principles employed in the operation of the vacuum tube as a rectifier, detector or amplifier have been described in detail in several treatises on the conduction of electricity through gases, or on the principles of electric wave telegraphy and telephony, this is the first adequate work devoted exclusively to that subject.

The book contains ten chapters, the first three of which are devoted to an introductory account of the properties of electrons, and of the conditions for their dislodgment from the atoms of gases and vapors and from solid substances. Chapter IV, on the physics of the thermionic valve—i.e., the two-electrode vacuum tube—discusses the general characteristics of the valve, while the effect of gases present in the tube is described in Chapter V. The principles of the use of the valve as a rectifier of alternating currents is described in Chapter VI. Chapter VII, the longest in the book, is devoted to a full description of the characteristics of the three-electrode vacuum tube and of the principles upon which its use as an amplifier is based. The use of the tube as an oscillation generator in a circuit having inductance and capacity is described in Chapter VIII, and Chapter IX is devoted to a description of its use as a detector and modulator of high-frequency electromagnetic waves as employed in radio telegraphy and telephony. Chapter X describes some of the miscellaneous applications of the thermionic tube, such, for instance, as its use as an electro-static voltmeter and as an ionization manometer, etc.

To those wishing to acquire a thoroughgoing acquaintance with one of the most important recent practical developments in the field of electromagnetism, this book is recommended.

C. C. VAN NUYS.

Personal

H. W. BLANCHARD recently severed his relations with the chemical division of Procter & Gamble Co., Cincinnati, Ohio, and is now connected with the physics department of Purdue University, LaFayette, Ind.

HIPPOLYTE COPAUX, of the School of Industrial Physics and Chemistry of Paris; PIERRE LELAUDOUX, of the Tunisian Phosphate Co.; Dr. EUGENIO DONEGANI, of the Sicilian Sulphur Co., and GEORGES FLUSIN, of Grenoble, are in the United States making a study of the fertilizer situation.

Dr. COLIN G. FINK, organizer and for the past four years director of the research laboratories of the Chile Exploration Co., has resigned his post. Formerly Dr. Fink was in charge of research at the Edison Lamp Works, Harrison, N. J.

ALFRED N. FLINN, who was formerly with the Hydraulic Steel Co., Cleveland, Ohio, in the research department, has been reinstated as associate chemist at the Bureau of Standards, Washington, D. C., where previous to the past year he was engaged for nine years in the chemical testing of structural materials, but his present assignment is in chemical control of the manufacture of optical glass.

ARTHUR L. HALVORSEN, who has been connected with the Roessler & Hasslacher Chemical Co. for the past ten years as research chemist, resigned Jan. 1 to do consulting work in cyanide hydrometallurgy and industrial chemical research in general. He is located at 174 Water St., Perth Amboy, N. J.

Dr. DAVID R. MERRILL has resigned his position as research associate in the Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology, in order to accept a position in the research laboratory of the Union Oil Co. of California, Oleum, Cal.

Dr. R. F. RUTTAN, head of the department of chemistry at McGill University, has been administrative chairman of the Honorary Advisory Council for Scientific and Industrial Research in the absence of Dr. A. B. Macallum in the Orient.

HERVEY J. SKINNER, HERBERT L. SHERMAN and GUSTAVUS J. ESSELEN, JR., have associated themselves under the name of Skinner, Sherman & Esselen, Inc., and will act as consultants in matters pertaining to the application of chemistry and biology to industrial operations.

Obituary

EDMUND COGSWELL CONVERSE, president of the National Tube Co. at the time of its merger into the U. S. Steel Corporation and later a director of the corporation, died suddenly of a heart attack on April 4, while at a hotel in Pasadena, Cal., where he and his wife had been living since February. His home was in Greenwich, Conn.

Dr. ERNST J. LEDERLE, the founder of the Lederle Laboratories and the Lederle Antitoxin Laboratories, which are now merged into the firm of Lederle & Provost, died on March 7, at Goshen, N. Y. Dr. Lederle was health commissioner of New York City during two administrations.

ELIE MILLETT, inventor of the Millett core oven and founder of the Millett Brass Co., died in Springfield, Mass., on Sunday, March 21. The Millett core oven was designed primarily to protect workmen in foundries from the intense heat from the old ovens and to eliminate the waste of heat when the charging door was opened. Mr. Millett acted on the theory that it was possible to have two doors on an oven instead of one and that it was also possible so to arrange the grates that the cores could be heated without opening both doors at once.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, April 11, 1921.

One of the most hopeful signs noted in the week's chemical activities was the gradual removal of distressed spot stocks of many materials from weak second-hand holders. This condition is beginning to exert its influence in many quarters and while sellers are content to quote around lately prevailing levels, buyers are having a hard time purchasing special brand goods.

A few large producers reported some improvement in domestic trade. Although the increase was not very noticeable, there was more steadiness and expansion than at any time since the beginning of the year. It seems reasonable to assume that the quiet absorption of resale goods will eventually make itself felt in first-hand quarters. With any signs of real buying, the spot market will recover very easily. The dormant buying movement since last fall has created a very artificial condition where the short seller may encounter some difficulty with any noticeable revival.

Special standard brands of *caustic soda* were in demand and where inquiries were heard at former quotations, buyers experienced much difficulty in obtaining any round lots. Resale standard *bichromate of soda* showed an extremely firmer tendency on several occasions.

GENERAL CHEMICALS

The *acetic acid* market continued unsettled, although tending toward the stronger end. Producers have held their prices on a fairly firm basis at former levels. The low prices are still quoted nominally, but it is generally known that deliveries are greatly delayed. The resale market is practically devoid of supplies, although an occasional odd lot is sold at former resale price levels. Quotations from leading manufacturers are based on 2½@3c. per lb. for the 28 per cent and 10@11c. for the glacial. A reduction in some directions has brought *nitric acid* down to a price basis of 6½@7½c. per lb. for the 40 deg. and 7¼@8½c. for the 42 deg. Prices on *sulphuric acid*, 66 deg., in tank cars are quoted at \$19@\$20 per ton f.o.b. works. It is understood that with the present weakness of sulphur, a firm order would bring about price concessions. *Ammonium carbonate* prices in some quarters are quoted firm at 9½c. per lb. Offers elsewhere are heard as low as 7½c. for imported material. Demand has been exceedingly slow, so that there is no definite agreement between sellers.

The market on *ammonium chloride* continues in an unsettled state with spot stocks moderate in the absence of any noted demand. Importers are doubtful as to the future and domestic producers are still firm in their prices. Imported white granular is quoted at 7@7½c. per lb. as against 10@10½c. by domestic makers. Manufacturers of *ammonium sulphate* are holding their prices at \$2.90@\$3 per 100 lb. in bulk lots f.o.b. works. Spot material in distressed hands is quoted at \$2.75@\$2.90 per 100 lb. f.a.s. steamer, in double bags. Lack of demand has forced down prices to a decided extent. *Bleaching powder* has remained in the same unsettled position. Makers are quoting \$2.75 per 100 lb. f.o.b. works, while the spot resale market is quoted at \$2.50@\$2.60. Prices on *copperas* are lower with the bulk quoted at 75c. per 100 lb. f.o.b. works. Quotations range upward to \$1.25 per 100 lb., according to the package and delivery.

The *caustic potash* market is stagnant with resale offerings still heard at the former levels of 9½@10½c. per lb. for reshipped American material. Makers' prices are meaningless in the presence of heavy stocks of spot goods and the absence of demand. Domestic producers have reduced the price of *sodium chlorate* and are now offering at 8½c. per lb. for any quantity. Resale lots of *caustic soda* were generally quoted at \$3.65 per 100 lb. ex-store and \$3.75 f.a.s. Odd lots could possibly be purchased at \$3.60, but most sellers were not eager to quote as low as this level

on standard material. The absence of any large inquiries gave the market a tame appearance, although the undertone remained quite steady. It was said to be doubtful if more than odd lots of domestic light *soda ash* could be bought below \$1.95@\$2 per 100 lb. in single bags, spot N. Y. Imported material was offered at \$1.90 and sales were recorded at this figure. Barrels were well held at \$2.20@\$2.25 per 100 lb. Trading in general was quiet with offerings small. Dense ash was held at 10c. per 100 lb. above the level.

Bichromate of soda dealers maintained the spot market at 7½c. per lb. in most directions, although it was intimated that a few odd lots might be purchased down to 7½c. Offerings were not heavy, but there was still enough material on hand to take care of the prevailing inquiry. Consumers are apparently content to restrict their operations to actual wants only. Strength in copper metal has strengthened the market for *copper sulphate*. Leading producers have made no revision in prices, but the market looks firmer and there are indications that buyers are taking more interest. Demand for domestic use is moderate, but the insecticide trade has not covered and improvement in business is expected from this source of consumption. Standard 99 per cent large crystals are quoted by first hands at 5½c. per lb. in carlots and small crystals, 98½-99 per cent, at 5½c. Odd lots of miscellaneous brands are on the market in moderate supply at 5½c. per lb. and possibly lower on firm business.

The following is a comparative list of miscellaneous chemicals since 1914:

Article	1921	1918	1914
Acetone, lb.	\$0.13	\$0.34	\$0.10
Acetic acid, 100 lb.	1.75	6.50	1.50
Ammonia alum, lb.	0.04	0.08	0.01½
Potash alum, lb.	0.05½	0.11	....
Ammonia carbonate, lb.	0.09	0.12	....
Ammonia aqua, 26 deg., lb.	0.07	0.10	0.02
Ammonia sulphate, 100 lb.	2.75	....	2.50
Arsenic, white powder, lb.	0.08	0.11	0.03
Arsenic, red, lb.	0.12	0.47	0.05
Bleaching powder, lb.	0.02½	0.07	0.01½
Blue vitriol, lb.	0.05½	0.10	0.04½
Bichromate soda, lb.	0.07½	0.20	0.04½
Bichromate potash, lb.	0.12½	0.45	....
Borax, lb.	0.06½	0.09	0.04
Caustic potash, 88-92%, lb.	0.09½	0.75	0.04
Carbon tetrachloride, lb.	0.10	0.70	....
Chlorate Potash, lb.	0.08	0.35	0.07
Citric acid, lb.	0.47	0.95	0.54
Cream tartar, lb.	0.30	0.65	0.23
Cyanide soda, lb.	0.20	0.32	....
Epsom salts, 100 lb.	2.25	3.50	0.75
Formaldehyde, lb.	0.15	0.22	0.08
Glycerine, C.P., lb.	0.17½	0.55	0.19
Lime acetate, lb.	0.01½	0.04	0.01½
Oxalic acid, lb.	0.16½	0.45	0.06
Phenol, lb.	0.11	0.40	0.07
Permanganate potash, lb.	0.35	2.00	0.08
Prussiate soda, lb.	0.12½	0.55	0.11
Prussiate potash, red, lb.	0.48	0.90	....
Prussiate potash, yellow, lb.	0.26	2.25	0.12
Rochelle salt, lb.	0.27	0.47	0.16
Soda ash, 100 lb.	1.95	2.75	0.75
Soda, caustic, solid, 100 lb.	3.65	5.25	1.80
Sulphur flour, 100 lb.	2.25	3.25	2.00
Sal ammoniac, gran., lb.	0.07	0.25	0.06½
Tartaric acid, lb.	0.36	0.85	0.30

COAL-TAR PRODUCTS

Trading in the coal-tar products marked during the past week has shown a tendency to expand in some quarters, but although sales are more numerous, the business is of a very small character, for spot lots, with nothing in the way of future requirements being considered. Production has been generally curtailed and covers a majority of the items on the list. Resale stocks in warehouses are not believed to be large and those close to the heart of trading expressed the opinion that the turning point in the dullness of the market has been passed. Prices have been steadily reduced and labor is gradually drifting back to work at revised schedules. Reports of developments from textile centers are very encouraging and the industry looks forward to a radical improvement in the very near future.

Crude products are moving in better volume and the tone of the market is steady. *Benzene* and *toluene* are not expected to show any further easiness in prices, while on the other hand any material increase would create a tight market in a short time. *Napththalene* is in easy supply and prices vary according to seller, with the flake at 8@9c. per lb. and the ball at 9¼@10c.

Intermediates are showing a much steadier tendency with sellers not trying to push business and shading only on

firm orders. *Aniline oil*, *beta naphthol* and *paranitraniline* are steady, with prices unchanged during the past week. Supplies of *nitro benzene* are reported as easy in most directions and figures range from 12@15c. per lb. Consumers are showing little interest in the market and only a light routine movement is recorded. The volume of trading in *ortho nitrophenol* during the period was said to be at a minimum. Supplies are available in some quarters on the basis of 75@80c. per lb. The market for *para phenylenediamine* has been quite steady during the week and a moderate volume of trading has been transacted on the basis of \$1.95@\$2 per lb. There has been no improvement reported in the market for *toluene*. The demand has been very light and supplies are fairly easy. Prices quoted by producers range from 28@31c. per gal., depending on quantity, with second-hand offerings slightly under these figures. Resale stocks of *para nitraniline* have been pretty well cleaned out and while it may be possible to find an occasional odd lot as low as 85c. per lb. the market has practically passed to first hands at 95c.@\$1.05 per lb., according to quantity. Demand has been quite slow. Offers of *dimethylaniline* on spot are heard at 48@50c. per lb. from second hands, with producers quoting 50@60c. per lb. Business has been limited to small lots.

MISCELLANEOUS MATERIALS

As far as prices are concerned very little change was evident in the miscellaneous materials market outside of a slightly firmer feeling in mostly all quarters. The demand in general is as yet confined principally to limited lots, but it was noted that transactions were more frequent. Indications pointed to an early increase in activity. Spring operations in the paint field are being pushed and relief is in sight. *Barytes* held steady and practically unchanged. *Blanc fixe* changed hands quite freely, but mostly in small lots. *Litharge* remained in much the same position. *Zinc oxide* figures held steady in all quarters.

While there continued to be little in the way of large-lot trading in *barytes*, a regular demand is heard for moderate amounts and on the whole a better feeling pervades this market. Prices held steady in all quarters with little inclination noted to change. The prime white remains quoted at \$30@\$35 per ton. Offerings of *blanc fixe* were plentiful but not pressed and prices held steady. The general asking price is 4½c. per lb., but intimations were made that bids of 4½c. would most likely be accepted. Numerous small lot sales were reported by factors, while on large lots very little activity was recorded. A firm tone prevailed in the *litharge* market, although trading in general was limited and spot stocks plentiful. First hands quote firm at 8½c. per lb. as an inside figure. Leading producers of *zinc oxide* reported nothing new and stated that the same routine inquiry continued to be received. Prices remained firm at 8½@9½c. per lb. for the XX grade.

The Chicago Market

CHICAGO, April 8, 1921.

Business in heavy chemicals showed a decided improvement during the past week, most factors reporting an unusually large volume of small orders. It is evident that supplies in consumers' hands are getting low and that they will soon be back in the market again.

In general the list remained firm, the most notable exception being c.p. *glycerine*, which was reduced by refiners to 17c. per lb., bulk basis. This marks the lowest level reached in seven or eight years. There is some demand for *soda ash*, which is quoted at 2½@3c. in a small way. *Caustic soda* is firm, the ground being offered at 4½c. per lb. in barrels, and the solid at 4½c. in drums. The inquiry for *formaldehyde* is good, and a considerable volume of business is reported at 16@16½c. per lb. Sales of *ammonium chloride*, white gran., are few, and lower prices are expected. Quotations vary from 11½@12½c., depending upon the quantity and the seller. The demand for *aluminum sulphate*, iron free, is rather light and the material is offered freely at 3½@4c. per lb. A fair inquiry is noted for *carbon bisulphide*, the price remaining firm at 8@8½c. in single drum lots. *Carbon tetrachloride* is not moving as well and is offered at 11c., in the large drums.

The lower prices in the New York market on *lead acetate*, white crystals, have not been reflected here and local dealers continue to quote 15c. per lb. in casks. They report a good volume of business and show little tendency to shade present prices. There is a small quantity of *potassium bichromate* in the market at 16c., but better prices are obtainable on material for prompt shipment from the East. *Potassium permanganate* is lower, spot goods being offered at 45@50c. per lb. As this material is offered for prompt shipment from abroad at much lower prices, the movement is slow and is confined to small packages. *Sodium bichromate* is firmer, the best price heard being 9c.; while some holders are asking as high as 11c.

Prices on *acetic acid* are unchanged, the glacial being offered at \$11 per 100 lb. and the 28 per cent at 2¼@3c. The demand for *citric acid* has increased and prices are firm at 47@49c. per lb. *Sulphuric acid* is unchanged, and manufacturers continue to ask \$19@\$20 per ton for the 66 deg.

VEGETABLE OILS

Unusually quiet conditions continue to prevail in this branch of the trade, and there is little or no demand to speak of. Buyers are holding off and there is a strong feeling in some quarters that several of the items will go lower, regardless of the talk of better prices. *Coconut oil* is quiet, the prevailing quotations running from 10@10½c. per lb. for single barrels. There is a slightly better demand for *linseed oil*, and dealers are asking 67@69c. per gal. in lots of 1 to 5 bbl.

NAVAL STORES

In general this market is dull and the only feature worth mentioning is the advance in *turpentine*. While it is still possible to secure small lots in some quarters at 60c. per gal., most factors have advanced their prices to 62c. *Rosin* continues as dull as ever, with most buyers showing little or no interest and few sales being reported. The holders are asking around \$7.25 for the WG grade, but this price could probably be shaded with a firm order.

COAL-TAR PRODUCTS

Benzene prices are lower, the new level being 28c. per gal. in drums for the 90 per cent and 30c. for the 100 per cent. There are a few small sales reported, but the demand is still far from satisfactory. *Naphthalene flakes* are moving in a small way and prices have been maintained at 9@10c. per lb.

The Iron and Steel Market

PITTSBURGH, April 8, 1921.

The iron and steel market continues its uneventful career. There is perhaps a slight farther broadening in demand for steel products, through shipping instructions becoming somewhat more numerous, but the business is very largely in carload lots and shows how very modest the requirements of consumers are at this time. Part of the business received is in new orders, but a large part is in releases against orders previously suspended. Buyers are not covering their full requirements in all cases with these shipping instructions, there being many cases in which stocks on hand are simply being pieced out. The proper conclusion seems to be that the rate of actual consumption is in excess of the rate of producing and shipping, but it does not follow that the rate of consumption will continue after all the stocks in buyers' hands have been disposed of. There is the automobile industry, for instance, which is increasing in activity from week to week and is reducing its inventories, but the spring buying season for automobiles will be entirely over before the stocks are all liquidated, and the sale of automobiles may then decrease.

In recent weeks the steel industry has been disposed to look for an improvement in steel demand at some time in the future by there being a large increase in dwelling house construction, contingent upon revision of wage rates and working conditions in the building trades. Latest trends, however, suggest that possibly the so-called "housing shortage" will be solved in part by a decrease in the demand for houses as incomes are reduced or disappear, as families separated by the search for the highest paid job with the least work are reunited and as men go back to the farm.

Detroit shows a surplus of houses after ten years of a "housing shortage," while the latest count in Cleveland shows 2,100 unoccupied houses.

PRODUCTION

Pig-iron production is down to about 35 per cent of capacity, there having been a sharp further decrease in the past few weeks. Merchant furnace production is particularly low, but there is a question whether production of pig iron by steel works is not still in excess of the current consumption by the works, for an estimate commonly accepted in the trade is that the independent steel works are operating at about 20 per cent of capacity and the Steel Corporation at between 40 and 45 per cent, which would make a rate for the whole steel industry of about 30 per cent. Independent operations have not changed materially for several weeks, while the Steel Corporation's operations continue to decline, though at a much slower rate than in February and the early part of March. The corporation is still operating to a considerable extent upon orders and specifications received long ago. Its incoming business is largely in the form of releases against orders previously suspended, and thus the natural trend would be for the Steel Corporation's production to continue to decline until business in general revives. A rough guess would be that if production is now at about 30 per cent of capacity it will decline slightly more in the near future, then rising to a rate of 45 or 50 per cent late in the year. At some time in the future there will be, of course, reasonably full industrial activity, but on account of the 50 per cent increase in steel capacity that has occurred since 1914 it is not entirely certain that at that time there will be full activity for the steel industry as now constituted.

PRICES

There has been no material change in the independent market for steel products in the past week and no great change for several weeks. This steadiness may be due to the almost complete absence of inquiry for large lots, which would promise a fair operating rate for the mill or department that secured the order. The independents are getting simply small orders, which do not afford anything like an economical operation. In many cases there is less competition for a carload order than might be expected, because some mills do not have an operation scheduled for an early enough date to meet the requirements of the prospective buyer. The independent market on carload lots is quotable at 2c. for bars, 2.10c. for shapes and plates, 3.75c. for black sheets, 4.80c. for galvanized sheets and about \$4 a ton off the standard list for pipe.

The Steel Corporation exhibits no intention of modifying its prices in the near future, its adherence to the Industrial Board price schedule being accepted by the trade now as a more natural thing than the trade was assuming a few weeks ago. Predictions as to when the corporation will reduce its prices have practically disappeared. It may be helpful to recall that during almost the entire period of more than a twelvemonth during which the corporation held its prices down to the Industrial Board schedule while the independents were charging higher prices there was continuous expectation that the corporation would advance its prices.

PIG IRON AND COKE

Pig iron displays no activity, and prices remain quotable at \$25 for bessemer, malleable and foundry and \$23 for basic, f.o.b. valley furnaces. Nearly all the independent coke operators in the Connellsville region have reduced wages to the scale of Nov. 10, 1917, involving on an average somewhat more than 30 per cent reduction from the former scale, which is still in force by the H. C. Frick Coke Co., the coke subsidiary of the Steel Corporation. On the inquiry for 500 tons of coke a day to a furnace at Portsmouth, Ohio, mentioned a week ago, it is understood the sale was made at not over \$3.75, the delivery being over five or six weeks until the byproduct coking plant at Portsmouth can be got in operation. The \$3.75 price is regarded as a close one even with the reduced wages now in force and little if any further liquidation in coke is to be expected. Coke sold at \$18 to \$19 last summer.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.			\$0.40 - \$0.45	
Acetone.....lb.	\$0.13 -	\$0.13½	.13½ -	.14
Acid, acetic, 28 per cent.....100 lbs.	2.50 -	2.75	3.00 -	3.25
Acetic, 56 per cent.....100 lbs.	4.00 -	4.25	4.50 -	5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	9.50 -	9.75	10.00 -	10.50
Boric, crystals.....lb.	.14½ -	.15	.15½ -	.16
Boric, powder.....lb.	.15½ -	.16½	.17 -	.18
Citric.....lb.			.47 -	.50
Hydrochloric.....100 lb.	1.60 -	1.75	2.00 -	2.20
Hydrofluoric, 52 per cent.....lb.	.13 -	.13½	.14 -	.14½
Lactic, 44 per cent tech.....lb.	.10 -	.11	.11½ -	.12
Lactic, 22 per cent tech.....lb.	.04½ -	.05½	.06 -	.07
Molybdic, C. P.....lb.	4.00 -	4.50	4.50 -	5.00
Muriatic, 20 deg. (see hydrochloric).....				
Nitric, 40 deg.....lb.	.06½ -	.06½	.07 -	.07½
Nitric, 42 deg.....lb.	.07½ -	.07½	.07½ -	.08½
Oxalic, crystals.....lb.	.16½ -	.17	.18 -	.19
Phosphoric, Ortho, 50 per cent solution.....lb.	.17 -	.17½	.18 -	.19
Picric.....lb.	.30 -	.32	.35 -	.40
Pyrogallie, resublimed.....lb.			1.90 -	2.15
Sulphuric, 60 deg., tank cars.....ton				
Sulphuric, 60 deg., drums.....ton			14.00 -	15.00
Sulphuric, 66 deg., tank cars.....ton	19.00 -	20.00		
Sulphuric, 66 deg., drums.....ton	22.00 -	22.50	23.00 -	23.50
Sulphuric, 66 deg., carboys.....ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 -	24.00		
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 -	26.00	26.50 -	27.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 -	35.00	40.00 -	
Tannic, U. S. P.....lb.			1.00 -	1.10
Tannic (tech.).....lb.	.50 -	.52	.54 -	.57
Tartaric, crystals.....lb.			.36 -	.40
Tungstic, per lb. of WO.....lb.			1.30 -	1.40
Alcohol, Ethyl.....gal.			4.90 -	5.25
Alcohol, Methyl (see methanol).....				
Alcohol, denatured, 188 proof.....gal.			.40 -	.45
Alcohol, denatured, 190 proof.....gal.			.44 -	.52
Alum, ammonia lump.....lb.	.04 -	.04½	.04½ -	.04½
Alum, potash lump.....lb.	.05½ -	.06	.06½ -	.07
Alum, chrome lump.....lb.	.13 -	.13½	.14 -	.14½
Aluminum sulphate, commercial.....lb.	.02½ -	.02½	.02½ -	.03
Aluminum sulphate, iron free.....lb.	.03 -	.03½	.03½ -	.03½
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07 -	.07½	.07½ -	.08
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 -	.32	.33 -	.35
Ammonium carbonate, powder.....lb.	.09 -	.09½	.10 -	.11
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	.07 -	.07½	.07½ -	.09
Ammonium chloride, granular (gray salamoniac).....lb.	.08½ -	.08½	.09 -	.09½
Ammonium nitrate.....lb.	.08 -	.08½	.09 -	.10
Ammonium sulphate.....100 lb.	2.75 -	2.85	2.90 -	3.00
Amylacetate.....gal.			4.00 -	4.25
Amylacetate tech.....gal.			3.00 -	3.25
Arsenic oxide, (white arsenic) powder.....lb.	.08 -	.08½	.09 -	.10
Arsenic, sulphide, powdered (red arsenic).....lb.	.12 -	.12½	.13 -	.14
Barium chloride.....ton	60.00 -	65.00	70.00 -	75.00
Barium dioxide (peroxide).....lb.	.19 -	.20	.21 -	.22
Barium nitrate.....lb.	.11 -	.11½	.12 -	.12½
Barium sulphate (precip.) (blanc fixe).....lb.	.04½ -	.05	.05½ -	.06
Bleaching powder (see calc. hypochlorite).....				
Blue vitriol (see copper sulphate).....				
Borax (see sodium borate).....				
Brimstone (see sulphur, roll).....				
Bromine.....lb.	.40 -	.41	.42 -	.45
Calcium acetate.....100 lbs.	1.60 -	2.00		
Calcium carbide.....lb.	.04½ -	.04½	.05 -	.05½
Calcium chloride, fused, lump.....ton	27.00 -	29.00	30.00 -	32.00
Calcium chloride, granulated.....lb.	.01½ -	.01½	.02 -	.02½
Calcium hypochlorite (bleach powder) 100 lb.	2.40 -	2.60	2.75 -	3.00
Calcium peroxide.....lb.			1.25 -	1.50
Calcium phosphate, tribasic.....lb.			.15 -	.16
Camphor.....lb.			.65 -	.68
Carbon bisulphide.....lb.	.07 -	.07½	.07½ -	.08
Carbon tetrachloride, drums.....lb.	.10 -	.10½	.11 -	.12
Carbonyl chloride (phosgene).....lb.			.75 -	1.00
Caustic potash (see potassium hydroxide).....				
Caustic soda (see sodium hydroxide).....				
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08 -	.09	.09½ -	.10
Chloroform.....lb.			.38 -	.40
Cobalt oxide.....lb.			3.00 -	3.10
Copperas (see iron sulphate).....				
Copper carbonate, green precipitate.....lb.	.23 -	.24	.25 -	.27
Copper cyanide.....lb.			.50 -	.62
Copper sulphate, crystals.....lb.	.05½ -	.05½	.06 -	.06½
Cream of tartar (see potassium bitartrate).....				
Epsom salt (see magnesium sulphate).....				
Ethyl Acetate Com. 85%.....gal.			.90 -	1.00
Ethyl Acetate pure (acetic ether 98% to 100%).....				
Formaldehyde, 40 per cent.....lb.	.15 -	.15½	.15½ -	.16
Fusel oil, ref.....gal.			3.50 -	3.75
Fusel oil, crude.....gal.			2.00 -	2.25
Glauber's salt (see sodium sulphate).....				
Glycerine, C. P. drums extra.....lb.			.17½ -	.18½
Iodine, resublimed.....lb.			3.75 -	3.85
Iron oxide, red.....lb.			.10 -	.20
Iron sulphate (copperas).....100 lb.	.75 -	1.00	1.10 -	1.25
Lead acetate.....lb.			.11½ -	.13½
Lead arsenate, as e.....lb.	.08½ -	.09	.09½ -	.10
Lead nitrate.....lb.			.15 -	.20
Litharge.....lb.	.08½ -	.09	.09½ -	.10
Lithium carbonate.....lb.			1.25 -	
Magnesium carbonate, technical.....lb.	.10½ -	.11	.11½ -	.12
Magnesium sulphate, U. S. P.....100 lb.	2.75 -	3.00		
Magnesium sulphate, technical.....100 lb.			2.25 -	2.50
Methanol, 95%.....gal.			.75 -	.77
Methanol, 97%.....gal.			.78 -	.82
Nickel salt, double.....lb.			.13 -	.13½
Nickel salt, single.....lb.			.14 -	.14½
Phosgene (see carbonyl chloride).....				
Phosphorus, red.....lb.	.45 -	.46	.47 -	.50
Phosphorus, yellow.....lb.			.35 -	.37
Potassium bichromate.....lb.	.12 -	.12½	.12½ -	.13

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$.35 - .40	\$0.30 - \$0.35
Potassium bromide, granular..... lb.	.35 - .40	.40 - .45
Potassium carbonate, U. S. P..... lb.	.06 - .07	.08 - .09
Potassium carbonate, crude..... lb.	.08 - .10	.11 - .15
Potassium chlorate, crystals..... lb.	.09 - .10	.10 - .11
Potassium cyanide..... lb.	.09 - .10	.10 - .11
Potassium hydroxide (caustic potash)..... lb.	.09 - .10	.10 - .11
Potassium muriate..... ton	57.00 - 65.00	2.75 - 3.00
Potassium iodide..... lb.	.09 - .10	.10 - .11
Potassium nitrate..... lb.	.09 - .10	.10 - .11
Potassium permanganate..... lb.	.35 - .37	.39 - .40
Potassium prussiate, red..... lb.	.48 - .50	.51 - .53
Potassium prussiate, yellow..... lb.	.26 - .27	.28 - .29
Potassium sulphate (powdered)..... per unit		2.15 - 2.25
Rochelle salts (see sodium potas tartrate).....		
Salammoniac (see ammonium chloride).....		
Salt soda (see sodium carbonate).....		
Salt cake..... ton		32.00 - 34.00
Silver cyanide..... oz.		1.30 - 1.35
Silver nitrate..... oz.		.39 - .40
Soda ash, light..... 100 lb.	1.95 - 2.10	2.15 - 2.40
Soda ash, dense..... 100 lb.	2.20 - 2.30	2.40 - 2.60
Sodium acetate..... lb.	.04 - .05	.05 - .06
Sodium bicarbonate..... 100 lb.	2.50 - 2.60	2.70 - 3.00
Sodium bichromate..... lb.	.07 - .08	.08 - .09
Sodium bisulphate (nitre cake)..... ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphite powdered, U.S.P..... lb.	.05 - .06	.05 - .06
Sodium borate (borax)..... lb.	.05 - .06	.07 - .08
Sodium carbonate (sal soda)..... 100 lb.	1.90 - 2.00	2.25 - 2.50
Sodium chlorate..... lb.	.08 - .09	.09 - .10
Sodium cyanide, 96-98 per cent..... lb.	.19 - .20	.21 - .30
Sodium fluoride..... lb.	.12 - .13	.13 - .14
Sodium hydroxide (caustic soda)..... 100 lb.	3.65 - 3.75	3.80 - 4.00
Sodium hyposulphite..... lb.	.03 - .04	.03 - .04
Sodium nitrate..... 100 lb.	2.60 - 2.70	2.70 - 3.00
Sodium nitrite..... lb.	.06 - .07	.06 - .07
Sodium peroxide, powdered..... lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic..... lb.	.04 - .05	.05 - .06
Sodium potassium tartrate (Rochelle salts)..... lb.	.12 - .13	.13 - .14
Sodium prussiate, yellow..... lb.	.12 - .13	.13 - .14
Sodium silicate, solution (40 deg.)..... lb.	1.25 - 1.35	1.40 - 1.50
Sodium silicate, solution (60 deg.)..... lb.	.03 - .04	.03 - .04
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.75 - 2.00	2.25 - 2.50
Sodium sulphide, fused, 60-62 per cent (conc.)..... lb.	.05 - .06	.05 - .06
Sodium sulphite, crystals..... lb.	.04 - .05	.04 - .05
Strontium nitrate, powdered..... lb.	.15 - .16	.16 - .17
Sulphur chl-ride, red..... lb.	.07 - .08	.07 - .08
Sulphur, crude..... ton	20.00 - 22.00	.09 - .10
Sulphur dioxide, liquid, cylinders ext a..... lb.	.08 - .09	.09 - .10
Sulphur (sublimed), flour..... 100 lb.		2.25 - 3.10
Sulphur, roll (brimstone)..... 100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent..... lb.	.18 - .19	.40 - .42
Tin oxide..... lb.		.19 - .20
Zinc carbonate, precipitate..... lb.	.16 - .18	.19 - .20
Zinc chloride, gran..... lb.	.11 - .12	.11 - .12
Zinc cyanide..... lb.	.45 - .49	.50 - .60
Zinc dust..... lb.	.12 - .13	.13 - .14
Zinc oxide, XX..... lb.	.08 - .09	.09 - .10
Zinc sulphate..... lb.	.03 - .04	.04 - .05

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.15 - \$1.25
Alpha-naphthol, refined..... lb.	1.45 - 1.50
Alpha-naphthylamine..... lb.	.38 - .40
Aniline oil, drums extra..... lb.	.20 - .26
Aniline salts..... lb.	.26 - .29
Anthracene, 80% in drums (100 lb.)..... lb.	.75 - 1.00
Benzaldehyde U.S.P..... lb.	1.00 - 1.50
Benzidine, base..... lb.	.90 - 1.00
Benzidine sulphate..... lb.	.75 - .80
Benzoic acid, U.S.P..... lb.	.65 - .70
Benzoate of soda, U.S.P..... lb.	.65 - .70
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 - .28
Benzyl chloride, 95-97% refined..... lb.	.28 - .30
Benzyl chloride, tech..... lb.	.25 - .27
Beta-naphthol benzoate..... lb.	3.50 - 4.00
Beta-naphthol, sublimed..... lb.	.70 - .75
Beta-naphthol, tech..... lb.	.33 - .45
Beta-naphthylamine, sublimed..... lb.	2.25 - 2.40
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 - .18
Ortho-cresol, in drums (100 lb.)..... lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.90 - .95
Cresylic acid, 75-97%, dark, in drums..... gal.	.85 - .90
Cresylic acid, 50%, first quality, drums..... gal.	.55 - .60
Dichlorobenzene..... lb.	.06 - .09
Diethylaniline..... lb.	1.25 - 1.30
Dimethylaniline..... lb.	.48 - .55
Dinitrobenzene..... lb.	.30 - .32
Dinitrochlorobenzene..... lb.	.25 - .30
Dinitronaphthalene..... lb.	.33 - .35
Dinitrophenol..... lb.	.40 - .45
Dinitrotoluene..... lb.	.25 - .27
Dip oil, 25%, tar acids, car lots, in drums..... gal.	.38 - .40
Diphenylamine..... lb.	.60 - .70
H-acid..... lb.	1.30 - 1.50
Meta-phenylenediamine..... lb.	1.20 - 1.25
Monochlorobenzene..... lb.	.14 - .16
Monoethylaniline..... lb.	1.90 - 2.00
Naphthalene crushed, in bbls. (250 lb.)..... lb.	.08 - .09
Naphthalene, flake..... lb.	.08 - .09
Naphthalene, balls..... lb.	.09 - .10
Naphthionic acid, crude..... lb.	.70 - .75
Nitrobenzene..... lb.	.12 - .15
Nitro-naphthalene..... lb.	.30 - .35
Nitro-toluene..... lb.	.16 - .18
Ortho-amidophenol..... lb.	3.20 - 3.75
Ortho-dichlor-benzene..... lb.	.15 - .20
Ortho-nitro-phenol..... lb.	.75 - .80
Ortho-nitro-toluene..... lb.	.17 - .20
Ortho-toluidine..... lb.	.25 - .30
Para-amidophenol, base..... lb.	1.90 - 2.00
Para-amidophenol, HCl..... lb.	2.10 - 2.20

Para-dichlorobenzene..... lb.	.15 - .20
Paranitroaniline..... lb.	.90 - 1.05
Para-nitrotoluene..... lb.	.90 - 1.05
Para-phenylenediamine..... lb.	1.95 - 2.00
Para-toluidine..... lb.	1.25 - 1.60
Phthalic anhydride..... lb.	.50 - .60
Phenol, U. S. P., drums (dest.), (240 lb.)..... lb.	.11 - .13
Pyridine..... gal.	2.00 - 3.50
Resorcinol, technical..... lb.	1.85 - 2.00
Resorcinol, pure..... lb.	2.30 - 2.50
Salicylic acid, tech., in bbls. (110 lb.)..... lb.	.22 - .23
Salicylic acid, U. S. P..... lb.	.24 - .26
Salol..... lb.	.85 - .95
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 - .16
Sulphanilic acid, crude..... lb.	.30 - .35
Tolidine..... lb.	1.35 - 1.45
Toluidine, mixed..... lb.	.40 - .45
Toluene, in tank cars..... gal.	.25 - .28
Toluene, in drums..... gal.	.28 - .31
Xylidines, drums, 100 gal..... lb.	.40 - .45
Xylene, pure, in drums..... gal.	.42 - .45
Xylene, pure, in tank cars..... gal.	.45 - .48
Xylene, commercial, in drums, 100 gal..... gal.	.33 - .35
Xylene, commercial, in tank cars..... gal.	.30 - .33

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.24 - \$0.26
Beeswax, refined, light..... lb.	.27 - .28
Beeswax, white pure..... lb.	.40 - .45
Carnauba, Florida..... lb.	.68 - .70
Carnauba, No. 2, North Country..... lb.	.30 - .32
Carnauba, No. 3, North Country..... lb.	.18 - .19
Japan..... lb.	.19 - .19
Montan, crude..... lb.	.07 - .08
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.04 - .05
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.03 - .04
Paraffine waxes, refined, 118-120 m.p..... lb.	.04 - .04
Paraffine waxes, refined, 125 m.p..... lb.	.04 - .04
Paraffine waxes, refined, 128-130 m.p..... lb.	.05 - .06
Paraffine waxes, refined, 133-135 m.p..... lb.	.06 - .06
Paraffine waxes, refined, 135-137 m.p..... lb.	.06 - .06
Stearic acid, single pressed..... lb.	.11 - .11
Stearic acid, double pressed..... lb.	.11 - .11
Stearic acid, triple pressed..... lb.	.12 - .12

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.70
Pine oil, pure, dest. dist..... gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.30
Turpentine, crude, sp. gr. 0.900-0.970..... gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.37
Pinewood creosote, ref..... gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl..... 280 lb.	\$4.90
Rosin E-I..... 280 lb.	5.15
Rosin K-N..... 280 lb.	5.50
Rosin W. G.-W. W..... 280 lb.	6.00
Wood rosin, bbl..... 280 lb.	6.25
Spirits of turpentine..... gal.	.57
Wood turpentine, steam dist..... gal.	.56
Wood turpentine, dest. dist..... gal.	.55
Pine tar pitch, bbl..... 200 lb.	7.00
Tar, kiln burned, bbl. (500 lb.)..... bbl.	14.50
Retort tar, bbl..... 500 lb.	15.00
Rosin oil, first run..... gal.	.45
Rosin oil, second run..... gal.	.48
Rosin oil, third run..... gal.	.60

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41
70-72 deg., steel bbls. (85 lb.)..... gal.	.39
68-70 deg., steel bbls. (85 lb.)..... gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30

Crude Rubber

Para-Upriver fine..... lb.	\$0.17 - \$0.18
Upriver coarse..... lb.	.11 - .12
Upriver caucho ball..... lb.	.14 - .14
Plantation—First latex crepe..... lb.	.18 - .18
Ribbed smoked sheets..... lb.	.16 - .16
Brown crepe, thin, clean..... lb.	.18 - .18
Amber crepe No. 1..... lb.	.20 - .20

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.08 - \$0.09
Castor oil, AA, in bbls..... lb.	.09 - .10
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.07 - .08
Cocoonut oil, Ceylon grade, in bbls..... lb.	.09 - .10
Cocoonut oil, Cochin grade, in bbls..... lb.	.10 - .10
Corn oil, crude, in bbls..... lb.	.08 - .08
Cottonseed oil, crude (f. o. b. mill)..... lb.	.04 - .04
Cottonseed oil, summer yellow..... lb.	.06 - .06
Cottonseed oil, winter yellow..... lb.	.06 - .06
Linseed oil, raw, car lots (domestic)..... gal.	.62 - .62
Linseed oil, raw, tank cars (domestic)..... gal.	.55 - .55
Linseed oil, in 5-bbl lots (domestic)..... gal.	.65 - .66

Olive oil, commercial.....	gal	\$1 90	\$2 50
Palm, Lagos.....	lb.	.07	.07½
Palm, Niger.....	lb.	.06	.06½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.05½	.05½
Peanut oil, refined, in bbls.....	lb.	.10	.10½
Rapeseed oil, refined in bbls.....	gal.	1 05	1 10
Rapeseed oil, blown, in bbls.....	gal.	1 15	1 20
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07½	.07½
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.04½	.....

FISH

Light pressed menhaden.....	gal.	\$0.45	\$0.47
Yellow bleached menhaden.....	gal.	.47	.....
White bleached menhaden.....	gal.	.49	.....
Blown menhaden.....	gal.	.84	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24 00	— 30 00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22 00	— 26 00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10 00	— 17 00
Barytes, floated, f.o.b. St. Louis.....	net ton	26 50	— 28 00
Barytes, crude, first grade, Missouri.....	net ton	10 00	— 10 00
Blanc fixe, dry.....	lb.	.05	— .05½
Blanc fixe, pulp.....	net ton	50 00	— 60 00
Casein.....	lb.	.14	— .16
Chalk, domestic, extra light.....	lb.	.05	— .05½
Chalk, domestic, light.....	lb.	.04½	— .05
Chalk, domestic, heavy.....	lb.	.04	— .05
Chalk, English, extra light.....	lb.	.05	— .07
Chalk, English, light.....	lb.	.05	— .06
Chalk, English, dense.....	lb.	.04½	— .05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8 00	— 10 00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12 00	— 15 00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18 00	— 22 00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8 00	— 12 00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15 00	— 47 00
China clay (kaolin), imported, lump.....	net ton	23 00	— 25 00
China clay (kaolin), imported, powdered.....	net ton	30 00	— 35 00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8 00	— 14 00
Feldspar, crude, f.o.b. Maine.....	net ton	7 50	— 10 00
Feldspar, ground, f.o.b. Maine.....	net ton	21 00	— 23 00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17 00	— 21 00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17 00	— 21 00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27 00	— 30 00
Fullers earth, f.o.b. Mines.....	net ton	16 00	— 17 00
Fullers earth, granular, f.o.b. Fla.....	net ton	25 00	— 25 00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18 00	— 18 00
Fullers earth, imported, powdered.....	net ton	30 00	— 35 00
Graphite, Ceylon lump, first quality.....	lb.	.08	— .09
Graphite, Ceylon chip.....	lb.	.07	— .08
Graphite, high grade amorphous crude.....	lb.	.03	— .03
Pumice stone, imported, lump.....	lb.	.04	— .50
Pumice stone, domestic lump.....	lb.	.05	— .05½
Pumice stone, ground.....	lb.	.06	— .07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	— 10 00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	.....	— 14 00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	— 17 00
Quartz, lump, f.o.b. North Carolina.....	net ton	5 00	— 7 50
Shellac, orange fine.....	lb.	.57	— 1 00
Shellac, orange superfine.....	lb.	.60	— 1 00
Shellac, A. C. garnet.....	lb.	.45	— 1 00
Shellac, T. N.....	lb.	.45	— 1 00
Soapstone.....	ton	12 00	— 15 00
Sodium chloride.....	long ton	14 00	— 15 00
Talc, paper-making grades, f.o.b. Vermont.....	ton	12 00	— 22 00
Talc, roofing grades, f.o.b. Vermont.....	ton	9 50	— 15 00
Talc, rubber grades, f.o.b. Vermont.....	ton	12 00	— 18 00
Talc, powdered, Southern, f.o.b. cars.....	ton	12 00	— 15 00
Talc, imported.....	ton	40 00	— 50 00
Talc, California talcum powder grade.....	ton	20 00	— 40 00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	
Carborundum refractory brick, 9-in.	1,000	1250.00	
Chrome brick, f.o.b. Eastern shipping points.....	1,000	1100.00	
Chrome cement, 40-45% Cr ₂ O ₃	net ton	80-100	
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	45- 50	
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	net ton	 55	
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55- 60	
Magnesite brick, 9-in. straight.....	1,000	45- 50	
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	90	
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105	
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	120	
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	45- 55	
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	45- 55	
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	45- 55	

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200 00	— \$225 00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	15	— 16
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	16	— 17
Ferromanganese, 76-80% Mn, domestic.....	gross ton	90 00	— 95 00
Ferromanganese, 76-80% Mn, English.....	gross ton	90 00	— 95 00
Spiegeleisen, 18-22% Mn.....	gross ton	32 00	— 35 00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2 50	— 2 50
Ferrosilicon, 10-15% Si.....	gross ton	50 00	— 55 00
Ferrosilicon, 50% Si.....	gross ton	85 00	— 90 00
Ferrosilicon, 75% Si.....	gross ton	145 00	— 150 00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	45	— 50
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	6 00	— 6 00
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5 00	— 6 50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$10.00	— \$11.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.45	— .50
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	45	— 50
Coke, foundry, f.o.b. ovens.....	net ton	5.00	— 6 00
Coke, furnace, f.o.b. ovens.....	net ton	4.00	— 5 00
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00	— 16 00
Fluorspar, lump, f.o.b. Hea hden, New Mexico.....	net ton	17.50	— 17 50
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	22.50	— 25 00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	— .01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.30	— .35
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	— 65 00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	— .60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00	— 30 00
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.16	— .16
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.16	— .16
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	— .14
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	— .15
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	— 3 25
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	— 3 25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	— 2 50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	— 2 50
Vanadium pentoxide, 99%.....	lb.	12.00	— 14 00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	— 1 50
Zircon, washed, iron free.....	lb.	.03	— .03

Non-Ferrous Metals

New York Markets

Copper, electrolytic.....		12.75	
Aluminum, 98 to 99 per cent.....		28.3@28.5	
Antimony, wholesale lots, Chinese and Japanese.....		5½@5½	
Nickel, ordinary (ingot).....		41.00	
Nickel, electrolytic.....		44.00	
Morel metal, spot and bl cks.....		.35	
Morel metal ingots.....		.38	
Morel metal, sheet bars.....		.40	
Tin, 5-ton lots.....		29.50	
Lead, New York, spot.....		4.25@4.35	
Lead, E. St. Louis, spot.....		4.25	
Zinc, spot, New York.....		5.15	
Zinc, spot, E. St. Louis.....		4.65	

OTHER METALS

Silver (commercial).....	oz.	\$0.57½	
Cadmium.....	lb.	1.00-1.10	
Bismuth (500 lb. lots).....	lb.	1.50@1.65	
Cobalt.....	lb.	4.50	
Magnesium (f.o.b. Philadelphia).....	lb.	1.25	
Platinum.....	oz.	72.00-74.00	
Iridium.....	oz.	250.00@300.00	
Palladium.....	oz.	65.00@70.00	
Mercury.....	75 lb.	45.00	

FINISHED METAL PRODUCTS

Copper sheets, hot rolled.....		20.00	
Copper bottoms.....		27.50	
Copper rods.....		18.75	
High brass wire.....		18.25	
High brass rods.....		15.25	
Low brass wire.....		20.25	
Low brass rods.....		20.25	
Brazed brass tubing.....		29.50	
Brazed bronze tubing.....		34.25	
Seamless copper tubing.....		22.00	
Seamless high brass tubing.....		21.00	

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York				Cleveland	Chicago
	Current	One Year Ago	One Month Ago	One Year Ago		
Copper, heavy and crucible.....	8 50@9 00	18.50	10.00	10.50		
Copper, heavy and wire.....	8 00@8 25	16.50	9.50	9.50		
Copper, light and bottoms.....	7 00@7 50	14.50	9.00	8.50		
Lead, heavy.....	3 00@3 50	7.25	4.00	4.00		
Lead, tea.....	2 00@2 12½	5.25	3.00	3.00		
Brass, heavy.....	4 25@4 50	9.50	7.00	10.00		
Brass, light.....	3 00@3 25	8.00	5.00	5.50		
No. 1 yellow brass turnings.....	4 00@4 25	9.50	5.50	6.00		
Zinc.....	2 00@2 50	5.00	3.00	3.50		

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	Current	One Month Ago	One Year Ago	Current	Year Ago	Current	Year Ago
Structural shapes.....	\$2 50	\$3 80	\$3 47	\$3.58	\$3.37	\$3.58	\$3.47
Soft steel bars.....	2 50	3 70	3 52	3.34	3 27	3.48	3 52
Soft steel bar shapes.....	2 50	3 70	3 52	3.48	3 27	3 48	3 52
Soft steel bands.....	2 85	4 65	4 22	6.25			
Plates, ½ to 1 in. thick.....	2 50	4 00	3 67	3.78	3.57	3.78	3.67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

LOS ANGELES—The All-In-One Mfg. Co., 504 Marsh-Strong Bldg., recently incorporated with a capital of \$1,000,000 to manufacture metal enameled bathroom fixtures, has plans under way for its proposed new plant on a 10-acre site at Slauson Ave. and Downey Rd., lately acquired. The plant will consist of a group of eight main buildings, including 1-story foundry, 200x200 ft.; 1-story casting cleaning building, 50x200 ft.; 3-story enameling plant, 75x200 ft.; 1-story assembling building, 75x200 ft.; 1-story pattern shop, 50x200 ft.; warehouse and shipping building, office building, employees' building and garage. The new plant will cost about \$350,000 with machinery. J. C. Peterson, Sacramento, Cal., vice-president of the company, will act as architect and engineer for the plant.

Delaware

MILFORD—The Valliant Fertilizer Co., Laurel, Del., has acquired the fertilizer manufacturing plant of William Pierce, Milford. Possession will be taken at once and plans are under way for enlargements, to include the installation of new machinery. Edward S. Valliant will be manager of the Milford works.

Illinois

ARGO—The Corn Products Refining Co. is reported to be planning for the early reopening of its local grinding works, recently closed temporarily. Since the first of the year the plant has been operating on a 4-day week basis. The works give employment to about 2,000 operatives.

CHICAGO—The American Magnesia Products Co., 106 North La Salle Street, is having plans prepared for extensions and improvements in its 2-story plant at 5726 Roosevelt Rd., to cost about \$50,000. Bids will soon be asked.

CHICAGO—The Liberty Raw Hide Mfg. Co., 1435 West Austin Ave., is having plans prepared for the erection of a 2-story addition to its plant, estimated to cost about \$12,000.

CHICAGO—C. F. Davis & Co., Inc., dealer in tin plate and sheet metals, is planning the erection of a new plant at 37th St. near Iron. The investment including lot, 132x135 ft., will be approximately \$65,000. There will be about 15,000 sq.ft. of floor space. The main offices of the company will be located in the new building. This company also has branch offices and warehouses in New York and Pittsburgh.

CHICAGO—The Illinois Brick Co. has purchased the 26 acres bounded by Sacramento, Lunt and California Aves. and Pratt Blvd. This property consists of a clay bank acquired with the intention of extending the company's plant at some future date.

Indiana

VINCENNES—A portion of the plant of the Indian Refining Co., manufacturer of oils, was destroyed by fire March 26, with loss reported at about \$150,000.

Kentucky

LOUISVILLE—The Louisville Soap Products is planning for the rebuilding of its plant destroyed by fire March 27, with loss estimated at \$270,000.

Maine

GREAT WORKS—The Penobscot Chemical Fibre Co. has completed the construction of a new digester building at its plant and plans to place the structure in service at an early date.

WATERVILLE—The Keyes Fibre Co., Fairfield Rd., has awarded a contract to the Horace Purington Co., 178 Main St. for the construction of three additions to its plant, consisting of a 2-story machine and pump department, 45x95 ft.; 1-story pulp works, 40x150 ft.; and 1-story drier building, 90x140 ft.

Maryland

BALTIMORE—The Zirconium Co. of America, recently organized with a capital of \$1,000,000 to manufacture ferrozirconium and a refractory specialty known as zirconium oxide, has acquired an interest in the plant of the Rare Metals Reduction Co., Old Frederick Rd., Catonsville, and will use the property in connection with its proposed new plant in this section. George F. Dixon is president and Philip C. Spencer vice-president.

MOUNT SAVAGE—The Mount Savage Fire Brick Co. has awarded a contract to Golin Gerlach, Frostburg, Md., for the construction of additions to its plant to cost about \$85,000. The work will consist of a new kiln building, 100x200 ft., and two other buildings, 98x286 ft., and 36x325 ft., respectively, with power house, 50x90 ft.

BALTIMORE—The Crown Oil & Wax Co., Eighth and Pratt Sts., is said to be planning for extensions and improvements at its plant to cost about \$25,000.

BALTIMORE—The Cooknut Corp., Lexington and Paca Sts., W. R. Spruill, president, recently organized with a capital of \$500,000 to manufacture lard substitutes and kindred products, is planning for the early erection of the first unit of its proposed new plant, to have an initial capacity of about 55,000 lb. per day.

Michigan

ROCKFORD—Machinery will be installed at once at the new local plant of Henry Ford, Detroit, for the manufacture of plate glass under a new process. A large portion of the output will be used for Ford automobiles. The company has extensive silica deposits in this section, claimed to be particularly suitable for the desired character of glass.

Missouri

KANSAS CITY—The Barada, Gordon & Page Chemical Co., 2018 Guinotte St., has awarded a contract to the McCallum Construction Co. for the erection of a new plant, 40x60 ft., on Michigan Ave.

New Jersey

PERTH AMBOY—Fire April 6 destroyed a portion of the local plant of the General Bakelite Co., 350 Rector St., with loss estimated at about \$15,000.

New York

BUFFALO—The Standard Milling Co., 49 Wall St., New York, has plans under way for its proposed new flour mill at the foot of Louisiana St., Buffalo. The mill, it is said, will be the largest plant of its kind in the world. It will comprise two elevators of 3,500,000 and 2,500,000 bu. capacity, respectively. Four complete flour mill units will be constructed, each with an output of 6,000 bbl. per day; a rye mill of 300 bbl. daily output; wheat mill of 300 bbl. capacity; corn mill of 500 bbl.; and oatmeal of 600 bbl. The new plant with machinery is estimated to cost about \$7,500,000. The A. E. Baxter Engineering Co., Ellicott Sq., Buffalo, is engineer.

CORNING—The Illig Cut Glass Co., East Market St., will soon take bids for the erection of a 1-story addition at Denison Parkway and Pearl St., 45x45 ft. John Illig is head.

Ohio

BREMAN—The Breman Metal Stamping Co. has plans under way for the erection of a 1-story addition, 28x70 ft. W. E. Trinkey is head.

LANCASTER—The Interstate Glass Co., Bradford, Pa., is having plans prepared for extensions and improvements in its plant at Lancaster to cost about \$70,000. H. J. Walters is president and general manager.

CAMBRIDGE—The Flannagan Pottery Co. has awarded a contract to Gamble & Bryan, East Liverpool, O., for the erection of a new kiln building to cost about \$20,000. It will be used for decorative work.

Oregon

PORTLAND—The Portland Flouring Mills Co. has arranged for a bond issue of \$3,000,000, the proceeds to be used, in part, for proposed extensions and betterments in its different plants.

Pennsylvania

PITTSBURGH—Fire March 31 destroyed a portion of the building of the Pennsylvania Paper Stock Co., with loss estimated at close to \$100,000.

PITTSBURGH—The Air Reduction Co., 2555 Liberty St. and 120 B'way, New York, manufacturer of commercial oxygen, etc., is having revised plans prepared for the erection of its proposed new plant on Ridge Ave. to cost about \$250,000 with equipment.

PORT KENNEDY—The Valley Forge Magnesia Co. has awarded a contract to the William Steele & Sons Co., 1600 Arch St., Philadelphia, for the erection of its proposed new local plant, comprising a 2-story building, 40x100 ft., and 1-story structure 40x48 ft.

Tennessee

KNOXVILLE—H. L. Dullin, affiliated with Anderson, Dullin & Varnell, is organizing a new company for the establishment of a new plant for the production of acid phosphate and kindred specialties.

KNOXVILLE—The Knoxville Fertilizer Co., recently organized with a capital of \$500,000, has plans under way for the erection of a new local plant. James W. Dean and S. B. Carter head the company.

MARTIN—The E. E. Gooch Mfg. Co., recently organized, is planning for the erection of a new plant for the manufacture of Skipper and other compounds. The installation will consist of grinding and mixing machinery, packing equipment, etc. The different machines will be electrically operated. E. E. Gooch is president and general manager.

Texas

HOUSTON—The Standard Rubber Co., Mason Bldg., has acquired the plant of the Universal Tire Co. for the establishment of a new rubber goods manufacturing plant. It is said that the plant will be remodeled and improved. E. H. Fleming is president and John T. Powers, Jr., secretary.

SAN ANTONIO—The Samuels Art Glass Co. has acquired a local site with about 100 ft. frontage for the construction of a new 3-story plant. L. M. Samuels is head.

SAN ANTONIO—Charles R. Tips, San Antonio, is organizing a new company for the construction of a glass-manufacturing plant at Three Rivers, near San Antonio. The initial works will be of 3-tank type, and will be devoted exclusively to bottle production. The company has its own silica properties in this district. The new plant is estimated to cost about \$30,000.

Washington

SPOKANE—The Northwest Iron & Steel Co., Rookery Bldg., is planning for the erection of a new iron furnace in the Boundary district of Stevens County. The plant will have an initial output of 25 tons per day, and at a later date, it is said, will be enlarged and improved.

West Virginia

ELLENBORO—The Insulite Co., recently organized to manufacture molded composition products, etc., has awarded a contract to J. M. Worstell, Ellenboro, for the construction of its proposed new plant, 80x160 ft. A number of machine tools in addition to regular operating equipment will be installed, including lathes, drills, grinders, etc. A power house also will be constructed. Edward J. White is president and manager.

HUNTINGTON—The International Nickel Co., 43 Exchange Pl., New York, has awarded a contract to the McClintic-Marshall Co., Oliver Bldg., Pittsburgh, Pa., for the erection of its proposed new plant at Huntington for the manufacture of rolled nickel products. The plant will consist of a group of 1-story buildings, approximating 200x400 ft. in size, including rolling mill and other departments. It is estimated to cost in excess of \$2,000,000 with machinery. Frank I. Ellis, Farmers' Bank Bldg., Pittsburgh, is consulting engineer for the project.

SUTTON—The Sutton Building Corp., recently organized, is planning for the erection of a local plant for the manufacture of brick, tile and other burned clay products. Benton B. Boggs is president.

New Companies

THE SUPERIOR SPARK PLUG Co., Detroit, Mich., has been incorporated with a capital of \$25,000 to manufacture spark plugs and other ignition equipment. The incorporators are I. J. Pettiford, Z. W. Laskalin and George Hadrich, 4001 Bewick Ave.

THE INTERNATIONAL ENGINEERING & CHEMICAL CORP., Boston, Mass., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture chemicals and chemical byproducts. The incorporators are C. Binnig, Benjamin J. Phipps and Samuel Arafe, 41 Draper St., Dorchester, Mass.

THE DRAGON DRUG & CHEMICAL Co., Brooklyn, N. Y., has been incorporated with a capital of \$300,000 to manufacture chemical products. The incorporators are G. B. Rose, S. Marchisio and J. Furcht, 26 Court St.

THE J. J. MURPHY PAPER Co., New York, N. Y., has been incorporated with a capital of \$125,000 to manufacture paper products. The incorporators are M. Syrkin, A. Aaronson and J. J. Murphy, Orange, N. J.

THE DE LUXE INK & DYE Co., 716 Ashland Blk., Chicago, Ill., has been incorporated with a capital of \$40,000 to manufacture ink, dyes and kindred products. The incorporators are Sampson Andalman, M. King Schragar and Samuel J. Green.

THE MOSCO REFINING Co., Newark, N. J., has been incorporated with a capital of \$25,000 to manufacture oil products. The incorporators are John J. McLean, Charles S. Halleron and William D. Duguid, 87 Irving St.

THE BAY STATE FIBRE Co., Portland, Me., has been incorporated with a capital of \$10,000 to manufacture fiber products. E. M. Pine is president; Edmund P. Mahoney, treasurer; and Jacob H. Berman, secretary.

THE EUCCO CHEMICAL Co., Tonawanda, N. Y., has been incorporated with a capital of \$25,000 to manufacture chemicals and byproducts. The incorporators are G. L. Corliss, C. L. Pack and W. W. Britt, Tonawanda.

THE SAGINAW CLAY PRODUCTS Co., Saginaw, Mich., has been incorporated with a capital of \$30,000 to manufacture burned clay specialties. The incorporators are F. J. Lohman, Henry W. F. and J. Fred Goetz, Saginaw.

THE LOS ANGELES-VENTURA OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are J. B. Harker, Charles I. Puffer and M. H. Serf, Los Angeles. The company is represented by C. E. Hobart, 500 Wilcox Bldg.

THE NORTH WEST ENVELOPE Co., Seattle, Wash., has been incorporated with a capital of \$50,000 to manufacture paper products. The incorporators are L. V. Carey and associates.

THE MERIT OIL Co., 355 East 47th St., Chicago, Ill., has been incorporated with a capital of \$20,000 to manufacture oil products. The incorporators are Leo and Jacob Adler, and Charles A. Schram.

THE VELVO OIL Co., Utica, N. Y., has been incorporated with a capital of \$150,000 to manufacture refined oil products. The incorporators are F. A. Hoyt, J. A. Ritchie and F. M. Tobin, Utica.

THE COLUMBIA CHEMICAL CONSTRUCTIVE CORP., Philadelphia, Pa., has been incorporated under Delaware laws with a capital of \$100,000 to manufacture chemicals and chemical byproducts. The incorporators are Fred J. Bergmann, Fred W. Moesta and Edward Ramsey, Philadelphia.

THE INDUSTRIAL MOLDED MATERIALS Co., Woodbury, N. J., has been incorporated with a capital of 2,500 shares of stock, no par value, to manufacture molded and compounded specialties. The incorporators are Harry M. Dent, Robert G. Griswold and Paul Knapp, Woodbury.

THE LEO DREYFUS Co., New York, N. Y., has been incorporated with a capital of \$250,000 to manufacture chemicals and chemical byproducts. The incorporators are L. Dreyfus, S. D. Kessler and J. Herron, Jr. R. Seelav, 51 Chambers St., New York, represents the company.

THE BURGESS PAPER Co., 37 West Van Buren St., Chicago, Ill., has been incorporated with a capital of \$20,000 to manufacture paper specialties. The incorporators are Roy H. and Frank A. Burgess, and Edwin I. Hoke.

THE CHEMICAL GAS DEVELOPMENT Co., Vancouver, Wash., has been incorporated with a capital of \$300,000 to manufacture chemical products. The incorporators are

A. S. Battson, E. D. Payne and F. L. Naul, Vancouver.

THE SUPERSOAP PRODUCTS Co., New York, N. Y., has been incorporated with a capital of \$10,000 to manufacture soap and kindred products. The incorporators are J. Sokoloff, M. M. Sokoloff and J. Stollmaker, 162 East 161st St., Bronx.

THE WILLARD BRICK Co., New York, N. Y., has been incorporated with a capital of \$50,000 to manufacture brick and other burned clay products. The incorporators are A. F. Hanrahan, W. F. Davis and E. A. Vosseler. The company is represented by E. W. Webb, 149 B'way.

THE HUNTINGTON OWNERS' OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are J. E. Yerby, B. S. Carr and M. P. Hansen. B. S. Hunter, Citizens' National Bank Bldg., represents the company.

THE APEX OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$1,000,000 to manufacture petroleum products. The incorporators are Arthur G. Gage, Fred H. Hammer and M. L. Jenks. The company is represented by Adams, Adams & Binford, 716 Van Nuys Bldg.

THE FORT WORTH ENVELOPE Co., Fort Worth, Tex., has been incorporated with a capital of \$10,000 to manufacture paper products. The incorporators are J. A. Stafford, E. C. and W. C. Lowden.

THE CHEMICAL PRODUCTS Co. OF NEW JERSEY, INC., Newark, N. J., has been incorporated with a capital of \$1,000,000 to manufacture chemicals and chemical byproducts. The incorporators are George A. Soden and Alfred Gable, Newark; and S. Ellsworth White, Glen Ridge, N. J.

THE MONUMENTAL OIL CORP., Baltimore, Md., has been incorporated with a capital of \$25,000 to manufacture lubricating oils, greases, etc. The incorporators are Howard M. Roberts, Stuart S. Scott and Charles D. Smith, 110 South Charles St.

THE ALLOY ORE & MINERAL Co., 128 Market St., Newark, N. J., has filed notice of organization to manufacture alloys, ore specialties, etc. Irving N. Schafman, 212 Elizabeth Ave., heads the company. The same interests have formed the Asbestos & Magnesia Co., Superb Bldg., to manufacture asbestos products, and the Atlantic Gulf & Pacific Oil Co., to manufacture oil specialties.

THE R. A. HUDSON Co., Auburn, N. Y., has been incorporated with a capital of \$175,000 to manufacture chemical and chemical byproducts, drugs, etc. The incorporators are N. D. Stone, W. T. and R. A. Hudson, Auburn.

THE MID-WEST DRUG Co., Akron, O., has been incorporated under Delaware laws with a capital of \$100,000 to manufacture chemicals, drugs and affiliated products. The incorporators are Edgar M. Williams, Akron; Albert B. Smith, Chicago; and L. J. Rothenbecker, Cleveland, O.

THE ART PARAGON PAPER BOX Co., 531 South Peoria St., Chicago, Ill., has been incorporated with a capital of \$20,000 to manufacture paper boxes and kindred specialties. The incorporators are Abraham, Louis S. and Samuel S. Berman.

R. A. FAWCETT, INC., Boston, Mass., has been incorporated with a capital of \$50,000 to operate a leather tanning plant for hides, skins, and for the production of byproducts. The incorporators are Benjamin Hemmerlin, 161 Summer St.; A. T. Parsons and L. A. Smith, Boston.

THE AUTO CITY OIL Co., Detroit, Mich., has been incorporated with a capital of \$10,000 to manufacture lubricating oils. The incorporators are Marble I. Tweedle and August L. Miller, 5441 Iroquois Ave., Detroit; and W. H. Stavk, Cleveland, O.

THE INTERSTATE TANNING Co., Newark, N. J., has been incorporated with a capital of 2,500 shares of stock, no par value, to manufacture leather products. The incorporators are W. R. Crosson, Willard S. Muchmore and A. P. Bachman. The company is represented by James B. Reilly, 31 Clinton St.

THE TRENTON FOLDING BOX Co., Trenton, N. J., has been incorporated with a capital of \$125,000 to manufacture paper boxes and kindred products. The incorporators are A. E. Serridge, Edwin W. Arnold and George F. Vanaken, Trenton.

THE ARUNDEL OIL CORP., 7 East Redwood St., Baltimore, Md., has been incorporated with a capital of \$400,000 to manufacture oil products. The incorporators are William A. Smith, Bruner R. Anderson and John A. Vogt.

THE KEYSTONE FIREBRICK Co., Philadelphia, Pa., has been incorporated with a

capital of \$150,000 to manufacture firebrick and other refractory products. The incorporators are A. M. Davis, James Warnock, Philadelphia; and Walter L. Hachnlen, Cynwyd, Pa.

THE CHARLES E. LESTER Co., New York, N. Y., has been incorporated with a capital of \$20,000 to manufacture chemical products. The incorporators are E. S. Bachrach, D. Rieser and W. Strauss. H. Hofheimer, 35 Nassau St., represents the company.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29. Headquarters will be at the Hotel Rochester.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17. Headquarters will be at the Congress Hotel.

AMERICAN PAPER & PULP ASSOCIATION is holding its annual meeting at the Waldorf-Astoria and Hotel Astor, New York City, April 11 to 15.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

AMERICAN WELDING SOCIETY, METROPOLITAN SECTION, will hold its regular meeting April 19 at the Engineering Societies Building, New York City.

AMERICAN ZINC INSTITUTE will hold its annual meeting in St. Louis May 9 and 10.

ASSOCIATION OF SCIENTIFIC APPARATUS MAKERS OF THE U. S. A. will hold its meeting at the Hotel Raleigh, Washington, D. C., April 14 to 16.

BRITISH IRON AND STEEL INSTITUTE will hold its spring meeting May 5 and 6, at the Institution of Civil Engineers, Great George St., S. W. 1, London, England.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

HARVARD ALUMNI CHEMISTS' ASSOCIATION will meet Tuesday noon, April 26, at Rochester, N. Y., for luncheon.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27 to 29.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

TECHNICAL ASSOCIATION OF THE PULP & PAPER INDUSTRY is holding its annual meeting at the Waldorf-Astoria and Hotel Astor, N. Y., April 11 to 14.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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Assistant Editors
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Industrial Editor
J. S. NEGRU
Managing Editor

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New York, April 20, 1921

Number 16

Wanted—

A Taragometer

ALL YOU have to do is to invent it and develop it and produce and market it successfully, and—there you are! The instrument is sorely needed. Those of our readers who have enjoyed the benefits of a classical education sufficiently to remember their Greek, and any who may be engaged in small-scale roasting and vending of peanuts, and are, like most of their colleagues, themselves Greeks, will readily understand the nature and purpose of the apparatus. It measures noise.

The late JOSEPH PULITZER, editor and owner of the *New York World*, could not stand noise at all. He was a great editor and a man who, although blind, was gifted with rare mental vision; but noise drove him wild. Being very rich, he had sound-proof rooms constructed in his house for his comfort, and when he traveled he engaged rooms above and below and all around the apartment that he occupied at a hotel. The rest of us have to stand it, but it is not good for all of us. Psychologists are beginning to make records of the effects of raucous, persistent and nerve-racking noises, and the results are worse than expected. They upset the delicate balance of the mind, which is a sensitive apparatus, even among those who exceed in dullness. The riveter may not mind it, because to drive rivets is his chosen calling, but he doesn't have to think much. It is constructive thought that is disturbed by noise; constructive thought and health—mental health. It would be interesting to learn whether boiler-makers and others who live in such rattles are not more addicted to beating their wives than those who dwell in peace. The half-hushed rumble of a city or the distant roar of a waterfall is often soothing, but there are noises, more especially factory noises, that never soothe. Many of them are unnecessary and some of them cost money.

Every bit of unnecessary noise is wasted energy, and when we say unnecessary we mean a strict construction of the adjective. Those who are heavy of wit need emphasis, but if we put it on where it is not needed we not only hurt, we injure. Those of us who engage in thoughtful occupations do not like to be yelled at, and those of us who work with our hands can do better without it.

We know of a laboratory that moved from a noisy street to a quiet place, and as soon as the chemists were freed from the racket and rumble and dust their work improved and their ideas were better. This also holds true of an artisan who needs to use his head at his work. He can't do as well if his ears are constantly recording alarms as he can if given a decent quiet place for his task. Nearly everyone who is sensitive has a little of the PULITZER in him in so far as he is disturbed by noise, while those who are not sensitive cannot make the fine distinctions that we want our best men to make. Noise spoils good work. It is a good thing to bear in mind

that we ourselves shall not only do better but also get better work done, if we make less noise. There is too much entropy in noise for it to be wholesome. One of the wisest men of science we know declares that entropy is original sin. We favor the idea.

So let's have the taragometer. It will record in degrees the raucousness, the unpleasantness, the nerve-stretching quality of noises wherever it is installed, and do it quantitatively. It will prevent accidents. Noise distracts, and the distracted brain cannot work.

Our idea of the Garden of Eden is that ADAM ate the forbidden fruit all right just as it is recorded, but that the apple was green and it griped him. Thereupon he lifted up his voice in pain, and a wise PROVIDENCE on hearing the noise determined that with such a racket the Garden ceased to be Paradise, and the result has been duly taught to all of us. Unnecessary noise is entropy, it is original sin, it causes accidents, inhibits good work, and provokes insanity. We need the taragometer.

Strangling Business by Too Much Organization

LATELY we had a little talk with a Chinese merchant about his business. Production, he said, was a simple problem, but selling in the United States was the very devil. "You can't drive it into the heads of buyers," said he, "that China is farther away than France or Italy." "Send your samples and name your prices, and then I'll tell you whether we will buy or not," they say. This means, it is explained, that deliveries come along nine months later, which is too long a time. Letters take more than a month in transit, and so do packages. "Give me," says the Chinese merchant, "samples of what you want, and the highest price at which the goods made in China will interest you. Then I will cable you my figure, which may be a quarter or even half off your price, if you name me present costs; and I will guarantee quality and insure delivery." "We don't do business that way," say the buyers. "We refuse to give up our patterns, and we demand deliveries three weeks after the cable order." Then the Chinese merchant goes to the head of the firm, shows what he can do, and how he does it, and the merchant understands. He appreciates the big killing to be made with Chinese goods, and sends for the buyer, who listens again to the story already told him, but the buyer repeats the statement that "that isn't the way we do business." He or she doesn't know any other way, because no matter how often it is explained "it isn't done."

The merchant is in the hands of his buyers, of whom so many are wooden-headed that he does not know how to get better ones, and time and again orders that are desired are lost for the very reason we have given.

The old gentleman who understands and wants to buy

is himself to blame. He has overorganized his establishment. He has so firmly fixed "the way we do business" that it has become gospel among his employees. It is even more stolidly established than Chinese tradition. He has killed initiative among his buyers so that a person who thinks for himself does not want the job, and the wooden-heads increase and multiply under him.

If we want good work done we must make it interesting; otherwise we can't get competent and high-class men and women to stay on the job and do good work. If we overorganize our business we are bound, in the long run, to surround ourselves with dullards.

Some Steel

Price Comparisons

SUBSTANTIALLY identical prices, as between the United States Steel Corporation and the independent steel producers, have developed again, and comparison of prices at various times is befitting. The course of steel prices may be reviewed briefly. The general substitution of mild or soft steel for wrought iron was completed before the end of the industrial depression of 1893-98, and by a combination of rich Mesabi ores, low wages and economies generally very low prices ruled in 1897 and 1898. Afterward there were various ups and downs and at the end of 1914 the lowest prices since 1898 were reached. Leaner ores were then used than in 1898 and wages were about 50 per cent higher, but manufacturing processes were much better.

During the war steel prices advanced and after the entrance of the United States the advances were spectacular. Then came Government price control. Dec. 13, 1918, slight reductions were made by the mills, as a step in deflation, and through the instrumentality of Secretary REDFIELD'S Industrial Board further reductions became effective March 21, 1919. From then until last week the United States Steel Corporation adhered to the Industrial Board prices. The independents at first cut those prices, until some time in June, 1919, and late in the year they advanced over those prices, while in 1920 there was a wildly advancing market on the part of the independents, with continued expectation on their part that the Steel Corporation would advance its prices. Such expectations were disappointed, and by the end of 1920 the independents were back to the Industrial Board or Steel Corporation prices. During January of this year there was a uniform market, while in February the independents began cutting. Early in April the independent market firmed up somewhat and then, effective April 13, the Steel Corporation made certain reductions in its prices, whereby the independents and the Steel Corporation are again at the same level.

Using a weighted average of the important steel products according to their tonnage importance, including bars, shapes, plates, pipe, wire, sheets and tin plate, a fairly complete summary of steel price movements can be made in small compass, as given below:

Ten-year average, 1904-1913.....	\$ 36.00
Five-year average, 1909-1913.....	34.00
Year 1913	34.50
Dec. 31, 1914.....	28.50
High, July 1, 1917.....	114.00
Government control	76.00
Dec. 13, 1918.....	72.00
March 21, 1919.....	65.00
Independent high, 1920.....	93.00
Dec. 31, 1920.....	65.00
Independent low, March 1, 1921.....	57.50
Present general market.....	60.00

In price comparisons in general of late, various bases for a pre-war level have been taken, and in the foregoing presentation several are therefore given for steel. The figures represent prices in dollars per net ton as a weighted average of the finished products just mentioned.

Pre-war averages are much the same, whatever period of years be taken as a basis, but pre-war high and low points are a different thing. We are not looking now for pre-war prices, for neither wages nor freight rates will get back to pre-war levels, but there is room for argument as to whether we should look for prices in relation to pre-war averages or prices in relation to pre-war low points.

Taking \$35 as a mean of pre-war averages, the present finished steel market is 71 per cent above that basis. On the other hand, it is 35 per cent below the high prices of independents in 1920, not the highest prices charged on small lots for prompt shipment, but the prices obtained on moderate sized lots for ordinary deliveries. It is 21 per cent below "Government prices" and 47 per cent under the very fancy prices ruling just before the Government undertook to take control as a necessary war measure.

Can we compare the 71 per cent excess in steel prices over the pre-war average with the relations that other commodities show to their pre-war averages? Some undertake to do so, but the showing depends simply upon what commodities are taken. Tin, copper, antimony, aluminum, lead and zinc are all below their pre-war averages. According to a statement prepared by the Bankers Economic Service, rubber, compared with its average Feb. 1 in each of the five pre-war years, is at 18 per cent, or less than one-fifth price, hides are at 62 per cent and coffee (wholesale) is at 63 per cent. Brick and lumber, on the other hand, are at more than double price, 264 per cent and 222 per cent respectively, while cement is set at 317 per cent.

Steel, apparently, would search in vain outside the industry for a standard. The industry will have to develop its price level from within.

Necessary Operating Conditions To Avoid Smoke Damage

JUDGE JOHNSON'S final decree in the Salt Lake Valley smoke suit, now at hand, impresses one as being quite unusual in that it apparently is able to point the way whereby smelters can operate with no interference to their development and future improvement and yet establish no nuisance to the neighboring residents.

Time was when any rancher, on finding his crops marked in any way or his stock drooping, or for that matter, if his own head ached, would sniff the air for smoke and join with his neighbors to sue for damages or to exjoin operations at any smelter within twenty-five miles. All damage was smoke damage. Many fanciful claims were advanced by the plaintiffs, and as we know now, almost as fanciful defenses set up. A vast amount of human energy and good feeling was spoiled in these squabbles; the operating companies upon which the bulk of the expense rested have spent sums of money easily aggregating millions in fighting unwarranted claims, in settling just claims, and in purchasing easements or damaged property. A half dozen or more plants stopped operations rather than face what seemed to be continuous guerilla warfare; their losses ran into millions more.

In those days arsenic, lead and sulphuric acid were thought to be the chief culprits; consequently courts decreed that extensive dust chambers, bag houses and flue systems must be installed to catch all but traces of these substances. Furthermore, the total tonnage of sulphur eliminated daily was usually specified, thus strictly limiting the amount of ore smelted in one place. Such stipulations, together with others limiting the SO_2 concentration in main stack gases, gave evidence that courts recognized the potential danger of that gas long before operating companies would admit the fact. Fortunately for the smelters, big dust chambers and long flues required draft, and draft was easiest had by high chimneys. High chimneys allowed the smoke to dilute itself in the atmosphere before again reaching the ground, and the real danger was thus inadvertently minimized.

Investigations of high scientific merit, continued during the past ten years and summarized from time to time in these columns, have made it plain that SO_2 would produce characteristic markings on the foliage of growing plants. This was something of a poser to those managers who had deluded themselves with thinking that if their smelter stacks showed no smoke—no visible fume, unconsumed carbon, or condensing vapors—then no damage would result. Or at least no damage would be ascribed by residents to smelter smoke. A further shock was due them when it was finally established that 1 part SO_2 per million for three hours would under optimum conditions produce foliar markings, and as little as 1.3 parts per million would do the same in one hour. In view of the fact that prolonged puffs of smoke are likely to sweep down at any time, it seemed that it would not be safe to operate a smelter so that the SO_2 content in the air of the so-called smoke zone would average more than 0.3 part per million—a dilution so high that operating officials freely declared it to be impossible of attainment. They almost fell into the error of denying the possibility of SO_2 damage, and the attempt to purchase peace by a discreet claim agent.

The more far-seeing and stout hearted, however, viewed the problem of dilution as one which could be solved. Theoretically, of course, it could be done by enormously high stacks or infinitely hot gas. The former was economically impossible, the latter would defeat the aims of metallurgy. A compromise, joining the correct chimney with a proper temperature above atmospheric, was evidently an engineering problem strictly, capable of definite solution when the necessary data had been collected.

The latest decree is therefore unique in several ways. It was postponed until the engineering solution had been found, put into operation, and finally investigated and found satisfactory by an independent commissioner. It may therefore be accepted, not only by courts as a precedent, but by smelter officials as a rule by which they can avoid damage to surrounding vegetation.

Given a modern smelter, with correct provision against leakage of smoke in the buildings or from the flue system, the principal precaution is that the dust-free gases be discharged from the main stack at a correct temperature above the atmosphere. In this decree no stipulation is made as to the amount of ore which may be smelted, the average sulphur on the charge, or the tons of sulphur eliminated. No reservation is taken as to the concentration of SO_2 in the

stack gases, nor the method of clearing them of solids; in fact, it may be remarked that probably for the first time the Cottrell system has been formally adjudged to be a satisfactory medium for collecting dust, fume and sulphuric acid, equal to the bag house.

In other words, while the SO_2 concentration in the stack gases, the chimney height, the topography, wind prevalence and general weather conditions all have their influence, it may now be taken as quite probable that foliar markings during the growing season may be entirely eliminated, no nuisance established in the eyes of the court, if the smelter management pay proper attention to discharging the gas during the day time at a correct temperature. What that correct temperature difference is may be established with relative certainty and at less than the cost of one damaged crop by merely studying the relation between average field concentrations, stack concentrations and stack temperatures. For the present Murray plant the figure happens to be 75 deg. C.

A General and Particular Confession of Pharmaceutical Fault

EVERY time we mention rats we get into trouble. Years ago we ventured to propose the tanning and use of rat skins as a means of getting rid of the pests, and the correspondence which followed from persons ambitious to profit by our suggestion included letters from a young man eager to enter the rat business, the secretary of a Woman's Vocational Association willing to sell tanned hides but unwilling to catch or touch rats, and a hardy son of toil who threatened to send rat skins to the office. It nearly upset us. We had a "scientific management" man in the establishment then who figured up inches of space and tabulated everything. It messed up his tables. It took us months to get over it, and the only compensation was Dr. ROEBER'S chuckle of delight over the episode.

Lately we mentioned, in an editorial on the chemistry of olfactics, a note from the London *Daily Mail* that rhodium was a wonderful lure for rats, and, being botanically ignorant, we tried to find a little amusement in quoting an eminent electrochemist to the effect that if the rodents liked rhodium they would probably take to platinum, and that they might be used to find it, for LORD knows it is scarce enough!

Now we confess ignorance for ourselves and for our entire staff in this respect. Probably we should have a department of pharmaceutical chemistry, but we haven't. Apparently, however, we have friends who are more familiar with botany and pharmacy than we are, and about a dozen of them have written to chide us for our ignorance. These letters make us humble and we confess it openly. They are printed elsewhere in this issue and will afford the reader a smile at our expense.

We do not know the name or address of the printer or the writer of the article in the London *Daily Mail*, but if Mr. ANDREWS can find them for us we promise the printer a good free-smoking hand-made Havana filler cigar, and a Flor de Convolvulus Scoparius to the author. There is a crumb of comfort for us in Mr. CRAIG'S note that rodent bait is not really and truly oil of rhodium after all, but we make no claim for a bill of wisdom in the assertion. The real mistake was ours, rhodium is a plant or a shrub or a tree as well as a metal and we did not know it.

Readers' Views and Comments

Rhodium for Rodents

To the Editor of Chemical & Metallurgical Engineering

SIR:—Anent your editorial on olfactics: Rhodium is rosewood. See "Condensed Chemical Dictionary," page 404. The name was in use before the metal rhodium was known.

D. D. BEROLZHEIMER.

New York, N. Y.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—On page 502, of the March 23, 1921, number of CHEM & MET., under the heading, "The Chemistry of Olfactics," at the end of the third paragraph you close with the following: "We wonder what the London writer wrote that the printer mistook for rhodium!"

It is perhaps not to be wondered at that an ex-president of the Electrochemical Society thought that a metal was meant and that perhaps a rat might be trained to track down any missing articles of rhodium or platinum, but I am sure that what the London writer meant and wrote was rhodium, which is the wood of *Convolvulus scoparius*, or rosewood. From this a volatile oil is obtained which is used as a bait for some animals. You will find this on page 404 of the "Condensed Chemical Dictionary." I think that you owe the unknown London writer a cigar.

A. B. ANDREWS.

Lewiston, Me.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—You are puzzled to know what is "oil of rhodium," on which rats (rodents) are so keen. Oil of rhodium or rodium was a nostrum, very familiar to youngsters before the civil war. It was used to bait fish as well as rats; all that was necessary was to buy a small—very small—phial of the widely advertised stuff at a drug store for an exorbitant price and use a drop of it on the fish-hook. I do not remember anything more about it except that my experience with it, as a small boy, led me to believe that it did not attract the fish.

W. GEORGE WARING.

Webb City, Mo.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—Some cynical person has said that the mishaps of our friends are never wholly unpleasant to us, and I must confess that I could not repress a chuckle after reading the interesting editorial entitled, "The Chemistry of Olfactics," which appeared on page 502 of your issue of March 23.

Did no guardian angel whisper to you to look in the dictionary to see whether there were not some kind of rhodium other than that with which you are familiar before you let go those flippant remarks about the use of rats in prospecting?

The story of the geologist reminds me of an equally famous one about the sea captain who could always tell the location of his ship by the taste of the earth that came up adhering to the bottom of the lead. One night when he was nearly asleep in his bunk the first mate thought to play a trick on him and so stuck the end of the lead into a flower pot that they had on board and then presented it to the captain to taste. To his great surprise, the captain leaped from his bunk and shouted

aloud: "Nantucket is sunk and we are right over Ma Jones' garden!" The story about the blind deaf-mute does not stagger my credulity, because when I lived in China I was able to apply a somewhat similar system to my Chinese servants, depending on whether or not they preferred garlic or peanut oil in their food.

T. T. READ.

Washington, D. C.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—Referring to your editorial "The Chemistry of Olfactics" will say that rhodium oil is not by any means an uncommon substance. This is another name for oil of rosewood from *Convolvulus scoparius* and *Convolvulus floridus*, coming from the Canary Islands.

Syracuse, N. Y.

WILLIAM BOOTH.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—The editorial section of this journal is usually so accurate and its policy in general so correct that a little malicious satisfaction at the slip made in the issue of the 23d inst. in the discussion of the odor of rhodium as being attractive to certain animals may be pardoned.

The rhodium referred to by the British correspondent is not the metal of the platinum group, but an oil distilled from a *Convolvulus* growing in the Canary Islands, and is used as an adulterant of oil of roses. It has also been used very extensively by trappers and hunters to attract animals to their traps, and was so used for many long years before the discovery of the metal rhodium.

It is a pity to thus "muss up" the elegant scheme of the ex-president of the Electrochemical Society relating to a rat detective corps for platinum thefts.

Washington, D. C.

WELLINGTON B. JOHNSON.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—Long before I had ever heard of rhodium, the element, in my days as an apprentice-apothecary, I was well acquainted with the rhodium of the catcher of rats, mice, muskrats and such vermin and rodents generally. The title in full is oil of rhodium. In some early textbooks it is Latinized as *Oleum ligni rhodii*. I believe that it is derived from *Genista canariensis* or some allied plant. Its use is most largely in the adulteration of oil of rose. In truth, the rodent-bait is not real oil of rhodium but copaiba scented with oil of rose or with oil of rhodium.

Ain't it true as how to the chemist all is chemical; to the botanist all is botany—to the editor (I admit the epithet) all is—what-in-ell is it anyhow? Yours for a broader life (Volstead volens).

HUGH CRAIG.

Oil, Paint and Drug Reporter,
New York City.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—I presume that by this time the interesting hypothesis that the olfactory sense of rats might be utilized as a reagent for the platinum group of metals has been given up, and that you have ascertained that

what the London writer wrote was, in fact, rhodium; or more explicitly, oil of rhodium, or rosewood (*Convolvulus* species); habitat, Canary Islands and elsewhere; odor, resembling roses and sandalwood, etc.

Not a very bad error for a metallurgical chemist; certainly more excusable than the reply of the wise lexicographer of a well known New York weekly who gave the meaning of the word "bitulithic" as "a chemical term, meaning two equivalents of the element thulium"!

F. D. DODGE.

Brooklyn, N. Y.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—In a recent editorial of your journal on the phenomena of odors you have apparently confused the metal rhodium with the herb by that name. See for example Lippincott's "Medical Dictionary"; under "Rhodium" there appears the definition as follows: "The root wood of *Convolvulus scoparius*, the oil of which has the odor of rosewood."

CARLETON ELLIS.

Montclair, N. J.

* * *

To the Editor of Chemical & Metallurgical Engineering

SIR:—I would like to correct an error in the editorial on "The Chemistry of Olfactics," which appeared in your issue of March 23, 1921. The writer of the editorial evidently takes "rhodium" to mean the element rhodium when he wonders why the rats are so keen on it. He even wonders what the London writer wrote that the printer mistook for rhodium.

Being conversant with the noble art of pharmacy, may I not point out that the joke is entirely on the writer of your editorial and in justice to his colleague of the London *Daily Mail* the mistake should be corrected.

Rhodium is the root of *Convolvulus scoparius*, growing in the Canary Islands. The oil obtained from this source is the article which was used as a lure for rats before the advent of the Pied Piper and Rough on Rats.

Columbia University,
New York City.

WILLIAM J. HUSA.

Dust Explosions

To the Editor of Chemical and Metallurgical Engineering

SIR:—We read with a great deal of interest the article on "Dust Explosions," by D. J. Price, in the March 16 issue of CHEMICAL AND METALLURGICAL ENGINEERING. On page 474, under the heading of dust removal, we note the following interesting paragraph:

In installations of this nature, a flammable mixture is usually formed when the dust passes through the exhaust fan. Explosions may be caused by the ignition of the dust by sparks from foreign material striking the fan blade or from the fan blade becoming loose. This situation has suggested the possibility of changing the location of the fan from its present position—namely, between the source of dust production and collection—to a position beyond the collector. In other words, can the dust be drawn into rather than blown into the collector?

We wish to draw the attention of the author of this article, and of engineers in general, to the fact that we have foreseen this danger and have eliminated all such fire and explosion hazards by placing the fan between the adjustable air separator and the centrifugal collector in our systems of dust collection. In all of our installations we have succeeded in removing the dust from the air, either partly or completely, before it is passed through the exhaust fan. The practical result is that in none of our installations has there been any fire or explosions.

CLARK DUST COLLECTING CO.

Chicago, Ill.

Cost of Nitrogen Fixation in Norway

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your issue of March 23 you published an article by T. C. Hagemann on "Cost of Fixed Nitrogen in Norway." Under the heading "Steps in the Process" Mr. Hagemann states that: "The air to be treated is let into a chamber, where it passes through an electrical arc, which by some artificial means is given an increased area in order to heat the air so intensely that a part of the nitrogen burns—that is, combines with the oxygen and forms NO."

I have been fortunate enough to have seen the large plants at Rjukan, Norway, and have also made myself acquainted with the theory upon which the Birkeland-Eyde furnace is designed. To my knowledge of the question at hand Mr. Hagemann makes an error in stating that the arc "is given an increased area in order to heat the air so intensely," etc. Also Mr. Hagemann should have mentioned of what nature the artificial means were that gave the increased area to the arc. To me these two things appear to be of the utmost importance because they are the main features in making the Birkeland-Eyde process commercially successful; hence they should be correctly stated.

In the chamber water-cooled copper electrodes are employed, the arc being "started" by bringing one of the electrodes close to the other by means of a screw device. As soon as the spark "jumps" the gap the electrode is screwed away to increase the length of the arc. It is clearly seen that the efficiency would be very low if the air which is blown through the furnace could come in contact with only the comparatively narrow arc, hence Prof. Birkeland and Mr. Eyde, utilizing the well-known fact that a magnet will deflect the arc, placed a powerful magnet on one side of the arc and a similar magnet diametrically opposite. With one magnet functioning, the arc will be "pulled out" to a semi-disk. The two magnets are alternately charged and discharged with a very high frequency, thus making the two semi-disks appear to be a complete disk. This is of course not done in order to "so intensely heat the air" but in order to increase the area in which the air comes in contact with the intense heat of the arc.

To summarize, the artificial means are simply two electromagnets and the increased area is given in order to give a larger heating surface—not increased heat. Steps in a process of such merits as the Birkeland-Eyde process should not for a moment be allowed to become wrongly stated.

K. W. JENSEN.

Detroit, Mich.

The Border Lines of Colloid Chemistry

To the Editor of Chemical & Metallurgical Engineering

SIR:—On page 547 of CHEMICAL & METALLURGICAL ENGINEERING, March 30, 1921, there appears the following statement:

On the basis of our present chemical status, the colloid chemist may pass off the contribution by Dr. Loeb in this issue with the statement that his observations have been limited to dilute solutions and that Dr. Loeb has only confirmed a common belief that any properly dispersed substance in a proper degree of subdivision will obey the gas laws and the others derived from them.

May I be pardoned for pointing out that the solutions and the gels of proteins used in my experiments were no more dilute than those on which the colloid chemists have based their hypotheses?

JACQUES LOEB.

New York City,

The New President of "Tech"

DR. ERNEST FOX NICHOLS, physicist, the new president of the Massachusetts Institute of Technology, was born in Leavenworth, Kan., fifty-two years ago. He obtained his Bachelor's degree in science at the Kansas Agricultural College in 1888. Then he went to Cornell, where he was a graduate student in science from 1889 to 1892, and there he took his Master's degree. From 1892 to 1896 he was professor of physics at Colgate University, but in part time, from 1894 to 1896, he was at the University of Berlin with Prof. Rubens, where, in their joint work, they were pioneers in the modern study of infra-red rays. For a long time the infra-red rays measured by them were the longest that had been recorded. In 1897 he took the degree of Sc.D. at Cornell. During another interim, 1894-95, he studied at Cambridge University, England, and in 1898 he became professor of physics at Dartmouth. While there he undertook the problem of measuring the pressure of light, which had been open since the days of Maxwell. In this, working in conjunction with G. F. Hull, the outcome was successful, and they succeeded in proving and measuring with considerable accuracy the forward pressure which a beam of light exerts. Lebedew in Russia was engaged in similar studies and published his findings a month or so earlier, but his results were less exact, and rather of a qualitative nature as compared with those of Nichols and Hull, which were more definitely quantitative.

From 1903 to 1909 he was professor of experimental physics at Columbia University, New York. This was, in effect, a research professorship, and here he soon had a group of students making investigations in the infra-red spectrum, and working on the generation, reflection and diffraction of short electric waves. At the same time, on his own behalf, he engaged in the effort to check up experimentally some of the fundamental assumptions of the electromagnetic theory, and particularly that of moving charges of electricity.

In 1909 he was called to the presidency of Dartmouth, where he remained for seven years, and in 1916 he became professor of physics at Yale. During his professorship at Columbia he was research associate of the Carnegie Institution at Washington in 1907-09, and from 1917 to 1919 he was in the Bureau of Ordnance of the U. S. Army, so that the war gave him but little opportunity for work at New Haven. Last year he left Yale to take up research in pure science with greater facilities and a larger staff than any university can

offer, at the General Electric Co.'s laboratories at Nela Park, Cleveland. He has seven honorary doctorates and many medals and other distinctions.

More important than the details of his history is the manner of man that he is. He enjoyed the process of education in three countries: the United States, Germany, and England. His preference is for the English type of culture over that of Germany. His theory of an engineer is that he must first of all be an educated gentleman rather than a man with the recollection of many facts loaded upon a possibly insecure foundation of understanding. All thoughtful friends of Tech have recognized that the school might develop into an institution for highly specialized training on the one hand, or an institution of advanced and progressive scientific scholarship on the other. The selection of Prof. Nichols indicates that the trustees had in their choice the latter ideal in mind.

His change from research and teaching to administration and back again is in accord with his order of life. His interest in the general problem of education has always been acute, and at the same time he is an experimental physicist of the first rank. While president of Dartmouth he continued to teach. Before he accepted the post he told his friends that he would stay there for seven years, and at the end of seven years he did return to teaching and research. He thinks a long way ahead, and with precision.

He is reserved in manner, a man of dignity and yet excellent company, who does not carry his heart in his sleeve. He is kindly and helpful to earnest and competent students, an inspiration to those who are gifted with rare understanding and character, but has very little patience

with those who do not take their work earnestly or seriously.

His scientific curiosity is keen and persistent, but its tendency is rather toward fundamental problems than toward the filling in of unimportant gaps. While his habit of mind is large, it leans to the experimental rather than to the purely theoretical side. He has slight interest in the co-ordination of guesses, but immense interest in the co-ordination of facts. And he is richly gifted with common sense.

The late president, Dr. MacLaurin, had completed the first part of his work. His next task, at the time of his passing, was to be the internal development of Tech and the consolidation of its great resources of scholarship.

It is a big job. But we believe the trustees have exercised unusual wisdom in seeking and finding the right pilot.



DR. ERNEST FOX NICHOLS



CALIFORNIA ALKALI CO. PLANT

Salts-Refining Plants at Owens and Searles Lakes

Report of a Recent Survey of the Salts-Refining Plants Producing Natural Soda Ash, Borates and Potash in the Owens and Searles Lakes District of California

By L. W. CHAPMAN

OWENS LAKE, in Inyo Co., Cal., is the principal source of natural soda in the United States. Searles Lake, in San Bernardino Co., Cal., was the second largest producer of potash from a single domestic source in 1919 and probably retained that position in 1920; in addition, an appreciable quantity of borax is being recovered at the Searles Lake plants as a byproduct. At Owens Lake there are three operating companies and at Searles Lake there are four; with a single exception the plants have become producers during the last six years, and two of the plants will market the first of their product in 1921. These developments indicate an appreciation of the importance of the sources of raw material as well as an increase in the demand for the refined products. The amount of recoverable soda, potash and borax is not unlimited, but is sufficient to meet local demands for many years, and with economical methods of operation should play a prominent part in the industrial development not only of the West, but of the country as a whole. These notes describe briefly the geology of the district and the different processes now in use for obtaining commercial products.

GEOLOGICAL CONSIDERATIONS

Owens Lake, Searles Lake and Panamint Valley are to be considered together geologically, there being evidence that in Quaternary times they constituted a chain of lakes, the water, at that time probably quite fresh, flowing through the series in the order named. The drainage area of this lake system covers about 9,600 sq.mi. (24,900 sq.km.), and there are no indica-

tions that there ever was an outlet to the ocean. Owens Valley has an area of 2,800 sq.mi. (7,250 sq.km.), and is located between the Sierra Nevada Mountains on the west and the Inyo Range, a southern continuation of the White Mountains, on the east. The drainage area of Searles Basin is about 4,850 and of Panamint Valley about 1,950 sq.mi. (12,600 and 5,050 sq.km. respectively). Owens Lake is the only existing remnant of the lake system; the others are completely dry, except occasionally during the rainy season when a few inches of water may cover a portion of the crystal surface of Searles Lake for a few days.

Owens Lake changes considerably in area from year to year, depending upon the ratio of the evaporation to the inflow of water; the present level of the surface above sea level is 3,565.58 ft. (1,086.79 m.); it is approximately 13 mi. long by 8 mi. wide at the present time (21 by 13 km.). The rate of evaporation of Owens Lake brine is about 40 in. (1 m.) per year. During the last three years the water level has lowered quite rapidly; 40.5 in. (103 cm.) in 1918, 48 in. (122 cm.) in 1919 and 51 in. (155 cm.) in 1920, and this has had the effect of concentrating the salts in the brine. But little further evaporation is needed to make it possible to use the lake brine without solar concentration in the soda ash works.

The present area of the lake is about 42,000 acres (17,000 hectares) and the volume approximately 381,000 acre-feet (470×10^6 cu.m.). Dr. W. Hirschkind, of the California Alkali Co., estimates the quantity of salts in the brine to be, in million metric tons: Na_2CO_3 , 46.6; NaHCO_3 , 11.08; Na_2SO_4 , 19.4; NaCl , 51.5; KCl ,



OWENS LAKE, INYO COUNTY, CALIFORNIA

5.53; $\text{Na}_2\text{B}_4\text{O}_7$, 3.55. In the table are given analyses of the lake water, showing the effect of the level of the water in the lake upon the concentration of the salts. But a slight increase in concentration will cause crystallization of trona, $\text{Na}_2\text{CO}_3 \cdot \text{NaHCO}_3 \cdot 2\text{H}_2\text{O}$, during the summer months.

The relative position and elevation of Owens and Searles Lakes are shown in Fig. 1 and the Quaternary lakes are indicated. It seems probable that during the geological history there was more than one desiccation

superficially much like other playa deposits of the Great Basin region.² One very evident indication that the basin was occupied by a deep lake is the old shore line which is distinct at an elevation of about 635 ft. (193.5 m.) above the present surface. The basin is roughly circular, 15 to 20 mi. in diameter (24 to 32 km.). Near the center of the basin is an area about 12 sq.mi. (35 sq.km.) in extent, the surface of which is

²See G. J. Young, "Potash Salts and Other Salines in the Great Basin Region," Bull. 61, U. S. Dept. of Agriculture, for a geochemical description.

TABLE I. ANALYSES OF OWENS LAKE WATER

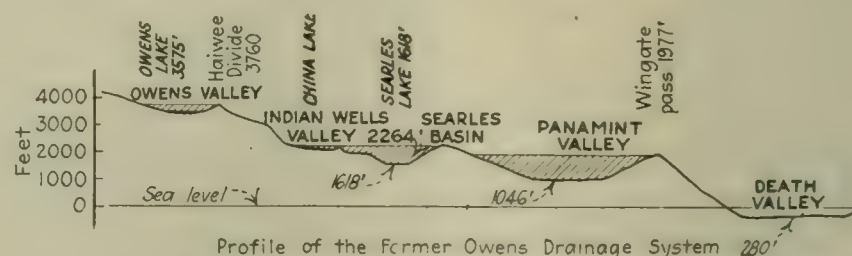
Sp. Gr.	Sept., 1886*	June, 1918†	June, 1920†
	at 25 Deg. C.	at 15.5 Deg. C.	at 15.5 Deg. C.
Total salts	1.062	1.108	1.222
H_2O	7.26	10.45	25.53
Na_2CO_3	92.74	89.55	74.47
NaHCO_3	2.54	3.55	8.32
Na_2SO_4	0.54	1.00	1.85
Na_2SiO_4	1.05	1.47	3.77
NaCl	2.78	3.78	9.87
$\text{Na}_2\text{B}_4\text{O}_7$	0.05	0.24	0.64
KCl	0.30	0.41	1.08

* Calculated from an analysis by Chatard, U. S. G. S. Bull. 60.

† Analysis by Natural Soda Products Co., Keeler, Cal. In October, 1920, the brine had a gravity of 1.23, with 28.4 per cent total salts.

and probably more than one period during which the waters flowed from Owens Valley through Indian Wells Valley and Salt Wells Valley into Searles Lake. Whether this had an appreciable effect on the relative composition of the brine remaining in Owens Lake and the crystalline deposit with its retained mother liquor at Searles Lake has not been determined, although Gale¹ is of the opinion "that these [Searles Lake] deposits are the normal product of the desiccation of a body of water of the same chemical character as the Owens Lake of the present time." It also seems probable that there was no considerable overflow from Searles Basin into Panamint Valley in what is to be considered recent geological history, and that therefore the greater portion of the deposited salts is the accumulation from the drainage system which includes both Searles and Owens Lakes, since this overflow. The water in Owens River comes principally from the Sierra Nevada Mountains, and at its present volume is adding more than 15,000 tons of sodium annually to Owens Lake. It is probable that part of the accumulation of salts in Searles Lake was derived from Owens Valley as well as from the much larger Searles Basin.

The dry lake basin that is known as Searles Lake is



Profile of the Former Owens Drainage System

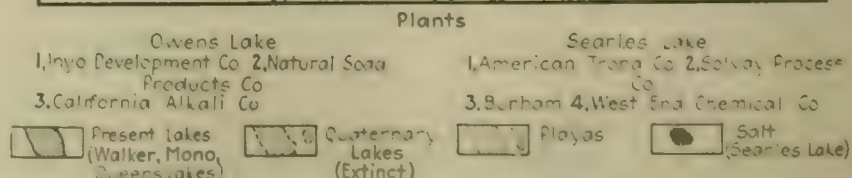
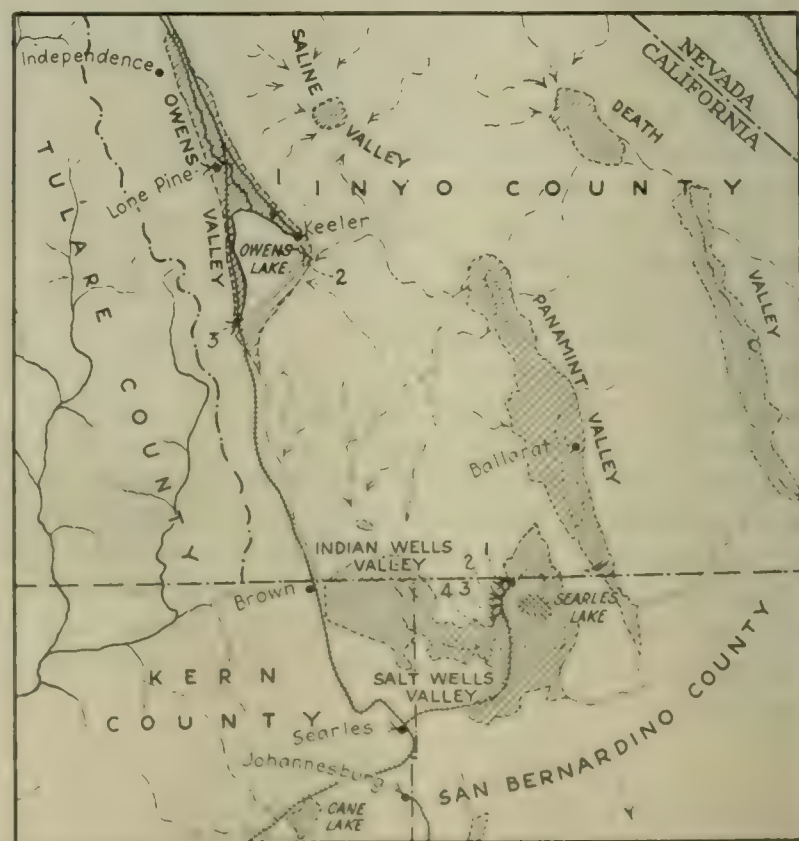


FIG. 1. OWENS-SEARLES-PANAMINT LAKE SYSTEM

¹Bulletin 1894-L, U. S. G. S., by Hoyt S. Gale.



OWENS LAKE, INYO COUNTY, CALIFORNIA

composed of quite pure sodium chloride. Beneath this is the "crystal body," a coarsely crystalline deposit containing a large variety of minerals consisting chiefly of halite, thernardite, trona and borax. Gale³ reports sixteen, stating that the list is incomplete. Clark⁴ lists twenty-two; to these must be added glaserite,⁵ $3K_2SO_4$, Na_2SO_4 , and possibly some others. The crystalline deposit is from 65 to 75 ft. (19.8 to 22.8 m.) in depth and is saturated to within a few inches of the surface with a brine of the composition shown in Table II.

The brine is variously estimated to occupy from 25 to 40 per cent of the volume of the crystal body. It averages 4.2 per cent potassium chloride and 1.1 per cent anhydrous sodium tetraborate. Using the lower estimate for the amount of brine in the crystal body, the KCl content is over eight million tons, and the borax content over four million tons. This estimate does not include any salts that may be added to the brine through solution from the "crystal body," so that the amount of recoverable salts may be much greater.

The central salt deposit is surrounded by a margin of mud, clay and sand, incrustated with salts or impregnated with solution. The Argus Range on the west and north separates the Searles Lake Basin from Coso Valley, this being separated from Owens Valley by the Coso Range. The abrupt wall of the Slate Range divides the basin from Panamint Valley to the east.

OPERATIONS AT OWENS LAKE: INYO DEVELOPMENT CO.

Of the three plants at Owens Lake that of the Inyo Development Co. on the east shore of the lake was the first to be operated, soda ash having been produced at this plant since 1886. The plant is designed to produce a crude dense soda ash by melting trona, obtained by solar evaporation of the lake brine. The plant is now operated by the California Alkali Co. Brine from the lake is pumped into the series of solar evaporating ponds in the spring after the previous year's crop of trona has been harvested. The brine as it becomes concentrated in the first pond, due to evaporation, is run into the second pond of the series and the first pond is filled with water from the lake. This process is continued until a sufficient amount of sodium carbonate is contained in the ponds to give the required amount of trona in the sea-

son's crop. The concentrated solution finally is run into crystallizing ponds, and trona is precipitated. Toward the end of the season, usually in October, the nights become cool and if the solution remains in the ponds the cooling of the liquor will crystallize out a mixture of sodium carbonate and sodium sulphate as decahydrate. The concentration of the liquor and the temperature are watched and when there are indications that there is a possibility that the trona may be contaminated by the salt and sulphate the remaining liquor is run into the lake. As soon as the deposited salts are drained harvesting is begun. The trona forms a hard crust on the bottom of the ponds, which is broken up with picks and loaded into side-dump mine cars, which are hauled to the plant on a narrow-gage track by a gasoline locomotive. The trona is dumped into a bin, where it is washed with water, loaded into dump cars and hauled to a storage pile to dry.

The dried product is melted in the furnace shown in Fig. 2, crude oil being used for fuel. The molten carbonate runs in a thin stream into a blast of air which produces a globular product analyzing from 55 to 56 per cent Na_2O , less than 2.5 per cent Na_2SO_4 , and a small amount of NaCl. From 18,000 to 24,000 tons of trona is produced per year, which is in part converted into soda ash and in part marketed as such.

NATURAL SODA PRODUCTS CO.

On the east side of Owens Lake, about three miles south of the plant of the Inyo Development Co., is the plant of the Natural Soda Products Co. This was built

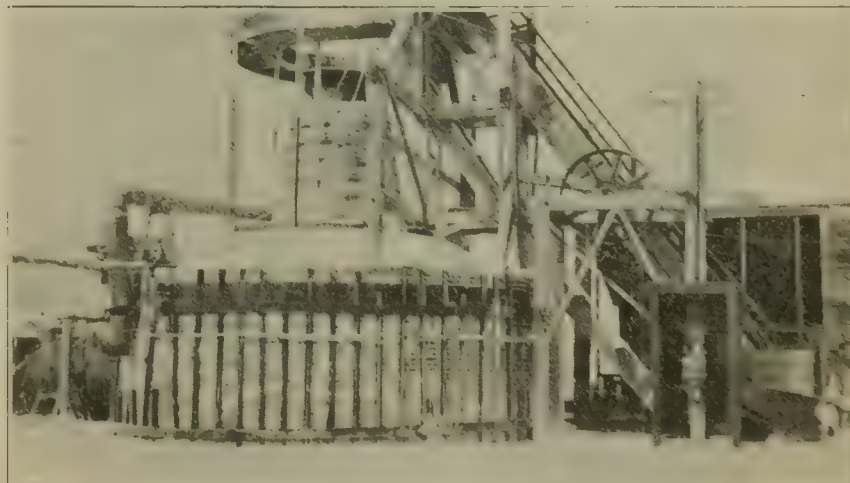


FIG. 2. FURNACE FOR MELTING TRONA, INYO DEVELOPMENT CO.

³Gale, Bull. 580, U. S. G. S., p. 265.

⁴F. W. Clark, "The Date of Geochemistry," Bull. 695, U. S. G. S.

⁵W. F. Foshag, *Am. J. Sci.*, vol. 49, May, 1920.

in 1915 and reconstructed after a fire in 1917. Melted soda ash has been the principal product, although crude trona and crude sodium bicarbonate have also been sold in small quantities. New equipment is being installed to produce a high-grade light soda ash.¹ After evaporating the lake brine in a system of solar ponds to the degree of concentration where trona will crystallize upon further evaporation, the concentrated liquor is pumped to carbonating towers. Carbon dioxide gas, obtained from kilns, is forced through the towers, precipitating sodium bicarbonate. The crystals are separated by filtration, air-dried in a storage pile (Fig. 3) and melted in an oil-fired furnace. The molten sodium carbonate is atomized by an air blast and the product is ground, screened and sacked for the market. Plant capacity is about 140 tons of this product per day. The new equipment will produce fifty tons of light ash, and a portion of the light ash can be converted into dense ash.

Limestone, in the form of a high-grade dolomitic marble, is obtained from a quarry about 9 mi. north of the plant. Coke is shipped from Utah. Rail transportation is provided by a narrow-gage line of the Southern Pacific which runs north to Mina, Nev., from the town of Keeler, on the east shore of the lake. Connection is made at Owenyo with the standard-gage line of the Southern Pacific running south to Mojave, Cal.

CALIFORNIA ALKALI CO.

At Catago, near the southwestern end of the lake on the standard-gage line previously mentioned, is the plant of the California Alkali Co. The method of operation is practically the same as at the Natural Soda Products Co., but no melted ash is produced and details of operation and equipment are somewhat different. Brine is pumped from the lake and concentrated by solar evaporation, and the concentrated liquor is filtered before carbonating. The bicarbonate is converted into

light ash in standard light ash furnaces, the product being of a very high grade. Dense ash furnaces are now being installed and a portion of the light ash now being produced will be made into dense ash. Total production will be about eighty tons a day.

As is evident from the brief description of the Owens Lake operations, the method of making soda ash is similar to the Solvay process, with the exception that no ammonia is used. Carbonating towers, furnaces and other equipment are of the standard design used in the alkali industry, except the furnaces for melting the crude trona at the Inyo Development Co.'s plant and for making the melted ash at the Natural Soda Products Co.'s plant, which are of special design.

Brine from Owens Lake is particularly suited for the manufacture of soda ash. The mother liquor from the carbonating tower contains both borax and potassium, the latter in the form of chloride. The liquor is not utilized at present, but it would seem possible to work out a method for profitably recovering these salts as byproducts of the soda ash operations. An experimental plant is being built by Wrinkle & Kuhnert for the production of borax and potash near the plant of the Natural Soda Products Co., and in the experimental runs will use the mother liquor from the carbonating towers after further solar concentration. The estimated capacity of the plant is ten tons each of potash and borax and twenty tons of sodium bicarbonate per day.

After the carbonates have been precipitated from the raw lake brine by solar evaporation, it is possible to crystallize from the residual liquor a crude sodium sulphate with which is mixed common salt. This material has a possible commercial value. It does not seem probable that salt can be produced at Owens Lake at a cost low enough to compete with that which is now being recovered from salt deposits in Inyo and San Bernardino counties, or with that obtained from sea water at plants near San Diego and San Francisco.

SEARLES LAKE OPERATIONS

Searles Lake was discovered by Dennis Searles and E. M. Skillings on Feb. 14, 1873, and 160 acres (64.75 hectares) of borax claims were located and patented by them.² Borax was first produced in 1874 and the deposit continued to be an important source of raw material until the discovery of the colemanite deposits in Death Valley and other localities in California. It would seem that C. E. Dolbear was the first to recognize the importance of Searles Lake as a source of potash, but the possibility of recovering potassium chloride was pointed out at about the same time by the U. S. Geological Survey. The first company to produce potash from the brine was the American Trona Corporation, which began active operations in 1915, first building a railroad 30 mi. in length from the line of the Southern Pacific to the lake. The company now has an investment in railroad, plant and equipment, housing facilities for the staff and workmen, water supply, etc., of over \$6,000,000.

AMERICAN TRONA CORPORATION

In outline the process of the American Trona Corporation is not complicated. Brine is obtained from wells drilled in the salt body, 500,000 gal. (1,900 cu.m.) being pumped per day to storage tanks at the plant.



FIG. 3. 10,000 TONS OF NATURAL SODIUM BICARBONATE, AT NATURAL SODA PRODUCTS CO.

¹Henry G. Hanks, in his Third Annual Report of the California State Mineralogist, gives original information on the discovery and geology of Searles Lake.



FIG. 4. SPRAY TOWERS OF THE WEST END CHEMICAL CO. AT SEARLES LAKE

Fresh brine, mother liquor and wash water are fed to triple effect 22-ft. (6.7-m.) Manistee evaporators and a hot solution concentrated with respect to KCl is obtained. This is cooled rapidly, first with raw brine and then by refrigeration, and a crop of KCl crystals produced. The crystals are separated from the mother liquor in centrifugals. Borax is recovered from the residual liquor and purified by recrystallization. Boiler equipment consists of twelve 500-hp. Babcock & Wilcox boilers, about 4,000 hp. being used. Evaporators con-

TABLE II. ANALYSIS OF SEARLES LAKE BRINE AND PRODUCTS OF AMERICAN TRONA CORP.

	Per Cent by Weight		
	Raw Brine	Refined KCl	Refined* Borax
NaCl.....	16.54	1.85	None
KCl.....	4.82	92.84	0.33
Na ₂ CO ₃	4.82	0.69	None
Na ₂ B ₄ O ₇	1.50	0.45	51.72
Na ₂ SO ₄	7.16	0.19	0.01
H ₂ O.....	65.16	3.98	47.94
Total.....	100.00	100.00	100.00

* Na₂B₄O₇ · 10H₂O, dry basis 99.65 per cent; free moisture 1.91 per cent.

tain 40,000 sq.ft. (3,716 sq.m.) of heating surface per unit. Three 200-ton refrigerating machines are installed and about 400 tons per day is required for cooling solutions and other uses about the plant.

An analysis of the refined products and of the raw brine is given in Table II. It will be noted that the potassium chloride is comparatively free from borax. To obtain a product of this degree of purity has been one of the most difficult problems at the plant. A further operating difficulty has been the frothing of the evaporators, but this has been recently overcome. Improved operating methods, that will be made possible when the installation of new equipment is completed, will increase production and further improve the quality of the potassium chloride. About fifty tons of potash and twenty-five tons of refined borax is being produced per day. It is to be noted that the process depends entirely upon the use of artificial evaporation to obtain a concentrated brine.

SOLVAY PROCESS CO.

The borax claims of Searles and Skillings are controlled by the Pacific Coast Borax Co. This company and the Solvay Process Co. built a plant in 1916 and 1917 for the recovery of borax and potash from brine obtained from the salt body. The plant is now managed by the Solvay Process Co., and no authorized statements have been given out concerning the method of operation or the amount of production. The following outline of the process is believed to be correct: Preliminary solar evaporation of the brine is depended upon to give a solution of maximum concentration without the crystallization of potash salts in the ponds.

Further evaporation in multiple effect evaporators produces a hot concentrated potash solution from which a crop of KCl crystals is obtained. These are separated by filtration and the mother liquor is treated either with CO₂ gas directly or with SO₂ gas which breaks up the carbonates, giving CO₂ and sodium sulphite. The treatment converts the biborate into the less soluble metaborate, and borax crystals are obtained from the solution upon cooling. As contrasted with the process at Trona a less amount of fuel is required.

WEST END CHEMICAL CO.

The third plant to be established at Searles Lake is that of the West End Chemical Co., and the plant will become an active producer this year. The process uses less fuel than the two described, no use being made of artificial evaporation for producing a concentrated liquor. Brine is pumped from the crystal body to preliminary ponds, thence to secondary ponds for final concentration. When a solution of maximum KCl content is obtained it is pumped to a storage tank at the plant. Spray towers, shown in Fig. 4, are used to produce a crop of mixed crystals containing borax and potash. Spray towers are made of wooden frames covered with corrugated iron, and the solution is sprayed downward through 1-in. nozzles by pumps having a capacity of 12,000 gal. (45,000 liters) per minute. Recirculation of the liquor which drains from the deposited crystals recovers a large portion of the potash salts. About six tons of salts is produced per hour in the spray towers. The deposited salts are filtered, and dissolved in hot water, producing a hot concentrated KCl solution, from which crystals are obtained upon cooling. Borax is recovered from the mother liquor.

An optional method, which permits of winter operation, is as follows: A deposit of mixed salts is obtained during the summer months by solar evaporation in ponds about 3 ft. deep. These are harvested in the fall and winter, crushed and leached with hot water, KCl and borax being recovered as described.

BURNHAM PROCESS

All three of the plants at Searles Lake so far described use fuel oil for heating solutions or for evaporation and have a more or less expensive plant and equipment. The cost of fuel oil and interest on investment are important items in the cost of producing the marketable product. A fourth process is operated at Searles Lake, the distinctive feature being the use of solar evaporation only for the production of borax and potash. The process is the invention of G. P. Burnham.⁷ Advantage is taken of fractional crystallization at different concentrations and temperatures, and the brine is so manipulated that the various salts come down separately in different ponds. The rate of evaporation from brine at Searles Lake is about 6 ft. (1.83 m.) per year. The brine contains eighty tons of KCl and fifty tons of borax per acre-foot (5.0 and 3.7 kg. per cu.m. respectively), so that a 100-acre (40.5-hectare) pond evaporating continuously will deposit 48,000 tons of potash and 30,000 tons of borax per annum. (A 10-hectare pond evaporating continuously will deposit 1,080 metric tons of KCl and 677 metric tons of borax per annum.)

In the Burnham process several ponds are provided and the potash is made by flowing the brine into shallow ponds during the summer days, then into deep ponds

⁷U. S. Pats. 1,328,614, 1,286,932, 1,317,954, 1,321,282.



FIG. 5. HARVESTING PURE SALT FROM THE SURFACE OF "CRYSTAL BODY" AT SEARLES LAKE

at night, in order to retain the heat. By continuing the process warm evaporation is maintained until the brine becomes concentrated with KCl. At this point the brine is circulated between two shallow ponds, and cooling at night crystallizes out KCl in one pond and during the day further warm evaporation crystallizes out NaCl in the other.

Borax is made by flowing the brine into shallow ponds at night during the winter to cool, sodium sulphate and sodium carbonate being deposited. When the brine is coolest, in the early morning, it is flowed into deep ponds where the temperature is maintained for several days, borax gradually crystallizing out.

It was previously mentioned that the surface of the crystal body at Searles Lake was composed of quite pure sodium chloride. Salt is harvested by the American Trona Corporation, a special market existing for the product, which is entirely free from calcium and magnesium compounds. A spiked-tooth harrow is used to loosen the hard crust to a depth of about 2 in. and the salt is scraped into windrows by a road scraper. It is then shoveled into side-dump mine cars, a train of these being hauled alongside the rows from a narrow-gauge railroad by a tractor. The loaded train is returned onto the track by the tractor and hauled to the plant by a gasoline locomotive. The salt is dumped into storage piles and after air-drying is loaded into standard-gauge box cars for shipment.

In addition to potassium chloride, borax and salt, it would seem that sodium sulphate and carbonate could be obtained from Searles Lake brine, at least in crude form, and a market developed for the product for such uses as the manufacture of glass and paper pulp. It is a safe prediction that processes will be developed for the commercial production of all the salts contained in the brine of both Owens and Searles Lakes.

To establish a chemical industry in the heart of a desert is not a simple undertaking; housing, a complete commissary and other accommodations have to be provided for the workmen and living conditions made as comfortable as possible. An especially large stock of general supplies has to be carried on hand at all times, machine shop and other repair facilities have to be of the best. That successful operations are now conducted in these out-of-the-way places is to the credit of the men who have pioneered in the establishment of a new industry.

The writer wishes to acknowledge the courtesies extended by the management of the plants at Owens and Searles Lakes in gathering information for the preparation of this article.

The German Cement Industry

Howard W. Adams, representative of the Department of Commerce in Berlin, reports that the government operation of the German cement industry, put into effect on Jan. 1, 1917, was provisionally dispensed with on July 27, 1920, by an order issued by the Federal Ministry of Labor. This action was taken because the pressing demand for cement appeared to be satisfied, with a resultant diminution in sales. Bavaria, however, was excepted from the operation of this order. The government, through the Federal Commissioner for Cement, still retains jurisdiction over the fixing of prices for the domestic market.

COURSE OF CEMENT PRICES, 1914-1920

The price of cement in Germany at the outbreak of the war was 350 marks per 10,000 kilos (kilo = 2.2 lb.) for both government and private contracts. Following the establishment of government operation of the cement industry and the accompanying official regulation of prices there was a rapid rise in the cost of this commodity. The following prices per 10,000 kilos (f.o.b. mill and exclusive of packing) show the course of these prices since 1914:

Periods	On Government Contracts Marks	On Private Contracts Marks
August 1, 1914.....	350	350
January 1, 1917.....	430	430
October 1, 1918.....	735	760
April 1, 1919.....	885	910
April 1, 1920.....	3,991	4,061
August 1, 1920.....	3,330	3,400

INCREASE IN PRODUCTION

During the middle of last summer the production of cement was somewhat increased, due in part to the resumption of operations by the Offenbacher Portland-Zementfabrik (Gruppe der Portland-Zementwerke Heidelberg-Mannheim-Stuttgart) after lying idle for more than five years. The cement industry in Germany has not felt the effect of the coal shortage as much as other lines of manufacture for the reason that the mills were, to a considerable extent, able to use low-grade coal. Germany has resumed the shipment of cement to foreign markets.

RECENT PRICES FOR CEMENT

An idea of the recent domestic prices of German cement may be gained from the order issued Dec. 8, 1920, by the Federal Commissioner for Cement, with retroactive effect from Nov. 1, 1920, and extending to and including Jan. 31, 1921. According to this order the following prices are fixed for this period: For the district of the North German Cement Manufacturers' Association, 3,200 marks per 10,000 kilos (f.o.b. mill and exclusive of packing); the Rhine Westphalian Cement Manufacturers' Association, 3,100 marks; and for that of the South German Cement Manufacturers' Association, 3,300 marks. Proportionally lower prices are fixed for contracts for cement to be furnished the state governments for use in public buildings. The three sets of prices indicated above represent a considerable reduction over the prices fixed for the three months preceding Nov. 1, such reduction being to the extent of 200 marks, 300 marks and 100 marks, respectively. In this order of the government protection was provided the manufacturers against increases in the cost of coal during the Nov. 1-Jan. 31 period by allowing for an increase of 55 per cent.

Promotion of Scientific Research

Outline of a Program for Forwarding Research in the Chemical and Physical Sciences at the Universities —Industries Licensed Under Patentable Discoveries to Pay Reasonable Royalties for Support of Further Research—An Impartial Study of Facts

BY WILLIAM HOSKINS* AND RUSSELL WILES†

THIS plan is derived from the suggestions of several different people who have given attention to the subject, and an especial object has been to reconcile various conflicting views so as to conserve the interests of the public and of the universities to the fullest extent.

NEED OF UNIVERSITY RESEARCH

Initially, let us consider the ultimate object to be accomplished. It is probably not necessary to argue that an immense increase in scientific research is perhaps the most important future step for the welfare of this country. It is only by such research, commencing as pure science and ending as applied science, that production and therefore the physical well-being of the people can be materially increased without a corresponding increase in labor. Eminent members of university faculties have repeatedly called attention to the important need of a tremendous expansion of scientific research. Industry is taking care of the application of science, and will do so to a continuously greater extent as experience demonstrates the wisdom of industrial laboratories and as the universities turn out trained research men capable of solving the problem.

But if research in pure science is not correspondingly increased the stream will dry up at its source not only from lack of fundamental information but from lack of trained men. Industry cannot be expected to maintain pure science laboratories, as the maintenance of such a laboratory in an industrial organization is difficult if not impossible. It seems evident that the proper place for pure science research is in our universities, where the atmosphere is admirably adapted to lead the investigator to examine his facts without any commercial or industrial bias.

EXPANSION OF UNIVERSITY EQUIPMENT A SERIOUS FINANCIAL PROBLEM

However, the expansion of the physical faculties of physics and chemistry by the addition of the requisite number of research professors and the expansion of equipment for their use is a very serious problem. It has been estimated by eminent and experienced scientists that a man should remain in pure science research for ten years after receiving his doctor's degree in order to become a thoroughly trained, mature and competent worker. At the end of such a ten years' experience the industries will be entirely capable of taking care of these men and will need them in industrial laboratories where today it is almost impossible to obtain any competent help. During this ten-year period, however, a man must be paid a sufficient wage as a research professor to keep him from entering industry prematurely,

which means, as matters stand today, he probably must draw an average salary of \$5,000 a year. If the university is to produce any respectable number of men after a course like this, it is evident that the research department or division must become a very large and expensive institution, since to turn out ten men in chemistry and ten in physics per year after ten-year courses would require two hundred residents continually. This number could be doubled or trebled for a long time without saturating industry.

INDUSTRY MUST FINANCE

It has frequently been said that since in the end the discoveries in pure science will redound to the benefits of industry, therefore industry ought to finance the necessary expansion of the universities. It is, however, exceedingly difficult to secure this result in the usual way for several reasons. What is really meant by industry financing research is that a few large stockholders of industrial corporations shall finance research. Most corporations are not legally permitted to make donations direct to educational institutions. Under present methods our corporations are heavily taxed and the large stockholders are again heavily taxed on their depleted dividends so that there is little left for the universities. Besides it is a fact that the great bulk of small stockholders of corporations who profit by scientific research are never reached at all. The prime advantage of the present plan is that it enables payment to be made directly by industrial corporations in a legal manner and in proportion to the benefits derived by the corporations from scientific research and it permits the payments to be charged to expense so that they are free from burdensome income taxes.

RESEARCH WILL LEAD TO DISCOVERY

In the normal course of pure science, research made wholly without reference to any commercial end will inevitably discover novel processes, novel machines and novel compositions of matter, many of which ultimately become of the highest industrial importance and most of which can be patented because, in the eye of the law, they are patentable inventions. These inventions, being made without reference to a particular commercial end, are usually of the most broad and sweeping character and they frequently underlie whole groups of industries.

The industries which use these inventions produced in the universities as part of their regular work should pay for them out of corporate funds. It is reasonable that a very considerable income can readily be obtained in this manner without begging for charity, but as a matter of right. Most of our large corporations are glad and willing to pay liberally for anything which benefits them, especially if the proceeds are to be reinvested in furthering similar work, the advantage of

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which may later be reaped by the corporation. This result can be brought about through the patent system, and every objection so far suggested to the patenting of inventions by members of university faculties can be overcome not only technically but in spirit and substance.

PATENTS OPEN TO ALL

And it is of the utmost importance that these inventions should not be monopolized in one or a few hands, but should be freely offered to the public for all possible uses upon very reasonable terms. This can be done by letting it become known that such patents are not for sale, that no exclusive rights will be granted, but that anyone can have a shop right or license for his own purposes and his own plant upon the payment of a reasonable fee. This is precisely what has been done with the patents in the Cottrell process, which have been held by the Research Corporation. The process is used in a great number of industries for all sorts of purposes and industry is in nowise hampered by the patents, since everyone knows he may use them freely upon paying a reasonable price. As a result other inventors treat the Cottrell patent as if it were entirely non-existent except that they realize that a reasonable royalty must be added to the cost of operation. The point is, however, that no one attempts to avoid this patent or to get along without it, simply because it is held under these unusual conditions. We see, therefore, no reason why the public should be injured in the slightest degree by the grant of more patents held in a like manner. Indeed, from the standpoint of the public, it would probably be more advantageous to have inventions patented and the patents held open to general use upon payment of a reasonable royalty than to continue as at present.

PRESENT PRACTICE ENCOURAGES PIRATES

Today the practice of scientists is to present purely scientific papers dealing with laws rather than their application, and little or no mention is made of possible practical applications, even though these are more or less obvious. Almost immediately these papers are read by commercial investigators and the most evident practical applications are promptly patented. Thus neither the public, nor the inventors, nor the universities benefit, but in too many cases a small group of sharp-witted engineers secure the patents. In some cases these patents are invalid because the application of new truths is too obvious, but in others they are perfectly valid because the exceedingly abstract nature of the original thesis makes any concrete application of its principles patentable invention.

Furthermore, the thesis is written in a form unfamiliar to the Patent Office and the courts, and oftentimes fails to receive its full evidentiary weight in controversies affecting a subsequent patent. The public would be very much better off, and justice would be much more closely approximated in patent suits if, contemporaneously with the publication of a thesis, its substance were expounded in a patent drawn in the language familiar to the Patent Bar and the Federal Bench.

Furthermore, the existence of such patents would greatly enlighten the Patent Office and prevent the grant of numerous ill-advised patents which by reason of doubts as to their validity constantly embarrass industry. After a wide experience in patent matters and particularly those relating to chemistry, the authors are

satisfied that industry at large would be vastly better off if all discoveries were patented as fast as they are made providing only that a liberal policy was followed in licensing the use of these discoveries. There is at large a type of engineer commonly called a "patent pirate," who thrives by monopolizing the practical applications of the abstract discoveries of others. The patent pirate is a menace to industry and a parasite on the community. Nothing would so hamper his activities as to have the real discoverer take out broad patents in every case.

PUBLIC, NOT INDIVIDUALS, TO BENEFIT

It seems to be agreed that to permit members of the science faculties of our universities to patent their discoveries for their own personal benefit is an entirely wrong policy for several reasons. It tends to restrict directions in which research may be conducted by placing a premium upon lucrative lines of investigation; and worse still it tends to focus the attention of the investigator upon applied science rather than pure science and *pro tanto* causes the university laboratory to do work which ought to be done in an industrial laboratory. Any proposal, therefore, to meet the conditions of the problem must remove all thought of personal reward to the individual making the invention so that he shall remain in the same mental state as heretofore. This can readily be accomplished if it is understood that the inventions are to be assigned when the applications are filed and that all proceeds are to be applied to the expansion of research and general research facilities under the exclusive control of the head of the department.

On the other hand, the patenting of these inventions would have a highly beneficial effect in increasing the immaterial rewards of those engaged in research. Patents must issue in the name of the actual inventor and if the time ever comes when many of our great industries are paying tribute for the use of patents issued upon the inventions of our university faculties, industry will have driven home to it in a most forceful fashion the importance and value to a community of a trained research professor. Instead of being looked at askance by business as a cloistered theorist he will of necessity be respected as a builder of foundations. We all realize that our genuine scientists are too little appreciated by the community at large and there is no way in which the public judgment can be rectified so readily as by direct attack on the public pocketbook.

PLAN OF ORGANIZING THE PATENT WORK

It has been suggested that the universities would not desire in their corporate capacity to take over and own the patents negotiated for licenses and perhaps conduct suits. Possibly in the future this view might be changed and in a decade or two it might be understood that it was as much a part of the duties of the business manager to administer patent property as to administer real estate. It is supposed the university would accept the gift of a valuable patent the same as that of a piece of real estate, and would administer it in the same business fashion, and it might well be that in due time it would be appreciated that the business manager ought to administer this property the same as any other. However, initially, and if desired, permanently, there is no need for the university to appear in the matter at all. A few friends of the university having no connection with the board of trustees or with the faculty can

readily organize a trustee corporation not for pecuniary profit. These patents can be taken over by this holding company; it can grant the licenses, collect the royalties and pay over the proceeds to the university as a trust fund for the furtherance of research. In this respect the holding company would stand to the university precisely as does any other donor, would administer the patent property according to its best judgment and would turn over the proceeds without limitation as to the manner of expense by the university, or to be used in gifts for special purposes. If at any time the university should decide to administer the property direct, it could all be turned over to the university in its corporate capacity, but until that time the university would have no responsibility.

This leads naturally to the question of the manner of administration and the expense thereof. The ordinary investigator has no idea of the limits to which patent protection can extend and in most cases has no appreciation of the fact that he has made patentable inventions. Furthermore he is incapable by training and education of picking out the patentable from the unpatentable part of his work, so that this would have to be done for him by someone else. The only feasible arrangement is to have the papers, thesis and results of investigation reviewed by a patent counsellor sufficiently versed in chemical and physical matters quickly to grasp the situation, and to have counsel segregate the patentable matter and prepare and file patent applications. If the plan should succeed and an enormous research organization be built up, this work would require the services of several trained men, but the expense could be borne without difficulty by the holding company out of its proceeds, for the expense of drawing and soliciting patents would necessarily be an insignificant feature. In initiating the plan the work involved is relatively small, because relatively little research is being done. The comparatively insignificant government fees for patent applications can be taken care of by friends of the plan and of the university, without costing the university any money. If a plan of this sort should be generally adopted for universities, it would be quite feasible to secure the patent services of the alumni to an extent sufficient to make each of the plans become self-sustaining without expense.

CAUSE FOR LITIGATION REMOVED

As to patent litigation, there probably would be none. No case is known where a patent thrown open so that all the world could have it upon a payment of a reasonable royalty was deliberately infringed by manufacturing concerns. They all prefer to pay a royalty rather than to take chances of litigation. A few patents, usually on processes which can be practiced in every shop, have been extensively infringed even though licenses were cheap and available, but these cases have been exceptional in that each infringement was trifling in extent, but the number was very great. This occurred in the case of the driven well patent and some dental process patents where there were thousands of users of the invention. In the ordinary case the infringer has a more substantial interest in the invention and would prefer to be a licensee on reasonable terms. Furthermore the fact that the license fees would be paid over to an educational institution would lead industry to treat these patents most kindly and it would be surprising if litigation ever occurred. The Cottrell

patent above mentioned has never been litigated and doubtless never will be, because the fees are reasonable, are equal between like users and are applied to the furtherance of research.

FOUNDING SPECIAL RESEARCH FELLOWSHIPS

There are two other questions which have been thoroughly discussed, both involving the case where an outside party desires the university to undertake a particular piece of research and is willing to contribute to the expense, as by founding a fellowship. Of course at the outset it must be understood that the head of the department involved is to decide on the scientific lines only whether this piece of research is worth while, and he should not permit himself to be influenced by any commercial consideration. Sometimes the suggested line will be of great scientific value, and yet the investigation will be of the utmost commercial value to the donor. Inventions made in research under these circumstances will be of two kinds.

The first will be the rarer, where the donor of the fellowship is a skilled chemist or physicist himself and is able to direct the investigation in detail by suggesting specific things to be done. In this case the donor would be the true inventor, he having made the suggestion of definite procedure to be followed. Since, however, the facilities of the university are employed in the investigation, it would seem equitable that the university might insist upon a division of the proceeds, and it is suggested that in cases of this kind the university might properly insist that the inventions should be held for public use and that the proceeds be divided upon some fair basis. In one case now in the chemistry department of a university the donor of a fellowship has actually suggested and mapped out many of the experiments which have been made. He would have a legal right to patent these inventions in his own name and give the university nothing, but is perfectly satisfied to divide the proceeds equally, the university's share to be employed in the furtherance of chemical research. There seems to be no reason why the university should not accept such an arrangement, more particularly since it has now no rights whatever in the premises, and it certainly should not be hindered from making an interesting scientific investigation merely because the investigation is on the scientific truths underlying an invention or inventions already made by the donor.

In the more common case the donor of a fellowship would not have the scientific knowledge to map out the work in detail, but would only want a broad line investigated. Here the donor would not be legally the inventor, but the inventions, if any, would be those of the fellow or other investigator. Under those conditions an arrangement such as that offered by the donor above mentioned should be highly satisfactory. The question of the technical inventorship should not change the proposition and the donor of a fellowship should have a broad consideration in the commercial proceeds therefrom.

It is probable that as time goes on, if a broad plan works out, the research departments may not need to ask or accept fellowships at all, for after a decade or two of development the departments might be entirely self-sustaining. At the present time, however, when the departments are in serious need of expansion, it seems that the accepting of fellowships under these general conditions would be highly desirable.

Legal Notes

BY WELLINGTON GUSTIN

Verbal Promise by Salesman Not Binding, Especially When Promptly Repudiated

In a recent case where the Pocahontas Guano Co. had brought action against a dealer and another it was said the unauthorized contract of the company's salesman was ineffectual when promptly repudiated by the company.

The action arose out of a consignment of fertilizer to defendant for sale as agent of the company. Notes were given to the company in settlement of the fertilizer consigned to and sold by the agent. The agent testified on trial that he had sent the notes in a letter claiming that they were sent without prejudice to his right to recover damages for an alleged breach of a verbal contract made with him by a salesman of the Guano company to ship him another carload of fertilizer for his own use. By reason of the failure to do so he had sustained damages to his crop, for which he set up a counterclaim for damages against the company's suit for balance due in the notes. On trial the agent was given a verdict on his counterclaim, and judgment for the balance over the company's claim was entered. From this judgment the company appealed.

WRITTEN CONTRACT BARRED VERBAL PROMISES

The Supreme Court of North Carolina has reversed this judgment. It said there was not sufficient evidence to go to the jury in support of the counterclaim made by the dealer-agent. The contract between the company and the agent was in writing and was for shipment of fertilizer to be sold as agent. This contract contained the clause, "No verbal promises that conflict with the terms of this contract will be recognized by this company."

Subsequently to the above consignment the agent ordered another carload of fertilizer for his own use. The company did not ship, but sent its salesman to see the agent, who testified that he still had thirty or forty bags of fertilizer on hand which he had received as consignee and agent. He further testified that the salesman told him to sell these bags and he "would see that he got another carload."

On the other hand, the agent put in evidence a telegram and letter from the company and its salesman, acknowledging receipt of a telegram and letter from the agent, but stating that owing to prior orders the company was unable to accept the agent's order for another carload of fertilizer. The court said this showed a case where the defendant ordered a carload of fertilizer, which order the company declined to accept and fill. It did not appear from the evidence that it was in the scope of the agency of the company's representative to bind it to ship the fourth carload.

HIS ORDER REFUSED BY THE COMPANY

When he reported the order to the company he was promptly notified that the company could not accept and fill the order, and the agent was not misled by any reliance upon his order being filled. The court says he had no right to rely upon the unauthorized state-

ment of the agent, if made, that if he, the defendant, sold the thirty or forty bags which he had on hand for sale as agent, he "would see that a carload was shipped to the defendant for his own use." The contract defendant held showed no agreement was binding until countersigned by an officer of the company, and the company as well as salesman promptly notified the agent by letter and wire that owing to the scarcity of fertilizer and prior orders, his order could not be accepted.

Government Need Not Pay for Product It Destroys Under Act of Congress of March 4, 1915

In the case of the Great Western Serum Co. against the United States, decided adversely to the Serum company in the Court of Claims, the Supreme Court of the United States affirmed the judgment of the lower court.

The Serum company sued to recover the value of anti-hog cholera serum, anti-cholera virus and serum blood, seized without agreement to purchase by agents of the Bureau of Animal Industry in November, 1914, and thereafter destroyed.

The act provided that in case of an emergency arising out of certain contagious diseases of animals which threatened the live stock industry of the country the Secretary of Agriculture may expend the sum of \$2,500,000, then appropriated, "in the arrest and eradication of any such disease, including the payment of claims growing out of past and future purchases and destruction, in co-operation with the states, of animals affected by or exposed to, or of materials contaminated by or exposed to, any such disease wherever found and irrespective of ownership, under like or substantially similar circumstances, when such owner has complied with all quarantine regulations, and said sum shall be immediately available for the purposes specified."

The Supreme Court ruled that there was no purchase of the destroyed product or agreement therefor, and none was claimed, and that the act does not itself raise an implied contract by the United States to pay for the property so destroyed; and therefore an owner of materials contaminated by or exposed to such disease and destroyed by Government agents cannot sue for its value where there was no purchase or agreement to purchase the property destroyed.

Creditor's Knowledge Relieves Stockholder in Corporation From Liability Under Georgia Laws

In an action between the Farmers' Warehouse & Fertilizer Co. and the Macon Fertilizer Works the Supreme Court of Georgia has held that a creditor of a corporation who knows that the requisite amount of capital stock has not been subscribed may not proceed to collect a bill by an action against a subscriber, under the Georgia laws. The Civil Code (1910), section 2,220, says:

"Persons who organize a company and transact business in its name before the minimum capital stock has been subscribed for are liable to creditors to make good the minimum capital stock with interest."

Now the Supreme Court in this case has said that if at the time credit is extended the creditor knows the fact that the requisite amount of capital stock has not been subscribed, he cannot claim or be said to have been misled, and relatively to him the subscriber to the stock would not be stopped from pleading such knowledge as a defense to a suit based on the above section of the statute. (148 Ga., 388.)

Removal of Arsenic From Zinc Electrolyte by Means of Hydrogen Sulphide

This Article Describes Large-Scale Generation of Hydrogen Sulphide and Using It to Precipitate Arsenic From Electrolyte—The Acid Used for This Generation Is Completely Consumed and the Gas Is Completely Utilized in Precipitating Arsenic

By HERBERT R. HANLEY*

THE economical operation of an electrolytic zinc plant is partly dependent upon the practically complete removal from the electrolyte of all metals more electro-negative than zinc. Where these metals are present in relatively small amounts, this can be done by precipitation upon metallic zinc. Arsenic in the form of arsenites can be removed economically, if present not in excess of 1 or 2 g. per liter, by precipitation by means of lime as iron arsenate. If present in larger amounts, some other means must be depended upon, as the above-mentioned methods are then impractical. The problem of treating the arsenical zinc-fume which had accumulated at the Mammoth plant of the United States Smelting, Refining & Mining Co. at Kennett, Cal., for the recovery of zinc and cadmium presented a particularly interesting problem.

This bag-house fume when first collected contained the arsenic in the trivalent form as arsenites of the various metals. Because of the voluminous nature of the fume it was necessary to collect it under water. This resulted in the breaking down of the flocculent deposit that would otherwise be obtained. The coalescence of the solids produced a mud, or slime, of a normal specific gravity. During the storage of the bag-house mud a gradual oxidization of the arsenic occurred, with the result that after a few years' storage approximately half of the arsenic was present in the pentavalent condition. The solution of this mud in dilute sulphuric acid naturally produced a certain amount of zinc arsenate. This is soluble in slightly acid solutions at moderate temperatures; at temperatures above 60 deg. C., however, it coagulates, forming a gelatinous translucent precipitate, the completeness of the reaction varying inversely as the acidity. Also, if the slightly acid solution of zinc arsenate be neutralized with any base, there is obtained a very voluminous and gelatinous precipitate which cannot be washed free from soluble zinc salts. When solutions containing arsenates are treated with hydrogen sulphide for the precipitation of the arsenic, the consumption of this gas is uneconomical, a portion of the hydrogen sulphide being reduced to sulphur; in addition, this operation required an inordinate length of time.

These conditions make it impractical to consider the precipitation of the arsenic from this solution with hydrogen sulphide, and it is evident that for the economical recovery of the zinc some method must be devised whereby the losses entailed in the handling of the precipitates are avoided.

These difficulties practically disappear if the arsenic

be present in the trivalent condition: no insoluble compound of zinc and arsenic is formed during neutralization; the precipitate produced may be easily washed; the consumption of hydrogen sulphide is normal. Preliminary to the removal of the arsenic from the fume by means of hydrogen sulphide it became necessary to develop an economical process for the reduction of the arsenic to the trivalent condition.

This problem was solved in a practical manner by circulating the solution through a tower through which sulphur dioxide gas is passing. The tower is 2 ft. square, 30 ft. in height. The sulphur dioxide gas is produced by a pyrite burner. It was found that the reduction takes place in cold as well as hot solutions. This is probably due to the relative solubility of sulphur dioxide in hot or cold solutions of zinc sulphate. While the rate of the reduction may be greater in hot than in cold solutions, the greater solubility of sulphur dioxide in the latter accomplishes the reduction in approximately equal times under average conditions.

The reduction of 1,000 lb. of arsenic in the solution which contains about 10 g. of pentavalent arsenic per liter requires the pumping of this solution through the tower at the rate of 225 gal. per minute for sixteen hours. The consumption of sulphur dioxide is approximately 4.4 lb. per pound of arsenic reduced.

In Table I is shown a record of experiments in the reduction of the arsenic in the zinc sulphate solution

TABLE I

Test No.	1	2	3	4	5	6	Av.
Gal. solution treated	947	514	950	500	840	516	711
Temp. solution, deg. C.	30	30	30	50	58	69	44.2
G.p.l. As v before treat.	10.2	7.8	8.0	9.8	8.0	9.8	8.93
G.p.l. As III before treat.	11.8	10.3	9.0	11.4	10.1	7.4	10.00
G.p.l. As v after treat.	0.0	0.3	0.5	0.8	0.5	1.8	0.78
G.p.l. As III after treat.	24.0	18.6	17.5	21.8	18.0	18.8	19.78
Pounds arsenic reduced	80	31	59	38	51	35	49
Pounds SO ₂ delivered to base of tower	210	216	252	219	160	146	200.5
Pounds SO ₂ delivered to base of tower per hr.	42	72	48	73	35	40	50.0
Time required, hours	5.0	3.0	5.2	3.0	4.5	3.4	4.0
Per cent SO ₂ in gas by volume	5.8	8.0	6.2	8.0	4.0	5.5	6.25
Pounds SO ₂ per pound As v reduced	2.6	5.8	4.2	5.7	3.0	4.0	4.44
Gal. solution circulated per minute	120	70	40	120	40	40	72
Pounds SO ₂ per sq.ft. grate area per hour	8.4	14.5	9.6	14.6	7.0	8.0	10.35

obtained upon leaching the bag-house fume with sulphuric acid. This solution contained approximately 6.0 g.p.l. H₂SO₄, 96.0 g.p.l. Zn, 4.0 g.p.l. Cd, 0.5 g.p.l. Cu and 8.9 g.p.l. As^v.

GENERATION OF HYDROGEN SULPHIDE

Two methods were considered for the generation of hydrogen sulphide: First, the distillation of oil with sulphur, a method formerly used for the production of

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asphalt from oil; and, second, the reaction of dilute sulphuric acid on low-grade copper matte. Under the local conditions which obtained at Kennett the sulphur-oil method proved to be more expensive and in general less promising of practical application than the sulphuric acid-copper matte process. With more favorable conditions the sulphur-oil method might, however, prove economical.

SULPHUR-OIL METHOD

In general, the sulphur-oil method consists in slowly distilling oil with sulphur at a temperature between 150 and 200 deg. C. To obtain maximum production of hydrogen sulphide from the sulphur it is necessary to use an oil of definite physical properties. If asphalt is to be made as a byproduct, the sulphur must not exceed 10 per cent the weight of the oil. The distillation of an oil with sulphur in excess of 10 per cent will, as a rule, produce a residue quite similar to coke. If the nature of the residue is immaterial, the amount of sulphur may be increased to 50 per cent of the weight of the oil with satisfactory results as regards

for the supply of an oil-residue with these particular characteristics.

SULPHURIC ACID MATTE METHOD

As is well known, hydrogen sulphide can be generated by the action of dilute sulphuric acid on the iron sulphide contained in matte. In order that this method may be used commercially it is not only necessary to obtain economical consumption of sulphuric acid but also necessary that the generating apparatus be safe in operation. A low-grade matte was available at Kennett of the following composition: Cu 10.0 per cent, Zn 3.5 per cent, Fe 54.0 per cent, S 28.0 per cent, insoluble 1.2 per cent, undetermined 3.3 per cent. In order to determine the ratio of the amount of acid consumed to the amount of hydrogen sulphide generated when this matte was treated with dilute sulphuric acid, seven 100-g. samples were treated with different amounts of acid, as shown in Table III. The residue was analyzed for copper, zinc and iron and the quantity of hydrogen sulphide liberated was determined.

The result of these tests brought out the fact that acid to the amount of 75 per cent of the weight of the matte is required to liberate the maximum quantity of hydrogen sulphide and that approximately 5.5 lb. sulphuric acid is required for each pound of hydrogen sulphide produced. Acid to the amount of 10 per cent of the weight of the matte is consumed by "acid-consuming" constituents of the matte before any hydrogen sulphide is liberated. This fact would make it economical to continue the treatment of the matte with acid until the maximum amount of hydrogen sulphide had been produced, varying somewhat due to local conditions.

RESISTANCE OF MATTE TO ACID TREATMENT

The treatment of matte with dilute sulphuric acid will not liberate hydrogen sulphide under all conditions. It was found that the physical condition of the matte, method of granulation, and the flux used in its production were factors that determined this characteristic. The results of investigations to control these conditions brought out the following facts:

- (1) High-grade mattes containing more than 20 per cent copper are usually active regardless of the furnace flux or the method used to reduce the matte to a granulated form.
- (2) Low-grade mattes containing about 10 per cent copper are usually active when the furnace flux consists of clean quartz, regardless of the method used to reduce the matte to a granulated form.
- (3) Low-grade matte containing about 10 per cent copper is usually inactive when the furnace flux consists of country rock, such as silicified rhyolite containing aluminum silicate. When this matte is granulated in water, however, it is active, but it loses this activity if allowed to become dry. This activity is retained indefinitely if the matte is kept immersed in water.

TABLE II.

Test No.	Temp. Deg. F.	Kind of Oil	Per Cent Weight of Sulphur to Weight of Oil	Hours Distilled	Per Cent Sulphur Converted to H ₂ S	Per Cent Weight of Asphalt to Weight of Oil
1	150-205	A	10	19	48.0	†
2	150-163	A	10	24	51.5	80
3	150	A	25	18	52.0	†
4	150-205	A	50	8	54.1	†
5	150	B	10	18	52.0	90
6	150-205	B	25*	23	7.8	†
7	150-205	A-1	10	7	73.7	90
8	150-205	B-1	10	10	50.0	90
9	150-205	A-2	10	11	82.1	84
10	150-205	C	10	9	60.0	94
11	150-205	D	10	7	60.0	†
12	150-205	E	10	3.5	72.2	†
13	150-205	2 pts. E 1 pt. D	10	8	45.2	†

* In the form of pyrite.
† Residue in the form of coke.
A. "Fuel oil" from Coalinga district, California.
A-1. Same as A distilled with live steam and outside heat; 11.3 per cent, by volume, distillate removed.
A-2. Same as A-1 further distilled with live steam and outside heat; 57 per cent, by volume, distillate removed.
B. Fuel oil from Shell district, California.
B-1. Same as B, distilled with live steam and outside heat; 18 per cent, by volume, distillate removed.
C. Cylinder oil stock.
D. Residuum obtained from the manufacture of road oil by the distillation of the fuel oil.
E. Road oil.

the yield of hydrogen sulphide. The maximum yield of gas is, however, not much in excess of 80 per cent of the theoretical obtainable from the amount of sulphur used.

RESULTS OF TESTS

The results of a series of tests are shown in Table II. The maximum conversion of 82 per cent of the sulphur to hydrogen sulphide in test 10 was obtained on a specially prepared oil. To obtain a similar yield in commercial-scale operation at the Kennett plant would have required co-operation with an oil-refining company

TABLE III.

Cycle No.	1	2	3	4	5	6	7	Total or Av.
Grams H ₂ SO ₄ used	10.4	11.75	11.75	11.75	11.75	11.75	6.2	75.40
Weight of matte residue after each acid treatment.	92.5	84.5	75.0	62.6	55.0	45.5	35.0	.....
Analyses of matte residue:								
Cu %	8.7	9.3	10.3	11.7	12.8	15.8	16.9	23.4
Fe %	54.2	52.0	48.8	46.2	42.6	39.6	34.7	33.4
Zn %	3.0	3.2	3.7	4.3	4.8	5.4	6.5	7.7
S %	27.5	28.5	28.0	28.0	29.3	28.7	27.4	29.0
Grams iron lost by matte	6.0	6.9	6.6	8.0	4.9	6.0	4.0	42.40
Grams sulphur lost by matte	0.6	2.8	2.6	2.7	2.6	3.2	2.3	16.8
Grams H ₂ S generated	None	2.27	2.34	2.40	2.63	2.53	1.68	13.85
Grams H ₂ SO ₄ consumed per gram H ₂ S generated.	.....	5.17	5.00	4.88	4.46	4.65	3.68	5.44
Grams iron dissolved per gram H ₂ S generated	.....	3.03	2.82	3.33	1.86	2.37	2.38	3.03

By meeting these conditions it was possible to keep on hand a dependable supply of matte for use in the generation of hydrogen sulphide.

APPARATUS FOR THE GENERATION AND USE OF HYDROGEN SULPHIDE

In the development of the process the apparatus used for the production of hydrogen sulphide consisted of a standard creamery churn, 4 ft. in diameter and 4 ft. in length, reinforced by the addition of double heads. The generator is supported on trunnions and may be rotated when desired. The gas outlet and the gas and acid inlet are inserted axially through stuffing boxes. The gas outlet pipe is connected to a Roots blower which delivers the gas to the precipitating tank. This tank is provided with a sealed top and pipes through which the gases may be circulated. The general layout of the apparatus is shown in Fig. 1. The matte is charged into the generator from the bin 1. Dilute acid is admitted from the storage tank 2, the amount of acid added being measured. A bin 7 is provided for the generator residue which is dumped into car 8 for disposal. The gas passes through a separator 4 to the Roots blower 11, which delivers the gas to the precipitating tank 16 through a perforated coil of pipe located about midway the depth of the tank, this particular location being important, as will be shown later. A blower 14 circulates a portion of the attenuated gas through the precipitating tank, delivery being at the bottom of the tank through a perforated coil of pipe, thereby causing a thorough agitation of the arsenical

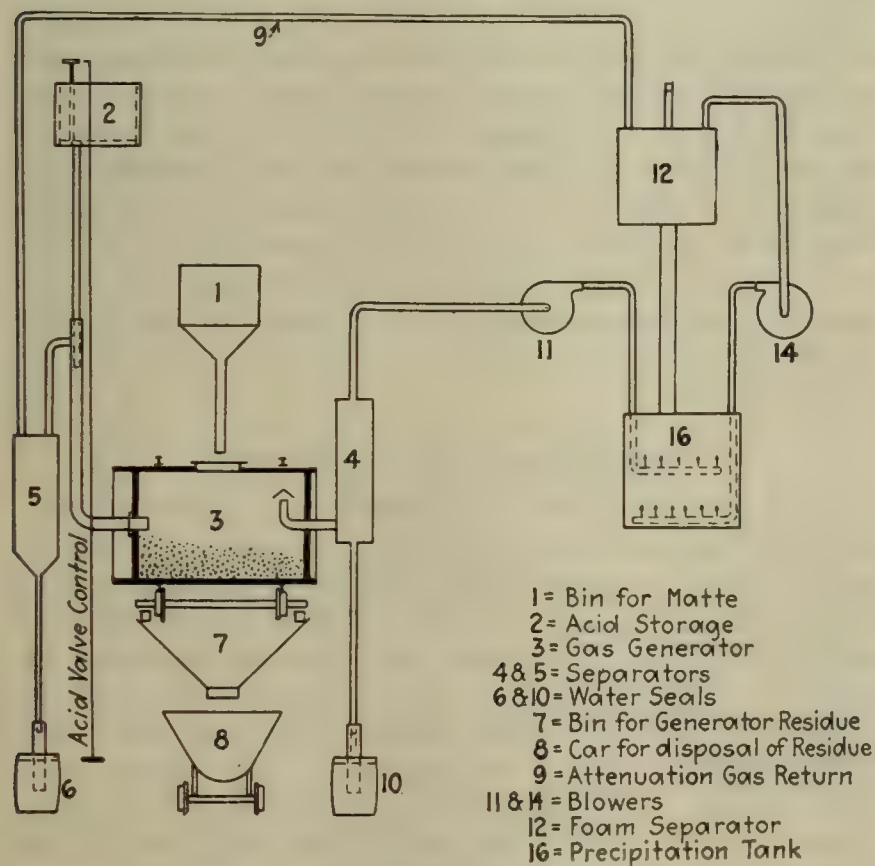


FIG. 1. LAYOUT OF APPARATUS

solution. The impoverished gas which is forced through the solution in the precipitating tank by the blower 11 returns through pipe 9 and separator 5 to the generator. This arrangement is not only economical in the use of hydrogen sulphide but by preventing the escape of the gas to the atmosphere renders the operation safe. A drum 12 separates the froth from the gases. The circulation systems are closed except for safety seals 6 and 10 and a relief valve. These are located outside of the building. The generator operates under a slight vacuum which not only accelerates the generation of the

hydrogen sulphide but also assists materially in preventing its escape into the atmosphere of the room.¹

It was discovered that there would be a precipitation of zinc sulphide due to a local depletion of the arsenic in the solution if the gas from the generator was delivered to the blower 11 at the bottom of the precipitating tank. This precipitation of zinc sulphide is prevented by the delivery of the gas from the generator at the zone of maximum agitation caused by circulating the attenuated gas by means of blower 14.

DETAILS OF OPERATION

One thousand pounds of granulated matte is introduced from the storage bin through the manhole of the generator and the cover is closed. The blower 11 is started and 50 gal. of dilute sulphuric acid (200 g.p.l.) added from the tank, this amount being sufficient to take

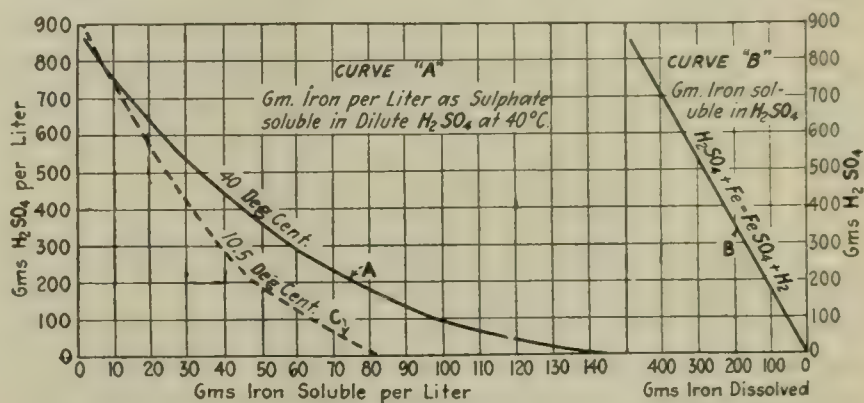


FIG. 2. SOLUBILITY OF IRON IN SULPHURIC ACID

care of the initial consumption of acid. The addition of acid is then continued at the rate of about 50 gal. per hour, with an occasional rotation of the generator, until there is a diminution of the rate at which the gas is generated. The rotation of the generator causes the inert coating on the particles of matte to be removed by attrition, increasing the rate at which the hydrogen sulphide is liberated. When an amount of acid has been added which is calculated to liberate the maximum amount of hydrogen sulphide from the matte, the generator is rotated continuously until this acid is neutralized. The solution from the generator is removed by decantation and the matte residue dumped from the generator through the manhole.

IMPORTANCE OF USING DILUTE SULPHURIC ACID OF CORRECT STRENGTH

It is important that the dilute sulphuric acid be of such strength that complete neutralization will not form a saturated solution of sulphates at the operating temperature of the generator, otherwise a crystallization will take place within the generator. The formation of a saturated solution also causes a loss of acid. Dilute sulphuric acid containing 200 g. per liter will react with iron, producing a solution containing 120 g. iron per liter. This amount of iron in the form of iron sulphate is soluble in dilute sulphuric acid containing not more than 40 g. per liter, if the temperature of the solution is not less than 40 deg. C. This temperature is lower than the normal operating temperature of the generator.

The importance of using a dilute sulphuric acid of correct strength may be illustrated by the following example: Suppose the dilute acid contained 300 g. per liter H_2SO_4 . Referring to Curve B, this amount of acid will dissolve 170 g. of iron. Referring to curve A, it is

¹U. S. Patent 1,360,524; Nov. 30, 1920.

TABLE IV.

Lot No.....	1	2	3	4	5	6	7	8	9
Gal. treated.....	362	410	498	433	455	450	424	402	392
Sp.gr. sol. before treatment.....	1.25	1.26	1.26	1.22	1.24	1.24	1.24	1.24	1.225
Sp.gr. sol. after treatment.....	1.22	1.21	1.22	1.21	1.25	1.23	1.25	1.22	1.21
G.p.l. ZnO before treatment.....	84.7	91	90	94	88	91.5	92	90	84
G.p.l. ZnO after treatment.....	86	94	92	104	90	93.0	94	91	85
G.p.l. As before treatment.....	24	18.4	25	16	16.5	17.2	15.3	15.8	15
G.p.l. As after treatment.....	1.1	0.2	0.1	0.7	0.8	1.2	1.2	1.2	0.5
Pounds As pptd.....	68	75	105	56	59.5	60	51.6	50.3	48
Pounds H ₂ SO ₄ used in generator.....	352	236	600	277	293	30.2	209	218	204
Time of treatment, hours.....	10	4.5	10	8	5	5	4	4	4.6
Pounds H ₂ SO ₄ used per pound arsenic, pptd.....	5.2	3.1	5.6	4.9	4.7	5.0	4	4.3	4.2
Analysis of ppt.:									
Arsenic, per cent.....	40.0	41.0	48.0	48.0	46.0	48.0	42.0	41.0	45.0
Insol. Zn, per cent.....	5.0	9.0	9.0	5.0	6.0	5.0	5.0	3.2	4.0
Cadmium, per cent.....	4.0	3.9	4.2	4.5	5.0	4.5	4.1	3.8	4.0
Copper, per cent.....	1.0	1.1	1.2	1.2	1.2	1.1	1.0	1.1	1.0

to be noted that a maximum of 145 g. of iron per liter is soluble in a solution containing no sulphuric acid. The difference between this maximum solubility and the amount of iron which would be dissolved by 300 g. of H₂SO₄ amounts to 25 g. iron per liter, which is equivalent to 43½ g. of sulphuric acid, and represents the amount which would be wasted if this strength were used.

PRECIPITATION OF ARSENIC

The precipitation of arsenic is accomplished in a solution containing not less than 10 g.p.l. H₂SO₄. This is necessary in order to prevent a simultaneous precipitation of zinc sulphide. The use of a more dilute solution is attended with an increasing precipitation of zinc sulphide; the use of stronger solutions not only results in the unnecessary loss of acid but also increases the amount of the precipitate produced upon the subsequent neutralization of this solution with lime rock and the expense necessary to handle it.

For the precipitation of one ton of trivalent arsenic there is required approximately 12 tons of matte and 4.5 tons of sulphuric acid. The matte residue will amount to about 8 tons and will contain practically all the copper of the original matte. The strength of the generator gas will vary between 0.5 and 8 per cent, depending upon the rate at which acid is added and also upon the activity of the matte.

Results obtained in treating the arsenical zinc solution are shown in Table IV. The amount of sulphuric acid used is calculated on the weight of arsenic precipitated, as this is the element which made necessary the treatment of the solution. Since the complete removal of the arsenic will cause the precipitation of zinc as sulphide, about 1 g. per liter of arsenic is left in solution. The precipitates obtained from lots 2 and 3 are high in zinc for this reason.

The arsenical precipitate is removed from the zinc solution by filtration. A plate and frame filter press is used, no difficulty being experienced in handling and washing the precipitate. It is uneconomical to wash the cake beyond the point where the water soluble zinc is less than 5 per cent.

REMOVAL OF LAST TRACES OF ARSENIC

The last traces of arsenic are removed by precipitation as an iron arsenic compound from a solution containing iron in excess of the amount required to form this compound, the precipitating agent being pulverized lime rock. This operation also results in the complete removal of the iron. The solution after the removal of the iron precipitate by filtration is given the usual treatment for the removal of cadmium and traces of other metals which may have escaped the previous treat-

ments. It is to be noted that the complete removal of cadmium with hydrogen sulphide is impracticable, since it is necessary to perform this precipitation in a nearly neutral solution, in which case there is simultaneous precipitation of zinc. The cadmium is removed by filtration and the solution delivered to the electrolytic zinc cells. The zinc cathodes produced are of excellent quality.

Generators holding 8 tons of matte have been designed, and consist of cylindrical wood drum, lead lined, and with an inner wood covering to protect the head from abrasion. This is supported in a manner similar to revolving driers, with circular track and bearing wheels.

This apparatus was operated over a period of ten months with satisfactory results; there were no accidents due to the use of hydrogen sulphide and no deleterious effects experienced by the workmen in or about the plant. This demonstration of the practical use of hydrogen sulphide in large-scale work may open up new fields of usefulness, removing this gas from the class of laboratory reagents. There is a possibility of its use for the sulphide coating of ore particles preliminary to recovery in flotation machines and as a reagent to assist in the selective flotation of complex ores. Its more extensive use in the chemical and metallurgical field may come about as a result of the success of this installation.

San Francisco, Cal.

Preparation of Pure Platinum

It is reported that the Bureau of Standards has recently succeeded in producing platinum of higher purity than any obtainable from the platinum dealers in this country or abroad. The "normal thermo-element platinum" of W. C. Heraeus has long been accepted by scientific laboratories as the standard for use in platinum resistance thermometers, thermocouples and other equipment requiring platinum of the highest possible purity. The platinum prepared by the bureau appears to be of a better quality than the best of the Heraeus wire to which the bureau has had access.

It was found that the Heraeus platinum, although free from other platinum metals and the usual base metals, contains small amounts of calcium. By careful control of the operation of melting, which is usually done on lime, the bureau has prepared platinum containing no more than a trace of this element. It was noted also that calcium, even when present in very small quantities, has a considerable effect upon certain of the physical properties of platinum.

The bureau purposes to make a further study of the best conditions for melting platinum on lime and will also investigate the suitability of other refractories.

Synthesis of Chlorine-Free Benzoic Acid From Benzene—II

Influence of Reaction Conditions on the Yield of Benzonitrile in Fusions of Benzene Sulphonate and Sodium Cyanide—Variation in Composition of Charge, Reaction, Temperature and Pressure*

BY RALPH H. MCKEE AND FRANK A. STRAUSS

THE chief conditions capable of variation in the benzonitrile reaction are: The composition of the charge, the reaction temperature, and the pressure.

The composition of the charge may be varied in three ways: By changing the proportion of cyanide to sulphonate, by the substitution of salts other than sodium salts, by the addition of other substances to the charge. All three methods of variation were investigated.

CHANGES IN THE RATIO OF CYANIDE TO SULPHONATE

The original method of Merz makes use of equal parts of cyanide and sulphonate. As the theoretical ratio is 1 part NaCN to 3.67 parts $\text{NaSO}_3\text{C}_6\text{H}_5$, it will be seen that Merz' mixture contained a large excess of cyanide. As the cyanide is the more expensive constituent, it is important to limit its use as much as possible.

A series of runs was made in which the proportion of cyanide to sulphonate was varied. The results are given in Fig. 3.

The experiments indicated the following general relations:

When cyanide is in excess, the time of reaction is

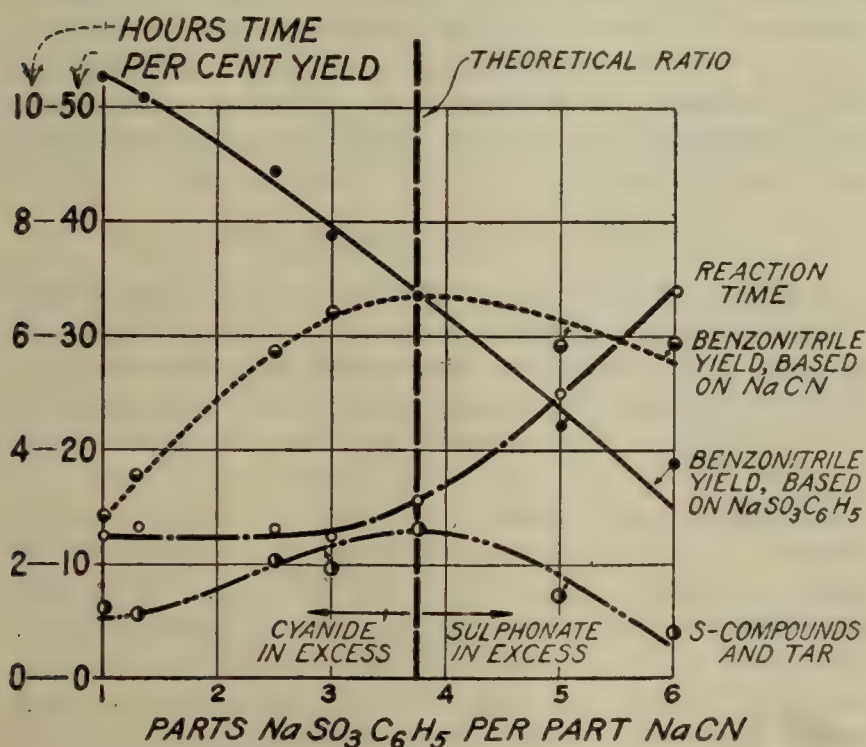


FIG. 3. EFFECT OF VARYING RATIO
NaCN : $\text{NaSO}_3\text{C}_6\text{H}_5$

practically independent of the composition of the charge. When sulphonate is in excess, the time of reaction increases approximately in proportion to the added sulphonate.

The yield of benzonitrile based on sulphonate de-

creases progressively as the proportion of sulphonate increases.

The yield of benzonitrile based on cyanide at first increases as the proportion of cyanide increases. It reaches a maximum with equimolecular proportions and after that falls off slightly.

The yield of volatile sulphur compounds and tar

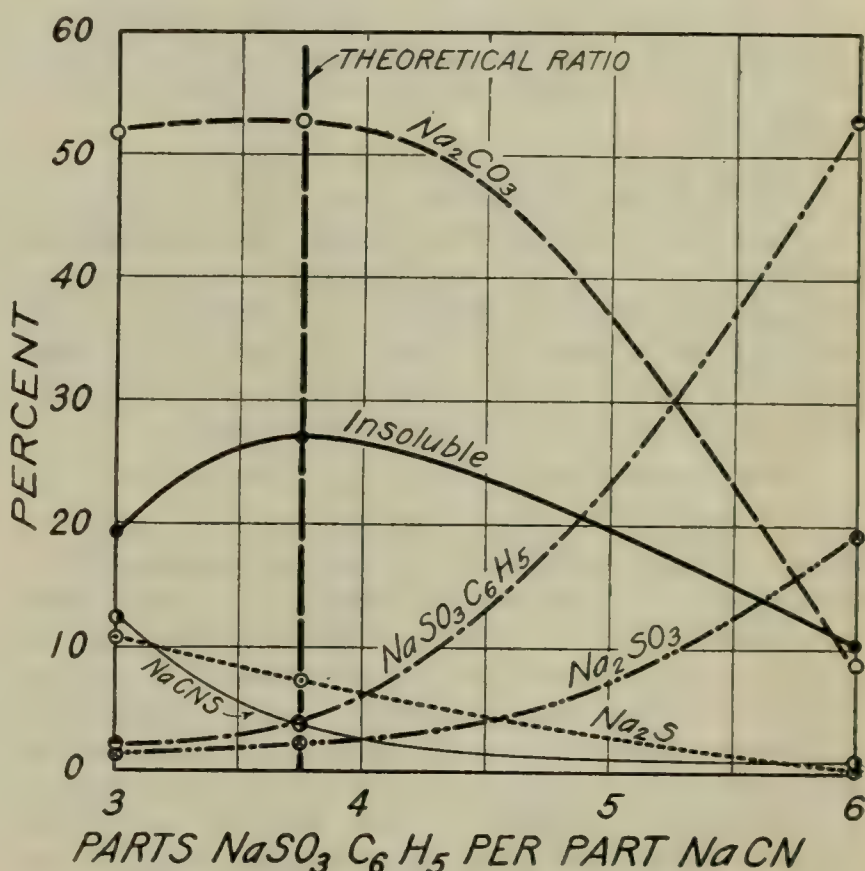


FIG. 4. ANALYSIS OF RETORT RESIDUE

is a maximum when equimolecular portions are employed. The figures are somewhat irregular because of the difficulty of collecting the tarry residue quantitatively.

These results may be interpreted somewhat more satisfactorily with the aid of the analyses in Table II.

TABLE II. ANALYSES OF RESIDUES FROM RETORT

	Temperature 430 deg. Atmospheric Pressure		
	Ratio Cyanide: Sulphonate		
	1:3.00	1:3.75	1:6.00
Na_2CO_3	49.9	54.2	8.4
Na_2SO_4	2.5	2.5	1.9
Na_2SO_3	1.2	2.1	19.1
Na_2S	10.7	7.2	0.3
NaCNO	1.9	1.0	1.3
NaCNS	12.4	3.8	1.0
NaCN	0.0	0.0	0.0
$\text{NaSO}_3\text{C}_6\text{H}_5$	1.9	3.9	50.2
Insoluble (carbon).....	18.5	27.9	9.9
$\text{Na}_4\text{Fe}(\text{CN})_6$.....	.....	.....	1.7
FeO}.....	.....	.....	1.0
	98.9	102.6	94.8

The variations in the principal components of the residue are plotted in the form of curves in Fig. 4.

From a study of the curves, the following conclusions may be drawn:

*For Part I see CHEM. & MET. ENG., vol. 24, No. 15, p. 638, April 13, 1921.

The products of reduction—sodium carbonate, sodium sulphide and sodium thiocyanate—are formed in smaller proportion as the proportion of sulphonate increases.

The percentage of sodium sulphite, the normal product of the benzonitrile reaction, is small when cyanide is in excess, but increases rapidly as the excess of sulphonate increases.

The percentage of insoluble (carbon) first increases and then decreases as the proportion of sulphonate increases, paralleling closely the curve for sulphur compounds and tar in the distillate. This indicates that the carbon and the sulphur compounds and tar are formed by the same action—namely, by pyrogenic decomposition, or “cracking.”

As long as an excess of cyanide is present the sodium benzene sulphonate in the mixture is decomposed almost completely. When an excess of sulphonate is present, however, a large amount will be found undecomposed in the residue. The excess sulphonate serves largely as a diluent, and this dilution seems to result in a smaller amount of undesired reduction and decomposition. The full significance of this dilution will be shown when the effect of temperature is considered.

Taken together, these results indicate that when cyanide is in excess the predominating side reactions are those due to its reducing action; as equimolecular proportions of the reacting material are approached, thermal decomposition becomes the predominant side reaction; while when an excess of cyanide is present the excess serves as an inert diluent and side reactions are repressed to a considerable extent.

THE USE OF SALTS OTHER THAN SODIUM SALTS

It is possible to effect substitutions for either the sodium benzene sulphonate or the sodium cyanide in the charge. Both types of substitutions were tried.

As substitutes for sodium benzene sulphonate, the sulphonates of potassium, ammonium, the alkaline earths and the heavy metals suggest themselves. Potassium salts, because of their high price at the time of this investigation, would not be considered as a commercial possibility. The alkaline earth sulphonates almost invariably give smaller yields in this type of reaction.

The ammonium salt melts at a relatively low temperature.¹² For this reason it was thought that it might react with sodium cyanide at a low temperature. However, double decomposition was found to take place, volatile ammonium cyanide being formed, which sublimed out of the retort, leaving sodium benzene sulphonate behind. Lead, copper and zinc benzene sulphonates were found to decompose at low temperatures.

As substitutes for sodium cyanide, potassium cyanide and the ferrocyanides suggest themselves. The cost of the potassium salt again limited its possibilities. Sodium ferrocyanide, however, is cheap and would have the advantage over the simple cyanide of being relatively non-hygroscopic and non-poisonous.

A mixture of anhydrous sodium ferrocyanide and sodium benzene sulphonate was heated in the retort in the usual manner. No distillate appeared until the temperature within the retort reached 455 deg. At this temperature a small amount of oil came over, but on examination it was found to contain not more than a trace of benzonitrile. As this is about the tempera-

ture at which sodium benzene sulphonate begins to decompose,¹³ it is evident that sodium ferrocyanide is non-reactive at this temperature.

Because of this unforeseen result, the work of Witt¹⁴ was repeated. A mixture of 56 g. anhydrous potassium ferrocyanide and 144 g. sodium benzene sulphonate were heated to 430 deg. in the retort in the usual manner. The reaction took place as usual, but the yield of the benzonitrile was small (24.4 per cent based on sodium benzene sulphonate). The marked difference between sodium and potassium ferrocyanides in this reaction is interesting.

THE ADDITION OF OTHER SUBSTANCES TO THE CHARGE

In all these runs the mass was apparently never in actual fusion during the reaction, but only sintered at the temperatures attained. It was believed that if the mass could be made to assume the liquid state, better yields could be obtained.¹⁵ As has been shown, the use of easily fusible salts is not possible in this reaction. It seemed possible that the same results could be obtained by adding to the charge a third component which would lower the melting point of the mixture. Unfortunately there are few cheap salts of low melting point which will not react with one of the components of the charge. Sodium thiocyanate is satisfactory in this respect. However, the addition of sodium thiocyanate did not lower the reaction temperature and caused no appreciable change in the benzonitrile yield. The thiocyanate rendered the mass somewhat more fluid during the reaction, but on laboratory scale this was a disadvantage rather than an advantage, as the pasty mass resulting tended to clog the delivery tube of the retort. The addition of sodium hydroxide to the charge was found to cut down the benzonitrile yield appreciably, as might be expected.

Results from runs with a large excess of sulphonate indicated that good results might be expected from the addition of inert diluting material. As a diluent, common sand was selected on account of its cheapness and inertness. A discussion of the runs with added sand is postponed until the effect of temperature has been considered.

THE REACTION TEMPERATURE

A series of runs under varying temperature conditions was made, using a mixture of cyanide and sulphonate 1:3 by weight. This proportion was found to be a convenient one, giving good yields with a short reaction time. The results of these runs are summarized in Fig. 5.

It will be seen that the reaction time decreased rapidly as the temperature increased. It was found that no reaction took place below 410 deg. Below 420 deg. it took place too slowly for definite measurement. The yield of benzonitrile fell off as the temperature increased above 430 deg. Thus temperature control within a narrow range is necessary to get good yields. The variation in yield of sulphur compounds and tar is of no special significance.

Fig. 6 shows the logs of the above runs plotted in the form of curves. The inside temperature of the retort, the outside temperature and the rate of distilla-

¹²Norton, *loc. cit.*

¹³*Loc. cit.*

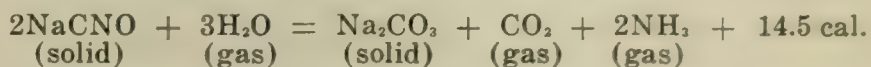
¹⁵*Cf.* also the work of Reid [*Am. Chem. J.*, vol. 43, p. 162 (1910)]. He investigated the formation of benzonitrile by the distillation of mixtures of benzoates and thiocyanates, and found that the use of easily fusible salts gave greatly increased yields.

¹²256 deg., Norton *J. Am. Chem. Soc.*, vol. 19, p. 835 (1897).

tion have been plotted against time for each run. Only the first part of the log of each run is shown.

These curves are typical of a strongly exothermic reaction. In each case the inside temperature rose steadily until a point in the neighborhood of 410 deg. was reached. Here the reaction took place more rapidly so the heat liberated could be conducted away. Consequently the inside temperature rose above that of the heating bath. At the same time the evolution of gas and fume (volatile ammonium salts), which up to that time had been negligible, took place with great rapidity. The rush of gases in the case of the run at 440 deg. was so vigorous that the stoppers were blown out of the collecting train, and because of the violence of the

20 deg. The actual heat of reaction at 420 deg. will, of course, differ slightly from this value. A rough calculation will show that this small heat effect is not sufficient to account for the marked temperature rise. The side reactions, therefore, must be responsible for a part of this unforeseen phenomenon. For example, the reaction:



is quite strongly exothermic. It has already been shown that this is probably one of the side reactions. The oxidation of sodium cyanide to the cyanate by sodium benzene sulphonate is, no doubt, also exothermic. Hence the heating effect observed is not due to the main reaction alone, but to undesired side reactions as well.

THE EFFECT OF ADDITION OF INERT MATERIAL

It is clear that the rise in temperature noted during the reaction is detrimental to the formation of benzonitrile, since, as has been shown, the yield falls off with increasing reaction temperature. The true significance of the effect of an inert diluent on the reaction now becomes apparent.⁷⁸ The dilution material can check the undesired temperature rise in two ways: By its heat capacity, and by improving the thermal conductivity of the mass, which normally is low.

A number of runs were made with added sand, using two different ratios of cyanide to sulphonate and varying proportions of sand. The results are given in Fig. 7. The addition of sand to the mixture at first caused an increase in the benzonitrile yield, as was predicted. The yield, however, attained a maximum with the addi-

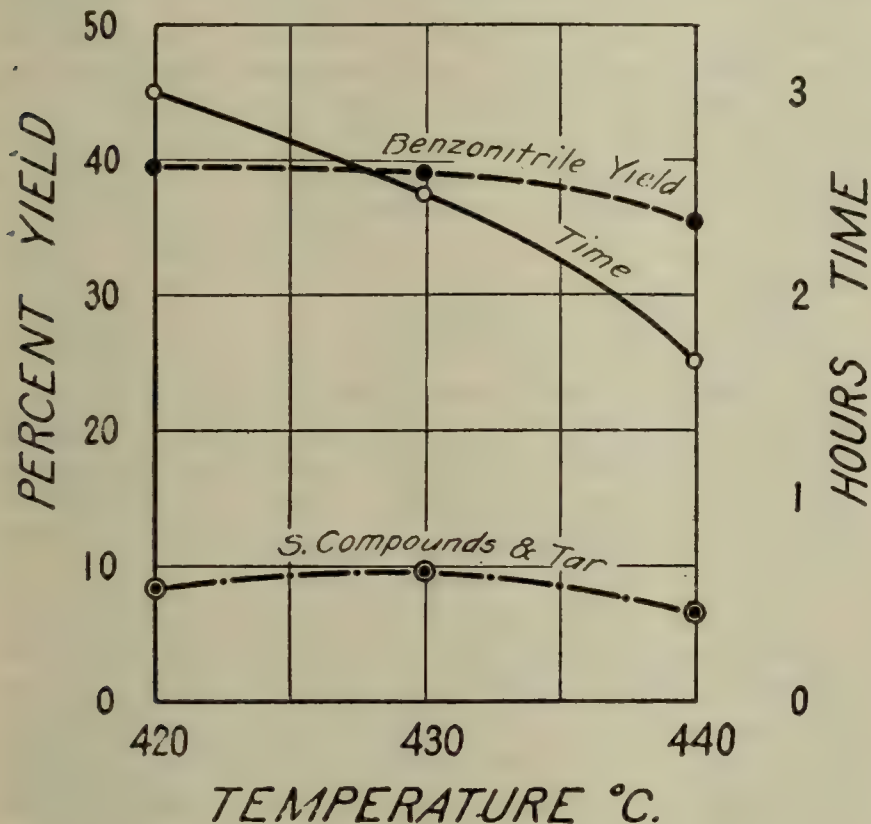
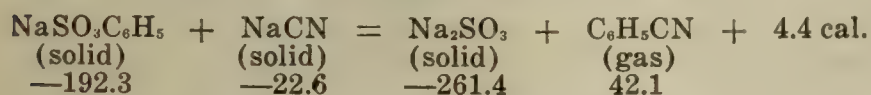


FIG. 5. EFFECT OF TEMPERATURE CHANGE.
RATIO NaCN : NaSO₃C₆H₅ :: 1 : 3

reaction it was not thought advisable to go above this temperature. Simultaneously the rate of distillation, especially in the run at 440 deg., increased greatly.

These temperature curves are exactly similar to those obtained, for instance, on heating an alloy showing a "reaction point." The temperature at which the exothermic effect occurred was practically constant at a value close to 410 deg., which was previously found to be the minimum for the reaction. The reaction temperature may, therefore, be definitely fixed at 410 to 415 deg.

The heat of the benzonitrile reaction may be calculated from the data in the literature.⁷⁶ Following the usual notation,⁷⁷ the reaction may be written:



The reaction, therefore, is exothermic to the extent of 4.4 large calories, based on thermochemical data for

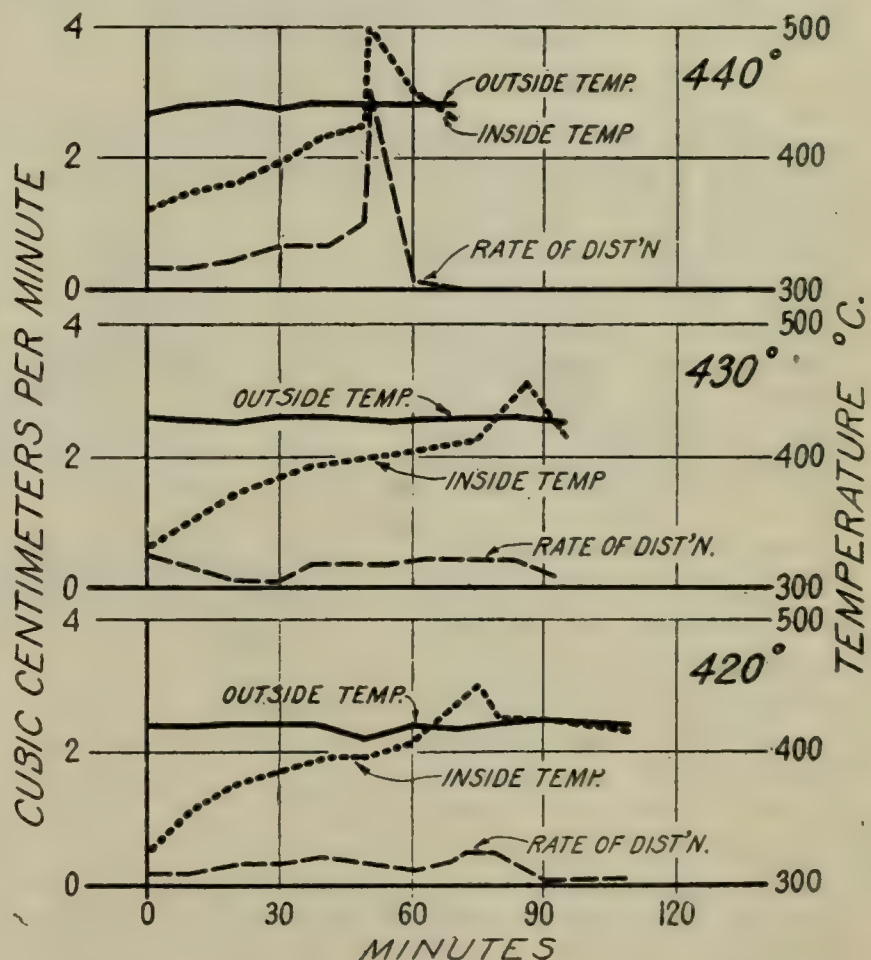


FIG. 6. EFFECT OF TEMPERATURE CHANGE

tion of about 70 per cent sand. These results indicate that the course of the reaction is influenced by several factors. In the first place, the sand dilutes the reaction mixture and lowers the undesired temperature rise, thereby increasing the yield. On the other hand, by dispersing the particles of the reacting materials, the

⁷⁶Molecular heats of formation at 20 deg.:
NaSO₃C₆H₅ +192.3 cal. Berthelot, *Ann. Chim. Phys.*, (5), vol. 9, p. 301 (1876); *Thermochimie* (1897), II, p. 418.
Na₂SO₃ +261.4 de Focrand, *Ann. Chim. Phys.* (6), vol. 3, p. 242 (1884); Berthelot, *Thermochimie*, II, p. 206.
NaCN +22.6 Berthelot, *Thermochimie*, II, p. 213; Landholt and Bornstein, *Tabellen*, 1912, p. 841.
C₆H₅CN -33.1 Berthelot and Pettersen, *Ann. Chim. Phys.* (6), vol. 18, p. 117 (1889).
Molecular heat of evaporation:
C₆H₅CN -9.0 cal. Kahlenberg, *J. Phys. Chem.*, vol. 5, p. 215 284 (1901); Landholt *op. cit.*, p. 841.

⁷⁷Morgan, "Elements of Physical Chemistry," 5th Edition (1914), p. 222.

⁷⁸U. S. Pat. 1,367,898.

sand renders contact between them less intimate and thus decreases the yield. The surface of the diluent probably has an influence as well; the benzonitrile vapor on coming in contact with the heated surfaces of the sand particles undergoes pyrogenic decomposition.

With proportions of sand up to 70 per cent the increase in yield due to dilution overbalances the

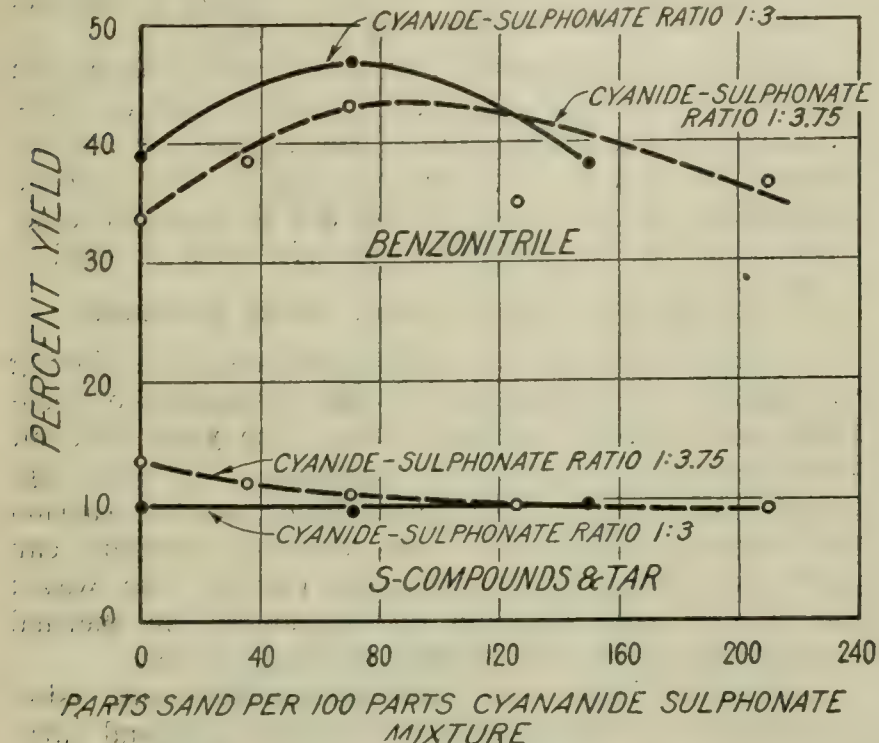


FIG. 7. EFFECT OF ADDITION OF SAND

unfavorable effects of the increase in surface and volume. Above this point, however, these unfavorable characteristics more than offset the beneficial influence of additional dilution, and the yield decreases.

EFFECT OF REDUCED PRESSURE

A run was made in which the pressure within the retort was maintained at 120 (± 5) mm. mercury, absolute pressure, by means of a suction pump. The reduction in pressure was found to make no change in the minimum temperature of the reaction. The results are given in Table III. A run at atmospheric pressure is included for comparison.

These results indicate that lowering the pressure favors the formation of sulphur compounds and tar at the expense of benzonitrile. As the formation of sulphur compounds is accompanied by the simultaneous liberation of large quantities of gaseous products, this result is in accord with Le Chatelier's theorem, the reaction taking place with the greatest increase in volume being favored by reducing the pressure. Hence the use of reduced pressure is undesirable.

In summing up the above results, it may be stated that the most favorable conditions for the benzonitrile reaction have been shown to be: Temperature 420 to 430 deg.; atmospheric pressure; cyanide and sulphonate in equimolecular proportions, or a slight excess of cyanide; the addition of a certain amount of inert material. For 40-mesh sand, the optimum quantity for

addition is 70, per cent, for other inert materials the amount to be added would probably differ.

THE USE OF LOW-GRADE COMMERCIAL CYANIDES

A number of processes which utilize atmospheric nitrogen in the manufacture of alkali cyanides have been developed. At least two of them are now being operated on a commercial scale. Since these processes are possible sources of cheap cyanide, it was thought advisable to determine the applicability of such material to the benzonitrile reaction.

Cyanide prepared from calcium cyanamide by heating with salt and carbon is being manufactured in large quantities and has proved a satisfactory substitute for the purer material for many purposes. Such "sodium cyanide" is relatively impure, containing 25 to 60 per cent NaCN equivalent, the remainder consisting of other sodium salts, calcium salts, carbon, etc.

TABLE III. EFFECT OF PRESSURE

Ratio NaCN : $\text{NaSO}_3\text{C}_6\text{H}_5$: : 1 : 3.00 by weight; temperature 430 deg.		
	Absolute Pressure	mm. Mercury
	760	120
Benzonitrile.....	39.0%	37.5%
S compounds and tar.....	9.7%	14.6%
Yield based on sodium benzene sulphonate		

A sample of this cyanide was obtained which was stated by the makers to have approximately the following composition: NaCN 30 per cent, NaCl 4 per cent, CaCl_2 35 per cent, CaO 13 per cent, remainder carbon and undetermined. The material was in the form of gray, flaky fragments.

A mixture of this material and sodium benzene sulphonate, in the ratio NaCN: $\text{NaSO}_3\text{C}_6\text{H}_5$ of 1:3, was distilled in the usual manner. A yield of only 11.7 per cent benzonitrile (based on $\text{NaSO}_3\text{C}_6\text{H}_5$) was obtained. Apparently the cyanide in this material is in a form not readily available for the reaction, or perhaps the impurities present, especially the large amount of free

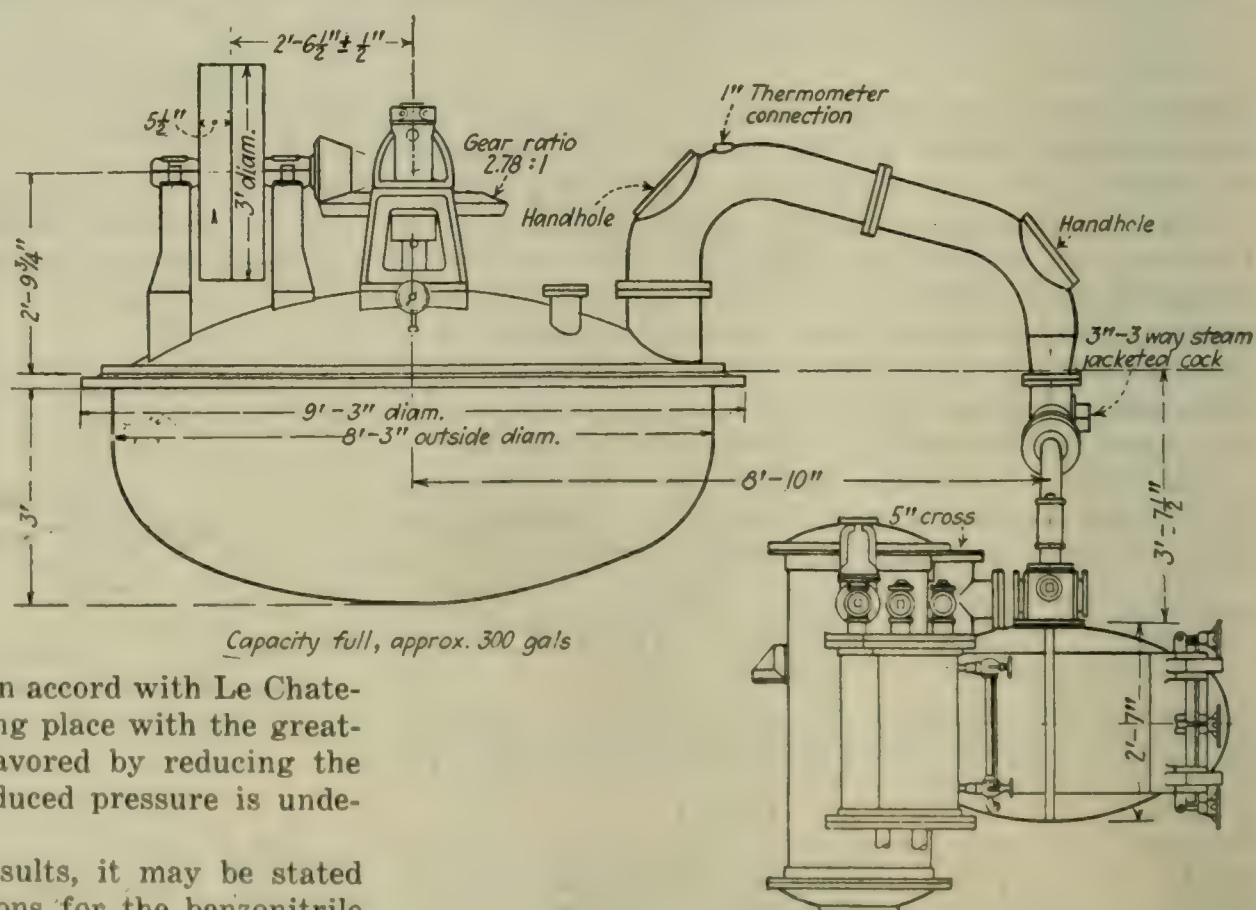


FIG. 8. STILL IN USE IN LARGE-SCALE EXPERIMENTS

lime, affect the yield unfavorably. As already stated, the addition of a small amount of sodium hydroxide

¹⁰Landis, Trans., Am. Electrochem. Soc., vol. 37, p. 87 (1920).

caused a large decrease in yield. Calcium oxide might well have the same effect. According to Landis, the cyanide is present as the calcium salt rather than as sodium cyanide.

EXPERIMENTS ON A COMMERCIAL SCALE

During the course of this work the apparatus shown in Fig. 8 became available for large-scale experiments. It consisted essentially of a beta-naphthol still of the usual type (capacity about 300 gal.) modified by the addition of a stirrer with two scraper arms set close to the bottom of the still. The still was set in brickwork and heated by a coke fire. A pyrometer was fixed in the hollow shaft of the stirrer. Reduced pressure could be maintained if desired. Although this equipment was clearly not well adapted to carrying out the reaction, it was thought that some information might be obtained by its use.

Commercial 96 to 98 per cent sodium cyanide and high-grade sodium benzene sulphonate specially dried were used. No machinery was available for grinding and mixing the components of the charge, so it was necessary to use the coarse materials and trust to the mixing action of the stirrer in the still.

In one run a mixture of several hundred pounds of cyanide and sulphonate in equimolecular proportions were charged into the still and the temperature raised. Temperature control was difficult, and the indications of the pyrometer were of little value. When the reaction began it was propagated through the mass with great violence. The gases evolved were not able to escape through the offtake pipe and receiver fast enough, and the pressure within the still rose, finally blowing out the packing between the cover and the body of the still and allowing large quantities of gases to escape. The distillate which collected in the receiver consisted mainly of sulphur compounds, as might be expected from the high reaction temperature.

In other runs attempts were made to feed the reaction mixture into the hot still in small quantities. Runs were also made in which one of the components was placed in the still and the other added gradually. These experiments were unsuccessful, partly because of mechanical difficulties, and partly, no doubt, because intimate mixing could not be secured. This work was carried out before the favorable effect of dilution had been demonstrated in the laboratory. No large-scale experiments using diluents were made.

This work showed conclusively that apparatus of the type used is absolutely unadapted to carrying out the reaction on a large scale. For successful operation, intimate mixing, accurate temperature control and means for dissipating the heat of the reaction are necessary.

HYDROLYSIS OF BENZONITRILE

Many workers have investigated the hydrolysis of nitriles in the past. Both acid and alkaline solutions have been employed. Although physicochemical studies⁸⁰ of the reaction velocities indicate that, in the cold, hydrolysis by dilute alkalis is more rapid than by dilute acids, it has generally been found that warm moderately concentrated acids give more rapid and more complete hydrolysis than aqueous alkaline solutions.⁸¹

From a commercial standpoint the use of acid seems

the more advantageous. If, for instance, sulphuric acid is used, the products of the reaction are free benzoic acid, and ammonium sulphate, which remains in solution. The benzoic acid may be recovered by steam distillate, while the acid ammonium sulphate solution may be circulated through a scrubber to absorb the ammonia in the gases from the benzonitrile still, after which the ammonium sulphate content may readily be recovered. If caustic soda solution is used as the hydrolytic agent, an absorption system must be employed to recover the ammonia evolved. Moreover, the resulting sodium benzoate solution contains an excess of alkali and other impurities, which prevent its direct evaporation for the production of sodium benzoate. Hence it must be acidified to precipitate out benzoic acid, thereby necessitating a considerable expenditure of acid and alkali.

EXPERIMENTAL WORK ON HYDROLYSIS

It was found that benzonitrile could be hydrolyzed smoothly and rapidly by heating with 2.5 to 4 times its volume of sulphuric acid, sp.gr. 1.60 to 1.66 (54 to 59 deg. Bé.; 68 to 74 per cent H_2SO_4). In fact, the reaction when once started proceeded spontaneously from its own heat. It was necessary to add the benzonitrile to the hot acid gradually when large amounts were hydrolyzed.

In order to determine the efficiency of this method of hydrolysis, a weighed sample (2 g.) of re-distilled benzonitrile (b.p. 190 to 191 deg.) was heated with 20 c.c. sulphuric acid (sp.gr. 1.6) in a flask with reflux condenser for thirty minutes. The flask was cooled, contents diluted, and extracted with four 10 c.c. portions of ether. The ether extract was washed with several small portions of water to remove traces of sulphuric acid, transferred to a tared flask, the ether distilled off, and the residue weighed. A weighed portion of the residue was then titrated with fifth-normal sodium hydroxide previously standardized against Bureau of Standards benzoic acid.⁸² A yield of 95.2 per cent of theory was obtained. It is probable that the actual conversion of benzonitrile into benzoic acid was nearly quantitative, and that the deficiency of 4.8 per cent was due mainly to losses inherent in the method of analysis, loss by incomplete extraction, by washing the ethereal solution with water and by volatilization of benzoic acid on distilling off the ether.

A sample of the crude benzonitrile as obtained by steam distillation was next analyzed in the same manner. A benzoic acid yield equivalent to 90.4 per cent of theory was obtained. Assuming again a loss of 4.8 per cent in analysis, the crude benzonitrile contained 94.7 per cent C_6H_5CN , a figure which confirms the results of fractional distillation.

These results indicate that hydrolysis by sulphuric acid is a rapid and efficient method of converting benzonitrile into benzoic acid. On a large scale the losses ought to be small, and a conversion efficiency of around 95 per cent ought to be readily obtainable.

A larger quantity of crude benzonitrile was next hydrolyzed in order to determine the purity of the resulting acid. The benzonitrile was allowed to flow drop by drop into 2.5 times its volume of hot sulphuric acid, sp.gr. 1.6 (54 deg. Bé.), contained in a flask provided with a reflux condenser and a stirrer. Flask and contents were maintained at 125 to 140 deg. during

⁸⁰Von Peskoff and Meyer, *Zeit. phys. Chem.*, vol. 82, p. 129 (1913).

⁸¹For a summary of methods of hydrolysis see Sudborough, *J. Chem. Soc.*, vol. 67, p. 601 (1895).

⁸²Morey, *Bull. Bur. Standards*, vol. 8, p. 643 (1913).

the addition of the nitrile and for thirty minutes thereafter. The contents were then subjected to steam distillation, and the beautifully crystalline benzoic acid filtered out of the cooled distillate.

A sample of this acid dried over concentrated sulphuric acid had a slight odor, a faint yellowish tinge, m.p. 121 deg. Its C_6H_5COOH content by titration was 99.67 per cent. A 2-g. sample was burned in a calorimeter bomb in the usual manner. The bomb washings showed only a faint opalescence with barium chloride, indicating that the acid was practically sulphur free. It was, of course, free from chlorine. By subliming this acid, or by dissolving it in alkali, re-precipitating and re-crystallizing from water, pure white samples, practically odorless, were prepared.

DISCUSSION OF RESULTS

Some estimate can now be made of the commercial possibilities of the proposed process. The table gives the cost of the principal raw materials per hundred pounds of benzoic acid for the commonly used benzyl chloride-bleach process and for the nitrile process. Comparison is made with the bleach process because this is the one at present in most common use. The prices of all materials except sodium benzene sulphonate are those current May 1, 1920. Sodium benzene sulphonate is not ordinarily quoted in the market reports, but sales are known to have been made at this date at the figure given. Present prices for delivery on contracts would be lower for every item.

RAW MATERIAL COST PER 100 LB. BENZOIC ACID	
Benzyl chloride-bleach process:	
143 lb. toluene at 4c.....	\$5.72
143 lb. chlorine at 6c.....	8.58
149 lb. bleaching powder at 4c.....	45.60
Cost per 100 lb. benzoic acid.....	\$59.90
Proposed nitrile process:	
330 lb. sodium benzene sulphonate at 7c.....	26.60
104 lb. sodium cyanide (96-98%) at 24c.....	24.96
Cost per 100 lb. benzoic acid.....	\$51.56

The quantities assumed for the benzyl chloride-bleach process are those actually employed in large-scale manufacture. Calculations for the nitrile process are based on a nitrile formation efficiency of 43 per cent and 90 per cent efficiency on hydrolysis. The cost of the acid required for hydrolysis has not been included, and no credit has been allowed for the ammonium sulphate formed as a byproduct. Assuming 70 per cent recovery of the nitrogen content of the cyanide used, a conservative figure, about 1 lb. of ammonium sulphate would be recovered for every pound of benzoic acid produced. At the present quoted price of ammonium sulphate this would far more than pay for the acid required.

These figures, of course, do not take into consideration manufacturing costs. In the case of the nitrile process no data are available on which to base an estimate. There is no reason to believe, however, that manufacturing costs of the two processes would differ greatly.

The nitrile process might perhaps labor under a certain handicap because of the highly poisonous nature of the cyanide used. Accidents in the other industries employing cyanide are infrequent, and with proper precautions accidents ought not be feared. A distinct advantage of the process would be the purity of the product, as benzoic acid free from chlorine commands a premium of 10c. a pound over the ordinary acid.

It is, however, in connection with the future of the cyanide industry that the proposed process appears most interesting. The problem of cheap cyanide has been attacked with great vigor in recent years, and with striking success. The price of sodium cyanide has been declining steadily for some time, and increases in production and improvements in methods of manufacture will probably cause a further drop. As production has increased, new uses for cyanide have been sought. Its use in the manufacture of organic chemicals has been proposed, but up to the present no appreciable amount has been employed in this branch of the industry. The proposed process, however, might well offer a profitable means of utilizing some of the surplus cheap cyanide produced by improved methods.

SUMMARY

A process for the manufacture of benzoic acid from benzene has been outlined and studied in detail. The mechanism of the reaction and the nature and extent of the side reactions have been investigated. The effect of variations has been studied and the optimum conditions for the reaction have been established.

The results of the experimental work indicate that, with a source of cheap cyanide, the process proposed would produce benzoic acid of a higher degree of purity than the bulk of the acid on the market today at a cost below that of the present methods of manufacture.

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Record Production of Borax in 1920

The quantity of borax produced and sold in the United States in 1920 was 35,280 short tons, valued at \$5,674,000, according to R. C. Wells, of the United States Geological Survey. This is a record production and value, exceeding even those of 1919—28,518 tons and \$4,351,891—which were higher than those of any previous year.

For many years borax has been manufactured in the United States from the mineral colemanite, a calcium borate, which is mined in California, but for the last two years some borax has also been obtained from the water of Searles Lake, California, as it is one of the salts that the brine yields by a certain method of treatment. This method of treatment marks a new departure in the borax industry and recalls the old days in the '60s when borax was made by recrystallizing the crude salt found in the mud of Borax Lake.

The total quantity of crude borates produced in the United States in 1920 amounted to 120,320 tons, valued at \$2,173,000. This is a record in quantity, though not in value, on account of the lower grade of the ores.

Borax is used in large quantities in making the enameled coating for cast-iron and steel ware used in plumbing fixtures, chemical equipment and kitchen utensils. It is also a constituent of borosilicate glasses, such as are employed in making lamp chimneys, baking dishes and laboratory glassware. Considerable borax is also used in the laundry and kitchen, in making soap and starch, in paper sizing, and in tanning and welding.

In the United States a considerable quantity of boric acid is made from borax as well as from colemanite. Boric acid is an antiseptic and is also used in cosmetics. It is also employed to preserve meats under conditions permitted by the food and drugs act.

Microstructure of Chromium Steels

Brief Review of the Literature, Especially From the Japanese Investigator Murakami, Presenting a Structural Diagram, Micrographs and an Explanation of the Changes in Transformation Temperature Following Various Reheatings

IN AN early investigation of the effect of chromium in steels Osmond¹ concluded that this element might exist in a state of solid solution in iron, as a compound of chromium, iron and carbon, or as a solid solution of the compound in iron. From his microscopic examination of two series of chromium steels Guillet² reported three types of structure—i. e., pearlitic, martensitic or troostitic, and double carbide, these differences being known to depend upon the thermal treatment. Double carbides of chromium and carbon have been reported by other investigators, though no formulæ have been agreed upon. By heating metallic chromium and carbon in an electric furnace Moissan³ obtained two carbides, Cr_3C_2 and Cr_4C .

Likewise Williams⁴ obtained a double carbide, $3\text{Fe}_3\text{C} \cdot 2\text{Cr}_3\text{C}_2$ by using a mixture of chromium oxide, iron and petroleum coke. Carnot and Goutal⁵ obtained chemically the residues $\text{Fe}_3\text{C} \cdot 3\text{Cr}_3\text{C}_2$ from a ferrochromium and $3\text{Fe}_3\text{C} \cdot \text{Cr}_3\text{C}$ from two chromium steels. Arnold and Read⁶ also carried out an extensive investigation of iron:carbon:chromium alloys and by analyzing the residues obtained by electrolysis (experimenting upon well-annealed samples containing 0.64 to 0.85 per cent carbon and 0.65 to about 24 per cent chromium) concluded that in steels containing less than 10 per cent chromium this element exists as carbides Cr_3C_2 or Cr_4C and forms an isomorphous mixture with cementite and that in steels containing 15 to about 24 per cent a double carbide $2\text{Fe}_3\text{C} \cdot 3\text{Cr}_3\text{C}$ exists. In respect to this latter conclusion, however, their experimental methods have been questioned and severely criticised.

The self-hardening property of certain chromium steels—as evidenced by the lowering of the Ar_1 transformation with increase in initial temperature—has also long been recognized. Osmond¹ noticed this effect and also reported the tendency of a high percentage of chromium to raise Ar_1 . Carpenter, however, who likewise observed this latter effect, concluded that chromium cannot be regarded as an element which imparts a self-hardening property to steels, because by raising the temperature of occurrence of Ar_1 it hastens the carbide transformation. On the other hand, Edwards and Kikawa⁷ in studying high-speed tool steels more recently demonstrated that within certain limits of composition chromium has an even greater self-hardening effect than tungsten, and further that the cooling rate plays an important part in producing this property. Using steel containing 0.63 per cent carbon and 6.1 per cent chromium, the critical cooling velocity which produces self-hardening was determined. Its variation with initial temperature was observed, being lower as this temperature is higher. These authors also proposed a

theory concerning the dissociation of the carbide, considered to be Cr_3C_2 . According to their view, the carbide first goes into solution as $(\text{Cr}_3\text{C}_2)_2$ at the Ac_1 point and then gradually dissociates into Cr_3C_2 as the temperature

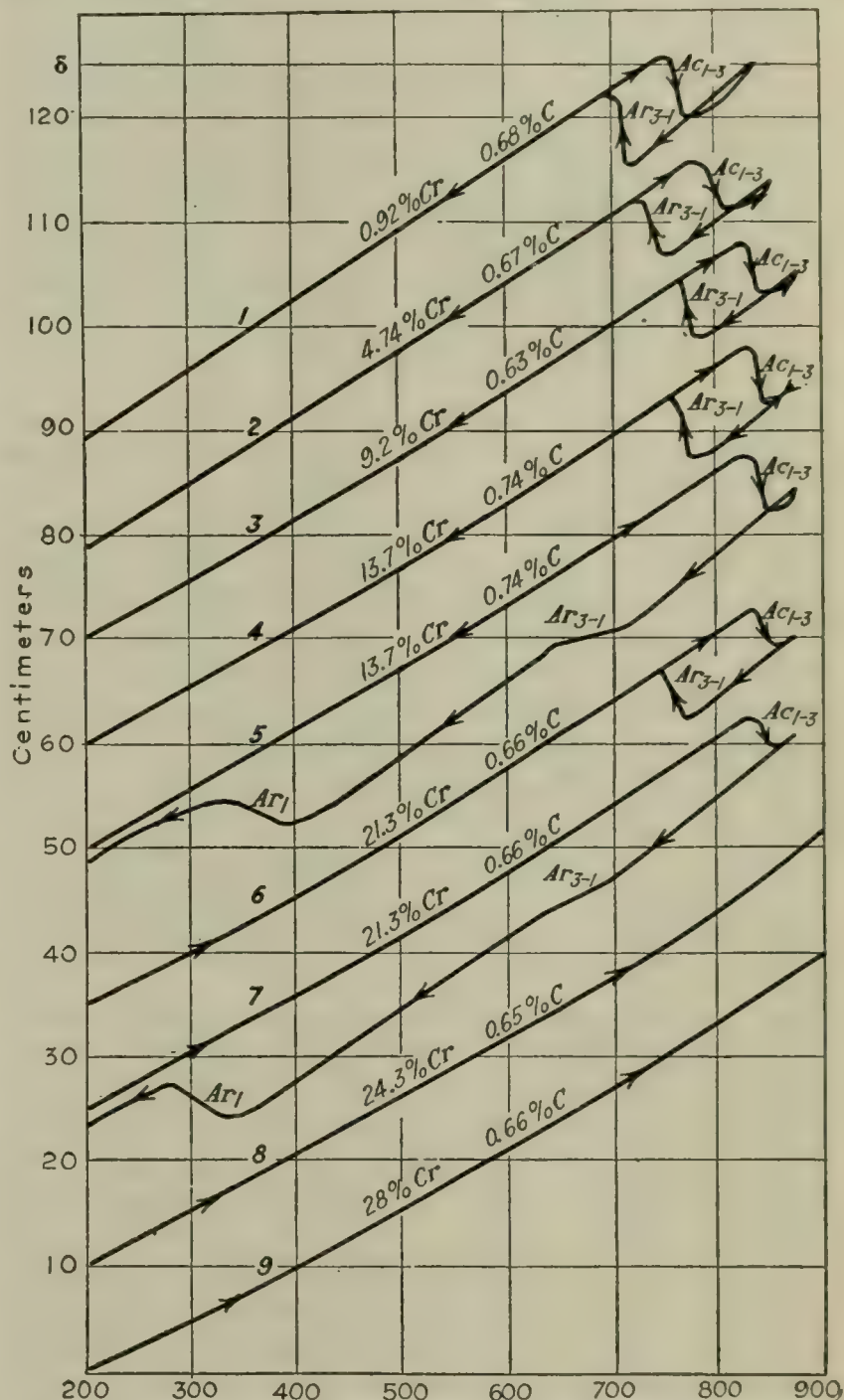


FIG. 1. THERMAL EXPANSION AND CONTRACTION CURVES OF SOME CHROMIUM STEELS

is raised, the carbide point being more readily lowered by this increase of the number of molecules in solution.

A Japanese paper comparing previous investigations and based on a study of the constitution of chromium steels⁸ containing less than 4 per cent carbon and 0.5 to about 90 per cent chromium was published in April, 1918, by Murakami. The effects of carbon and chromium and various thermal treatments on the A_1 transformation were studied by magnetic analysis, using a magnetometer and torsion balance described briefly in

¹J. Iron & Steel Inst., 1892, No. 2, p. 115.

²Rev. Met., 1904, p. 155.

³Elect. Furnace, 1904, p. 144.

⁴Compt. rend., vol. 127 (1898), p. 410.

⁵Compt. rend., vol. 126 (1898), p. 1,243.

⁶J. Iron & Steel Inst., 1911, No. 1, p. 249.

⁷J. Iron & Steel Inst., 1915, No. 2, p. 6.

⁸"On the Structure of Iron-Carbon-Chromium Alloys," T. Murakami, Sci. Reports, Tohoku University, vol. 7, No. 3, p. 217.

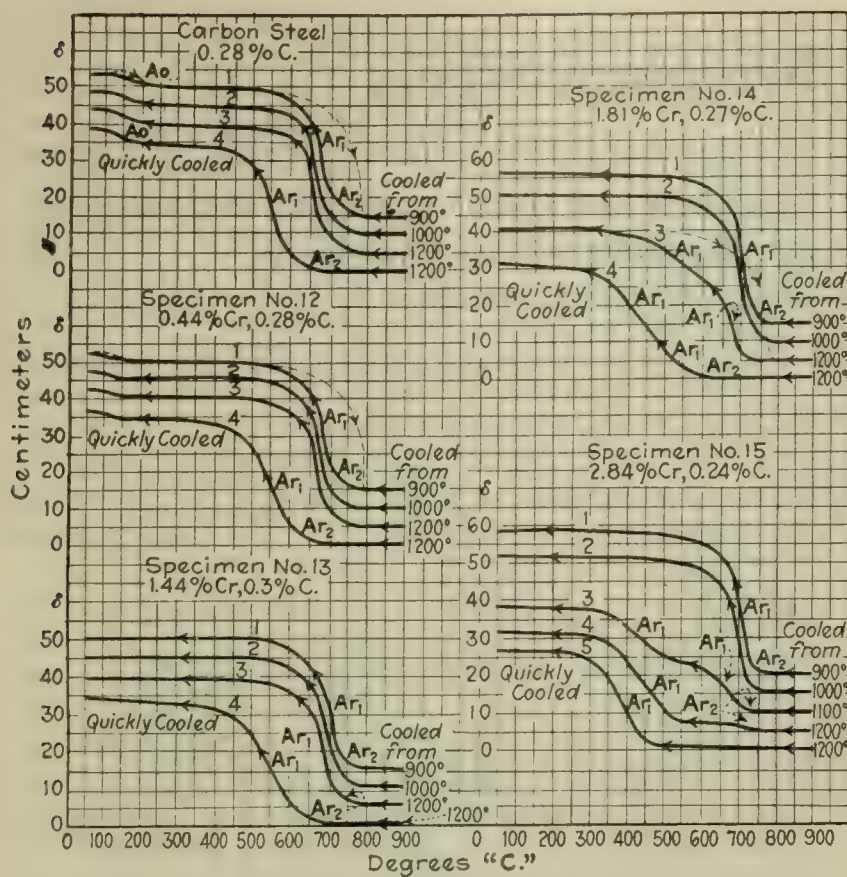


FIG. 2. MAGNETIZATION-TEMPERATURE CURVES OF SOME CHROMIUM STEELS

CHEMICAL & METALLURGICAL ENGINEERING, vol. 24, p. 573, March 30, 1921. The latter apparatus was used for alloys worked with difficulty or not at all. Thermal-expansion measurements, as illustrated in Fig. 1, were used to study more closely effects of such variables on the A_1, A_2, A_3 transformations, while these tests were supplemented by and correlated with thermal analysis and microscopic examination. Typical magnetization-temperature curves are shown in Fig. 2.

The results of this investigation may be summarized as follows:

MAGNETIC ANALYSIS

1. Magnetic analysis shows that in steels containing relatively high carbon and low chromium the A_1 transformation occurs at about 700 deg. C. Increase in chromium content raises its position, a result which agrees with the work reported by earlier investigators. Similarly in low-chromium steels the magnetic transformation of cementite A_0 and that of the double carbide occurring at 150 deg. C. are found, the former disappearing before the latter as the proportion of chromium increases.

2. Certain chromium steels containing a relatively high proportion of chromium to carbon are self-hardening. The amount of lowering of the transformations increases with maximum temperature, increase of carbon or of chromium, the other element remaining constant. In steels of high chromium and low carbon the A_2 transformation is the only one found, decreasing as chromium increases.

3. The rate of cooling has a marked effect on the transformations. In steels for which the lowering does not take place by normal cooling it may be obtained by faster rates, and the transformation which is lowered by normal cooling is further suppressed by rapid cooling. Sufficiently slow cooling, however, throughout a range about 700 deg. C. will allow it to take place completely.

CONSTITUTION

After annealing at about 900 deg. C., and slowly cooling through the range about 700 deg. C., the iron:

carbon:chromium alloys may be divided into five classes having characteristics as noted. Parentheses indicate constituents present in a free state.

I. Alloys having three transformations at about 700, 210 and 150 deg. C. consist of $(Fe) + (Fe_3C)$ and (α) double carbide.

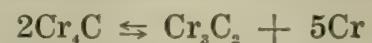
II. Alloys having two transformations at about 700 and 150 deg. C. consist of $(Fe) + (\alpha)$ and (β) double carbides.

III. Alloys having a single transformation at about 700 deg. C. consist of $(Fe) + (\beta)$ and (γ) double carbides.

IV. Alloys having the lowered A_1 transformation. Present in both regions IV and V of Fig. 3, region IV representing alloys consisting of $(Fe) + (\gamma + Cr_4C)$.

V. Alloys having only the A_2 transformation. Consist of $(Fe + Cr) + (Cr_4C + Cr)$. These steels show lowering on normal slow cooling provided the proportion of chromium to carbon is relatively low. They are martensitic. Very slow cooling through the range about 700 deg. C., however, sets the dissolved carbide free.

Murakami points out the fact that the only two regions where lowering occurs on normal cooling (IV and V) are those containing the carbide Cr_4C and concludes therefore that the lowering is related to this constituent and further proposes the following hypothesis: When alloys containing Cr_4C are heated to above the A_1 transformation the carbide changes thus:



The higher the temperature the further the reaction proceeds from left to right. During cooling Cr_3C_2 and chromium only slowly associate and by the retarding action of the latter the carbide change is lowered even in normal cooling.

Lowering of the transformations also occurs on rapid cooling from 1,200 deg. C. in alloys of region III, Fig.

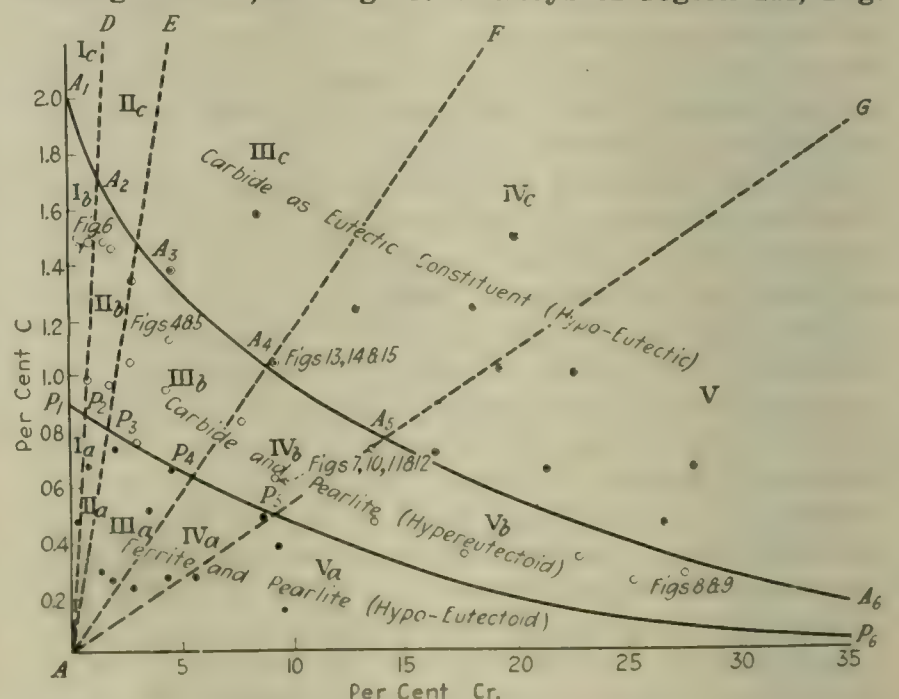


FIG. 3. CONSTITUTIONAL AND STRUCTURAL DIAGRAM FOR IRON: CARBON: CHROMIUM ALLOYS

3, which is similarly explained by previous dissociation of the double carbide, producing Cr_4C . The formulæ proposed for the α , β , and γ double carbides and dissociation of the last two are given below:

α double carbide $(Fe_3C)_{18}Cr_4C$ (6.01 per cent Cr, 87.40 per cent Fe, 6.59 per cent C).

β double carbide $(Fe_3C)_9Cr_4C$ (11.30 per cent Cr, 82.18 per cent Fe, 6.52 per cent C).

Dissociation $2(Fe_3C)_9Cr_4C = (Fe_3C)_{18}Cr_4C + Cr_4C$.

γ double carbide $\text{Fe}_3\text{C} \cdot \text{Cr}_7\text{C}_3$ (52 per cent Cr, 42 per cent Fe, 6 per cent C).

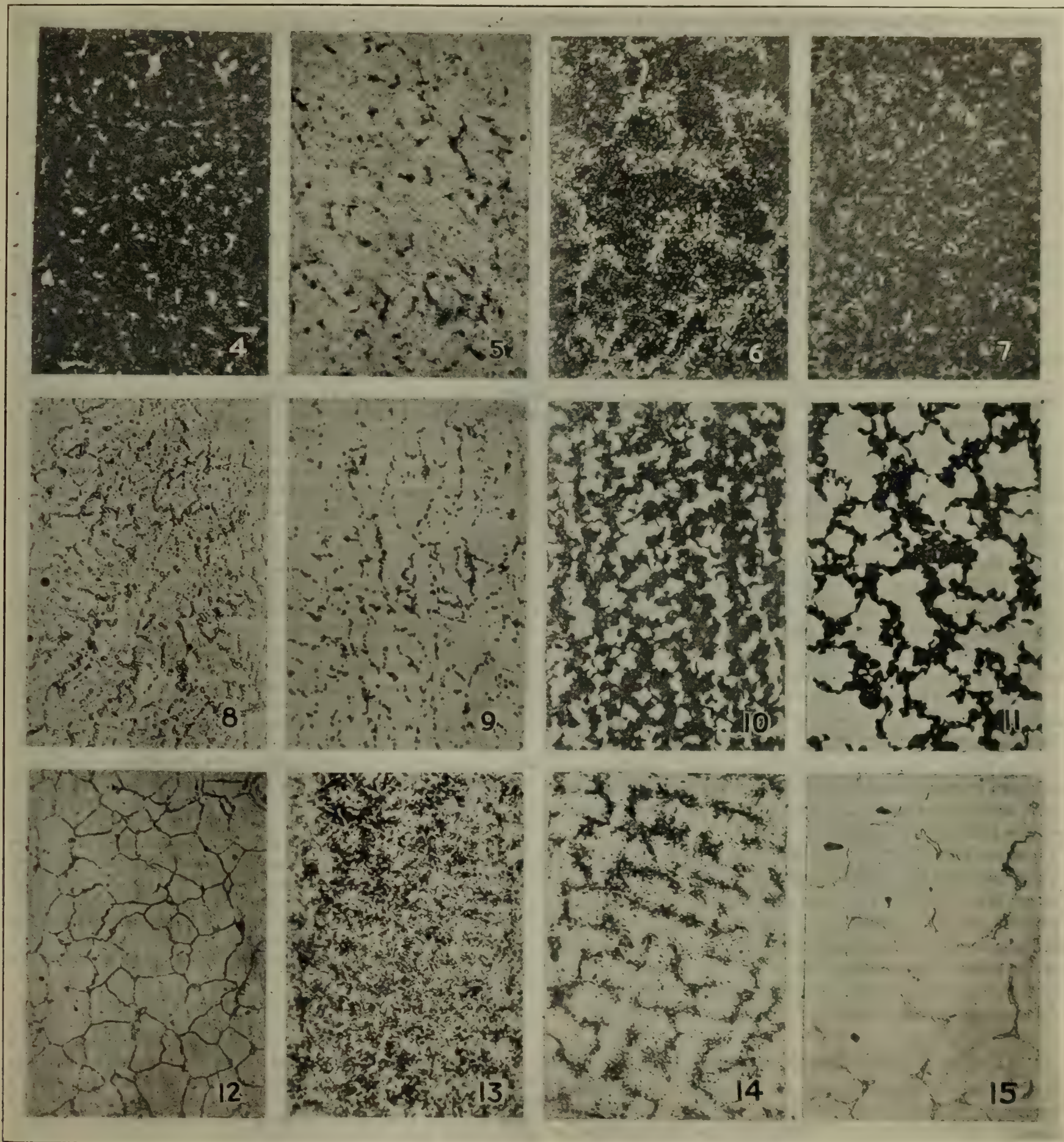
Dissociation $9\text{Fe}_3\text{C} \cdot \text{Cr}_7\text{C}_3 = (\text{Fe}_3\text{C})_9 \cdot \text{Cr}_7\text{C}_3 + 8\text{Cr}_7\text{C}_3$.

On normal cooling these products of dissociation recombine, but in rapid cooling the components have not sufficient time to associate and lowering is produced.

Thus the self-hardening of a chromium steel is related to the lowering or complete suppression of the Ar_1

transformation, the hardness being caused by the solid solution of Cr_7C_3 in iron which has already dissolved chromium. Steels having the normal transformation point show troostitic or pearlitic structures, while those having the lowered transformation are martensitic. Where this transformation is completely suppressed the steels are austenitic.

Fig. 3 shows the locations where normal structures of



FIGS. 4 TO 15. MICROGRAPHS OF SOME CHROMIUM STEELS. $\times 120$. ALL ETCHED WITH ALCOHOLIC PICRIC OR NITRIC ACID EXCEPT AS NOTED

Fig.	Analysis	Heat Treatment
4.....	4.63 Cr, 1.13 C.....	Slowly cooled from 900°
†5.....	4.63 Cr, 1.13 C.....	Slowly cooled from 900°
6.....	1.12 Cr, 1.49 C.....	Slowly cooled from 900°
7.....	9.2 Cr, 0.63 C.....	Slowly cooled from 900°
8.....	27.5 Cr, 0.28 C.....	Slowly cooled from 900°
†9.....	27.5 Cr, 0.28 C.....	Slowly cooled from 900°

†Etched with $\text{K}_3\text{Fe}(\text{CN})_6$.

Fig.	Analysis	Heat Treatment
10.....	9.2 Cr, 0.63 C.....	Cooled from 1000°
11.....	9.2 Cr, 0.63 C.....	Cooled from 1100°
12.....	9.2 Cr, 0.63 C.....	Cooled from 1200°
13.....	9.33 Cr, 1.09 C.....	Slowly cooled from 900°
14.....	9.33 Cr, 1.09 C.....	Quickly cooled from 900°
15.....	9.33 Cr, 1.09 C.....	Quickly cooled from 1200°

the forgeable alloys may be expected. Steels showing ferrite and pearlite are represented by a dot, those having the carbide primarily separated from austenite and pearlite by a circle and those having the carbide separated from the melt as a eutectic constituent by a dot inside a circle. Typical micrographs are shown in Figs. 4 to 15, inclusive.

Except as otherwise specified, alcoholic solutions of picric or nitric acids were used for etching alloys low in chromium, and an aqueous solution of hydrochloric acid for high-chromium steels. The double carbides of chromium and iron, except the α carbide, are not colored by sodium picrate solution, either hot or cold. An etching reagent consisting of 10 g. of potassium ferricyanide and 10 g. of potassium hydroxide dissolved in 100 c.c. water colors the γ double carbide brown in ten to twenty seconds, and turns it blue to yellow on longer immersion. The β double carbide is hardly colored by this reagent at room temperature, but is readily colored brown to blue when the solution is boiling. The α double carbide and cementite are colored brown in the boiling solution, but the color is less intense than that obtained by use of sodium picrate. The carbide Cr_7C_3 is hardly attacked by either hot or cold solution while the solid solution of iron and chromium is colored brown to blue.

Figs. 4 and 5 show typical structure of region III_b of Fig. 3, containing a quantity of γ double carbide which is not colored by the cold ferricyanide solution, acids or boiling sodium picrate. Cementite and α double carbide are shown in Fig. 6, it being possible to color the globules by boiling sodium picrate but not by the cold ferricyanide reagent.

γ double carbide dissolving some Cr_7C_3 is shown in Fig. 7, while in Fig. 8 is shown a ground mass of the solid solution of iron and chromium and a chain of fine globules of a solid solution of Cr_7C_3 in chromium. The coloration obtained in cold ferricyanide is shown in Fig. 9. This latter alloy belongs in region V_b of Fig. 3.

Figures 10, 11 and 12 show the effect of maximum temperature on the structure of the steel represented in normal condition in Fig. 7. White patches in Fig. 14 are martensite; dark are troostite. With increase in maximum temperature the patches of martensite become larger, as shown in Fig. 11, and in Fig. 12 the structure becomes entirely martensitic.

Figures 13, 14 and 15 show the effect of rate of cooling on the structure of a steel containing 1.09 per cent carbon and 9.33 per cent chromium. Slow cooling from 900 deg. C. results in pearlite (Fig. 13), while rapid cooling gives martensite, as shown in Fig. 14. On slow cooling from 1,200 deg. C. this steel shows martensite and troostite, while on rapid cooling from the same temperature austenite is retained (Fig. 15).

Hydro-Electric Development in Italy

Hydro-electric development in Italy has made rapid progress during the last few years. It is estimated that whereas in 1915 Italy's electric power resources amounted to 2,500,000,000 kw.-hr. per annum, this figure had been increased to 3,700,000,000 before the end of the war, and now approximates 4,000,000,000. Whereas in 1915 the capital of Italian electric companies was less than 600,000,000 lire, it now reaches about 1,500,000,000 lire. During the five years from 1915 to 1920 there were completed new hydro-electric plants yielding 265,000 hp., and plants now under construction will yield 400,000 hp. additional.

Synopsis of Recent Chemical & Metallurgical Literature

Present Status of the Synthesis of Ammonia by the Hyper-Pressure Method.—At the Feb. 21, 1921, meeting of the French Academy of Sciences, Georges Claude presented a note on the present status of the synthesis of ammonia by the hyper-pressure method. The first practical demonstration of the process before a number of members of the Academy took place Jan. 9, 1920, when the mixture $\text{N}_2 + 3\text{H}_2$ was first compressed to 100 atm. by an ordinary compressor of 60 cu.m. per hour capacity and then compressed by two hyper-compressors in series to 300 and 1,000 atm. The hyper-compressed mixture after it had been purified was passed through a catalyzer tube giving from 6 to 7 liters of liquid ammonia per hour. All the apparatus had to be placed in wells and the manipulations were difficult.

The second demonstration took place Nov. 20, 1920. At this time there were four catalyzing tubes instead of one. The tubes were arranged two in parallel and the other two in series and sufficient for the combination of 80 per cent of the gases treated. The tubes were placed in separate compartments located in a building on the ground. The same hyper-compressors were used as during the first demonstration, but were operated to produce 150 cu.m. per hour instead of 60. All the installation proved to be perfectly gas tight, as there was no trace of ammonia odor in the building. The production was 60 to 70 liters of liquid ammonia per hour—i.e., about 1.25 tons per day. This installation is still running for experimental purposes only. The hydrogen used is produced by an electrolytic cell and this makes its cost very high. Extensive research work is now going on to obtain cheaper hydrogen.

At the present time a great step in the process has already been realized—namely, the production by a single hyper-compressor of the two stages 100 to 300 atm. and 300 to 900 atm., which is the final pressure used. This hyper-compressor has been made by M. Le Rouge and compresses 700 cu.m. of the mixture per hour, a quantity sufficient to give 5 tons of anhydrous ammonia per day, equivalent to 25 tons of ammonium sulphate per day. The energy consumed for the compression of 710 cu.m. from 1 to 100 atm. was 187 hp. and for the compression from 100 to 900 atm. 122 hp.—i.e., about $\frac{1}{2}$ hp.-hr. is required to compress 1 cu.m. of the mixture to 900 atm. The tightness of the installation is such that under the hardest conditions of starting and stopping of the operations the loss of gas mixture was less than 0.5 per cent. One of the four catalyzing tubes of a capacity of 5 tons NH_3 per day was tested at the same time and found to work successfully.

Since former tests showed that it is easy to have all four tubes working simultaneously, the application of the process to large industrial units seems certain to prove successful, provided an adequate cheap source of hydrogen can be found.

Use of Belting in Fertilizer Plants.—The severe service to which belts are subjected in fertilizer factories makes their selection and care a matter of more importance than in most manufacturing establishments. Acid fumes and gritty dust are both found in varying quantities in every fertilizer plant, and both are enemies of belt efficiency. The introduction of electric motors in a number of the larger plants has reduced the amount of belting required, but there is no indication that any plant will ever be able to dispense altogether with belts.

Results of a study of the use of belting in this industry have been published in *American Fertilizer*, March 12, 1921, p. 57. Replies to a questionnaire were received from manufacturers having an annual output of a little over 3,000,000 tons, somewhat less than one-half of the total production.

Power transmission belting. An analysis of the data received indicates that the fertilizer industry in the United

States uses approximately 765,000 linear ft. of power belting, of which 85 per cent is rubber, $9\frac{1}{2}$ per cent leather, and $5\frac{1}{2}$ per cent fabric. The favor with which rubber belting is held in fertilizer factories is due primarily to its acid-resisting qualities. The fumes from the acidulating room and the acid reaction from the acid phosphate dust both affect largely the life of the belts. As long as the rubber coating on a belt completely protects the enclosed fabric the belt stands up well against acid vapors.

The first cost of a rubber belt is less, which is an additional argument in its favor. This was especially true when the war-time demand for leather reduced the supply available for belts. As a general rule leather belting is used on heavy drives which can be separated from the unfavorable factory conditions. This is often the case with the belt transmitting from the primary source of power. There is some leather belting in use which has been impregnated with an acid-resisting substance.

Dust is second only to fumes as a source of belt trouble in fertilizer factories. It increases the wear on the belt, and thus shortens the time, in the case of rubber belting, when the protective covering is worn through and the underlying fabric exposed. As soon as this occurs the deterioration of the belt is rapid. Dust also increases the slipping, which is an inherent weakness in rubber belting. This excessive slipping must be counteracted by running the belt tighter or by using a belt dressing. Both of these remedies are costly in the end. One company estimates that fumes and dust in its factory reduce the life of its belting by one-half.

Where care is taken to keep down dust, the increase in the life of the belt is noticeable. Some companies report that they have obtained nine and ten years of continuous service from favorably located rubber belts. As a general rule the unfavorable conditions in fertilizer factories more than counterbalance the natural superiority of leather belting for the transmission of power. Experience has demonstrated that rubber is better adapted for most of the work.

Conveyor belts. The conveyor belts in fertilizer factories vary in width from 12 to 30 in. From the figures received it is estimated that the industry uses about 28,000 linear ft. of conveyor belting, 89.9 per cent of which is rubber, and 10.1 per cent fabric. About 40 per cent of the manufacturers use conveyor belts.

The same conditions which affect the power belting cause deterioration in conveyor belting. A certain density of surface is necessary in conveyor belts to prevent the gritty material from working into the body of the belt.

Where the design of the building and the location of the machinery permits the use of bucket elevators and other devices for conveying materials, these are preferred to belt conveyors by a number of the manufacturers.

Test Code for Evaporating Apparatus.—In 1918 the Power Test Committee of the American Society of Mechanical Engineers was reorganized to revise and enlarge the power test codes of the society published in 1915. The committee is a large one, under the chairmanship of Fred R. Low, and under its direction are nineteen individual committees of specialists which are drafting codes for the different classes of apparatus comprised in power plant equipment. The third of these codes, the test code for evaporating apparatus, was published in *Mechanical Engineering*, vol. 43, p. 184, March, 1921. This code is intended primarily for apparatus heated by steam, such as vacuum pans or single- and multiple-effect evaporators.

Trade Notes on Bauxite.—In order to encourage the development of mineral resources, the Geological Survey of India has prepared a series of papers on the more important minerals. One dealing with bauxite, by J. Coggin Brown, has been published in the *Journal of Indian Industries & Labour*, vol. 1, part 1, p. 54, February, 1921. After discussing distribution of Indian deposits, uses, grades, specifications, other sources of supply and statistics, the question of the best method of developing the deposits is taken up. Since the present consumption of aluminum in India is comparatively small, manufacture of the metal on an economical scale would involve building up an export business. An alternative would be the manufacture of pure alumina locally for export to aluminum works or for the local manufacture of aluminum salts.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Carbon Bisulphide.—Through the use of a hot blast, a low blast furnace is operated as a slagging gas producer, anthracite, coke or charcoal being used as fuel. At the bosh, or just above the zone of highest temperature, sulphur vapors are introduced. Carbon bisulphide is formed by contact with the heated carbon, any SO_2 present in the vapors being reduced to CS_2 at the same time. It is even possible to use smelter gases and roaster gases instead of sulphur. The gases and vapors leaving the furnace are cooled in a condenser. This removes most of the moisture coming from the fuel, any sulphur vapor and a little CS_2 , the amount of the last depending upon the ratio of its vapors to the gas present. Carbon bisulphide is separated from the cooled mixture of gases and vapors by scrubbing with chilled oil. (1,369,825; KARL P. McELROY, of Washington; March 1, 1921.)

Electric System for Electric Furnaces.—HARRY A. GREAVES and HARRY ETHELLES, of Sheffield, England, have devised a system for the practical application of three-phase alternating current to an electric furnace having three (or a multiple of three) upper electrodes and a conductive hearth which is an electrical resistor in one unit. Each of the electrodes is connected to one terminal of the secondary windings of three transformers. The primary windings of the transformers are connected in delta and the secondaries in what is sometimes called an inverted star. The other terminals of the secondary windings and the lead from the hearth of the furnace are connected to a common point. Assuming the transformers to be of identical transforming ratios and the electrodes to be in equal adjustment, equal currents will pass through the secondaries, when the meshed primaries are excited by three-phase currents.

The common resultant current of the three electrodes will pass through the bath of liquid metal and through the resistance hearth of the furnace to the common point. This resultant current will be equal to twice the current passing through any one electrode and consequently any one transformer secondary winding. This arrangement has the additional advantage of making the arcs of a three-electrode furnace on a three-phase system entirely independent of each other, consequently making automatic regulation much more efficient. This also prevents fluctuations on one electrode circuit varying the current in the other electrode circuits. The permanent resistance of the furnace hearth also tends to damp short circuit currents passing through the electrodes, and consequently steadies the load fluctuations of the furnace as a whole. A better power factor is thus more easily maintained, as it is not necessary to introduce so much reactance as in furnaces in which the resistive hearth is not a feature. (1,370,016; March 1, 1921.)

Method of Making Wrought Iron.—Slag distribution in the usual puddle ball or bloom is coarse and the refining incomplete. This necessitates rolling the balls or blooms into bars which are then sheared, piled and re-rolled after heating to welding temperature. According to JAMES ASTON, of Pittsburgh, Pa., these operations may be eliminated by introducing slag into the product of a steel-making process in such a way that uniform slag distribution is obtained. In the preferred method, the molten substantially slagless product of a steel-making process is granulated while dropping through the air and is received in a receptacle containing a bath of molten slag of the proper consistency and temperature, so that a ball of mixed slag and metal will be formed below the surface of the slag in the receptacle. (1,370,507 and 1,370,622; assigned to A. M. Byers Co.; March 8, 1921.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Saccharine.—Saccharine is prepared by oxidizing *o*-toluene sulphamide with chromic acid mixed with sulphuric acid of more than 35 per cent strength. The chromic acid may be formed in situ by the use of a chromic acid salt. After cooling and diluting the reaction mixture, the product is filtered off and the saccharine separated from unchanged starting material by any known method. (Br. Pat. 153,520; SOC. CHIMIQUE DES USINES DU RHÔNE, Paris. Jan. 19, 1921.)

Acetic Acid.—In the manufacture of acetic acid by the oxidation of liquid acetaldehyde at 10 to 20 deg. C., the catalyst employed is the residue which remains after igniting the carbon from animal charcoal, with or without the addition of sodium acetate. As the residue mainly consists of calcium and magnesium phosphates, it may be replaced by a mixture of these compounds, with or without small quantities of lime, silicon dioxide and fluorides. (Br. Pat. 154,680, H. DREYFUS, London. Feb. 2, 1921.)

Treating Sulphide Ores of Lead and Zinc.—Sulphide ores of lead and zinc are treated with sulphuric acid containing free sulphur trioxide or with sulphur trioxide in the gaseous form to convert the lead, etc., into sulphates while the zinc remains in the form of sulphide. The lead sulphate is separated from the zinc sulphide, for instance, by flotation. Silver sulphate may be separated from lead sulphate by treatment with water. Cadmium and bismuth if present are converted into sulphates which are readily separated from lead sulphate. (Br. Pat. 154,718, P. A. MACKAY, London. Feb. 2, 1921.)

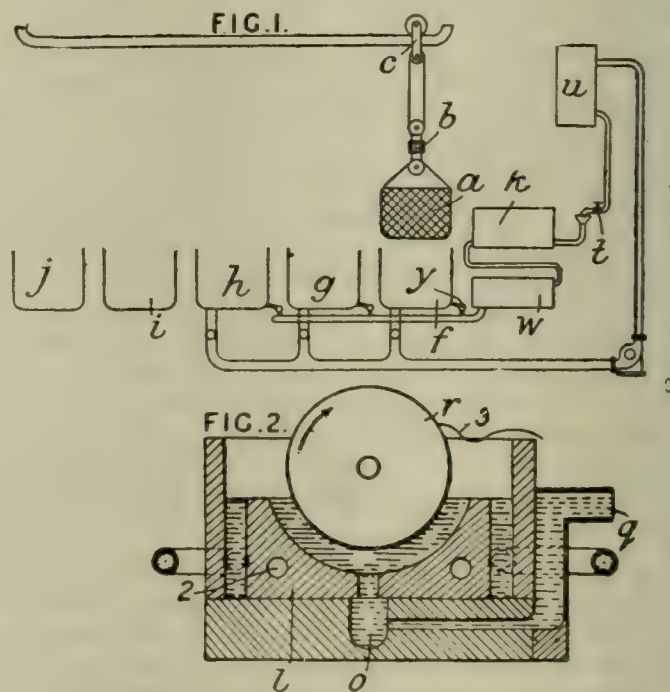
Potassium Sulphate.—The production of potassium sulphate and hydrochloric acid from a pulverulent mixture of potassium chloride and aqueous sulphuric acid is effected in a single direct-flame furnace having a long flame, and which may be divided into three compartments if necessary, the arrangement being such as to provide for desiccation at a low temperature, say 120 to 300 deg. C., heating at 300 deg. C. and finally heating at 700 to 800 deg. C. Alternatively a compound furnace may be employed allowing the same stages of heating, in which one or more of the stages is effected by indirect heat as in a muffle. In another modification the process is effected in a single furnace so as to obtain first a desiccation at 120 to 300 deg. C. and in the rest of the furnace a temperature increasing from 300 to 800 deg. C., care being taken that the mass moves through the desiccating section slowly enough to remain solid and porous. The sulphuric acid may be of strength exceeding 70 to 72 per cent SO_3 . (Br. Pat. 154,111; FABRIQUES DE PRODUITS CHIMIQUES DE THANN ET DE MULHOUSE THANN, France. Jan. 26, 1921.)

Casein Compounds.—Metallic pyrophosphate casein compounds, which are of use in therapeutics, are prepared by dissolving casein in alkali pyrophosphate solution and adding a metallic salt, such as calcium chloride or ferric chloride. (Br. Pat. 154,112; F. HOFFMANN-LA ROCHE & Co., Basel, Switzerland. Jan. 26, 1921.)

Cellulose Acetate.—In the manufacture of solutions, celluloid-like masses, films, dopes, artificial silk and other compositions, and preparations and articles having a basis of cellulose acetate, the following high boiling-point or plastic-inducing agents are employed: Benzene monomethylsulphonamide, benzene methylethylsulphonamide, mixtures of *o*- and *p*-toluene dimethyl- or diethyl- or methylethylsulphonamides, *o*-toluene dimethyl- or diethylsulphonamides, or mixtures of isomeric xylene dimethyl- or diethyl- or methylethylsulphonamides; or mixtures of these dialkylsulphonamides and the monoalkylsulphonamides referred to above or in specifications 132,283 and 133,353 may be used. In conjunction with these high boiling-point solvents there may be used any other suitable low boiling-point solvents, agents such as triphenyl or tricresylphosphate, acid neutralizing aliphatic derivatives of urea such as mono-, di-, or tri-methyl, or tri-ethyl-urea, coloring matters and filling materials. The benzene methylsulphonamide may be prepared from com-

mercial benzene, for example, distilling between 79 and 88 deg. C., the sulphochloride being first prepared and then treated either with ammonia and afterwards with suitable alkylating-agents, or directly with suitable amines; the mixtures of *o*- and *p*-dialkylsulphonamides, from commercial toluene distilling between 95 and 132 deg. C., the *o*-toluene dialkylsulphonamides, from pure toluene distilling between 110 and 111 deg. C.; the mixtures of isomeric xylene dialkylsulphonamides, from commercial xylene distilling between 135 and 146 deg. C. (Br. Pat. 154,334; H. DREYFUS, London, Jan. 26, 1921.)

Electrolytic Detinning Process.—Tin is dissolved from tinned scrap, etc., by a strong solution of tin and iron chlorides, preferably containing a small proportion of hydrochloric acid. A suitable solution is made by treating a 25 per cent solution of ferric chloride with 1 per cent of hydrochloric acid and with metallic tin until it contains 6.5 per cent of stannous chloride and 1.5 per cent of stannic chloride. This solution, after use for dissolving tin from scrap, is electrolyzed to deposit a small amount of tin, equal to that dissolved from the scrap, for instance 0.2 per cent of the solution, the current density and rate of flow and speed of the cathode being regulated to attain this end, and to deposit non-adherent tin, which is scraped off the rotary cathode. The scrap may be placed in two enameled baskets *a*, Fig. 1, hung from the ends of a beam *b* centrally supported by lifting tackle from a carriage *c*. Three pairs of tanks *f*, *g*, *h* are successively used for the treatment, the liquid being admitted from a heater *w* by separate cocks *y* and afterward pumped to a storage tank *u*, whence it is led through a cock *t* to the electrolytic cell *k* and back to the heater. After detinning, the scrap is washed in tanks *i* and coppered or treated with lime water in tanks *j*. The electrolytic cell may comprise an anode *l*, Fig. 2, of trough form and preferably of graphite impregnated with paraffine wax. Copper conductors 2 are embedded in the anode. Electrolyte flows over both edges of



the anode into the trough and through holes in the bottom to a well *o* and outlet pipe *q*. The deposited tin is removed from the cylindrical rotating cathode *r* by a scraper 3. The speed of the cathode may be 10 in. per minute, the current density 450 amp. per sq.ft., and the rate of flow 10 gal. per hour through a channel $\frac{1}{2}$ in. x 6 in. between the electrodes. (Br. Pat. 154,242; M. A. ADAM, J. STEVENSON and A. T. MABBITT, all of London. Jan. 26, 1921.)

Acetic Acid.—In the manufacture of acetic acid by the oxidation of liquid acetaldehyde, the catalyst employed is kaolin, with or without the addition of sodium acetate. The temperature is preferably maintained at 10 to 20 deg. C. If, instead of oxygen, gas containing oxygen be employed for the oxidation, it is introduced at a pressure up to 7 atmospheres. (Br. Pat. 154,304; BRITISH CELLULOSE & CHEMICAL MFG. CO., London; M. SOLLER, Ruddington, Nottinghamshire, and J. HOLTZ, Spondon, Derbyshire. Jan. 26, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Final Decree in the Salt Lake Smoke Suits

On March 21, 1921, Federal Judge T. O. Johnson signed various orders setting aside all previous judgments and stipulations regarding the operation of the Murray smelter of the American Smelting & Refining Co. and the Midvale smelter of the United States Smelting, Refining & Mining Co., formerly ordered with a view of avoiding smoke damage to the surrounding country. Based upon the report of Commissioner Robert E. Swain—reviewed at length in *CHEMICAL & METALLURGICAL ENGINEERING* March 16, 1921, page 463—the court finds that both of these smelting plants can be operated at their present locations without injury to their neighbors, and they are permitted to operate subject to the following conditions:

"1. That all necessary measures shall be taken to maintain all furnaces, flues and other portions of the plant in such good operating condition as to prevent excessive leakage of noxious gaseous or solid emanations.

"2. That all gases and accompanying solid emanations or dusts from roasting or blast-furnace operations shall be subjected to bag filtration, or to electrical precipitation by the Cottrell process, or to any other process or processes of equal efficiency for the removal of suspended solids, sulphur trioxide or sulphuric acid, and that these installations or processes shall be maintained and operated at the highest practicable efficiency; provided, however, that if blast-furnace gases and their accompanying solid emanations or dusts are treated by the Cottrell process, they shall first be conditioned by the addition of sulphuric acid or other modifications in the present process, made to give it an operating efficiency equal to that which it shows in the treatment of the gases and other emanations and dusts from roasting furnaces.

"3. That all gases from roasting operations shall be discharged at a point not less than 450 ft. above the level of the ground, and that through heating apparatus installed at the base of the exit stack, or by other means, there shall be maintained during the growing season for vegetation in this district, during the time each day between sunrise and sunset when roasting operations are in progress, a difference in temperature between the stack gases at any point of measurement within the stack and the outside air amounting to at least 75 deg. C.; provided, however, that upon proper showing to the court, a commissioner may be appointed to receive any submitted evidence and make any necessary investigations, at the expense of the applicant, with a view to the formulation of any modification of the provisions as to temperature of gases hereinabove set out in this paragraph.

"4. The United States Smelting, Refining & Mining Co., one of the defendants, expressed its willingness to make such alterations and improvements in its smelter as to enable it to operate the same subject to the foregoing conditions; it is further ordered that it be permitted to continue to operate subject to the conditions and limitations specifically set forth in the interlocutory decree made on Jan. 21, 1921*, with the proviso that said defendant shall proceed with all due diligence to so alter its smelter as to permit it to operate the same subject to this decree."

National Research Council, Division of Chemistry

The annual meeting of the Division of Chemistry, National Research Council, will be held at Rochester at 12:30 Wednesday, April 27. The various committees will report upon activities of the past year. There will be a general discussion of plans and projects for the ensuing year.

*See "Smoke Litigation in Salt Lake Valley," *CHEM. & MET. ENG.*, vol. 22, p. 1145, June 23, 1920.

Hoover Resigns as President of Engineering Council

At the meeting of the executive board of American Engineering Council in Philadelphia, April 16, noted elsewhere in these columns, Herbert Hoover tendered his resignation as president of American Engineering Council. He did this because he considered that the activities of the council and of the Federated American Engineering Societies in national affairs would be likely to place him in an embarrassing position on account of his Cabinet post. He indicated that his interest in the work of the council and of the federation had in no degree diminished. In fact, he reiterated that he believed the formation of the Federated American Engineering Societies was the starting point of one of the most valuable voluntary services that could be rendered the nation.

His successor as president of the council was not elected at the meeting, but the selection was referred to the consideration of the council's committee on procedure.

Engineering Council's Executive Board Meets

The executive board of American Engineering Council held its regular bi-monthly meeting in Philadelphia on April 16 at which it was decided to hold an "Engineering Assembly" in Washington in January, 1922. The remaining time of the sessions was devoted to the consideration of reports of committees and the reference to these committees of various new matters brought to the consideration of the board.

The "Engineering Assembly" is to be a two-day session for the discussion of engineering problems. A committee was appointed to make arrangements for holding it.

The secretary reported the completion of the moving of the office of the council to Washington, the retention of A. C. Oliphant as assistant secretary, and the engagement of James T. Grady to handle publicity.

The Duluth Engineering Society, the Boston Society of Civil Engineers and the Milwaukee Engineering Society were admitted to membership. The next meeting was fixed for June 3, and, according to previous decision, will be held in St. Louis. W. W. Varney, who has been serving as acting treasurer, was elected treasurer.

The committee on public affairs reported that it deemed it inadvisable for the council to engage in activities with reference to the general reorganization of the government. It believes that the council will be stronger if it confine its efforts to presenting to Congress and the public the merits of the proposal to establish a Department of Public Works.

Investigation of Fertilizers Sold in Pennsylvania

The State Department of Agriculture, Harrisburg, Pa., has concluded an investigation of fertilizers sold in the state during the past year. A total of 1,312 samples was tested, showing a deficiency of 29.9 per cent in one or more of their guarantees for nitrogen, phosphoric acid and potash. The samples represented 676 different brands of fertilizers manufactured by a total of seventy-seven manufacturing companies. The largest proportion of deficiencies was found in the complete fertilizers supplying potash, nitrogen and available phosphoric acid.

To Concentrate C.W.S. Work at Edgewood

Training activities and the proving of shells and other ordnance have been conducted on a considerable scale at Lakehurst. In the future these activities will be transferred to Edgewood.

The proving grounds at Edgewood are somewhat limited, but will serve most of the purposes of Chemical Warfare Service tests.

Tentative Program of the Rochester Meeting of the American Chemical Society

The following program was announced by Secretary Parsons on Friday, April 15:

Monday, April 25

- 4:00 p.m.—Council Meeting, Rochester Club.
6:30 p.m.—Dinner to the Council at the Rochester Club.

Tuesday, April 26

- 9:30 a.m.—General Meeting at Chamber of Commerce, 67 St. Paul St.
Addresses of Welcome, Hiram Edgerton, Mayor; E. G. Miner, Chamber of Commerce.
Response, President Edgar F. Smith.
2:00 p.m.—Some Problems of National Defense, Hon. James W. Wadsworth.
The American Chemical Industry, Hon. Nicholas Longworth.
Ammono Carbonic Acids, E. C. Franklin.
Measurement of Color, C. E. K. Mees.
Blue Eyes and Blue Feathers, W. D. Bancroft.
Surface Films as Plastic Solids, R. E. Wilson.
Stability and Structure of Molecules, Irving Langmuir.
Ionization of Electrolytes, G. N. Lewis.
6:30 p.m.—College, Fraternity and Group Dinners.

Wednesday, April 27

- 9:00 a.m.—Division Meetings, Mechanics Institute, 55 South Plymouth Ave.
8:00 p.m.—Chemistry in the United States, Charles F. Chandler.

DIVISION OF PHYSICAL AND INORGANIC CHEMISTRY

Symposium on Contact Catalysis, 9 a.m.

- Platinum Black and Carbon Monoxide, F. H. Pollard.
Esterification of Silica Gel, C. H. Milligan and E. Emmet Reid.
Adsorption by Oxide Catalysts and the Mechanism of Oxidation Processes, A. F. Benton.
Dissociation of Some Mixed Oxides, J. C. Frazer.
Adsorption by Metallic Catalysis, R. M. Burns and H. S. Taylor.
The Action of Nickel on Diethyl Ether: A Study in Contact Catalysis. Preliminary Report, F. L. Simons.
R.P.M.'s as a Catalyst, C. H. Milligan and E. Emmet Reid.
Catalysis in the Reduction of Oxides and the Catalytic Combination of Hydrogen and Oxygen, R. N. Pease and H. S. Taylor.
A Case of Autoxidation: $\text{MnO}_2 \rightarrow \text{HMnO}_4$, J. C. Fraser.
Catalysis in the Interaction of Carbon With Steam and Carbon Dioxide, N. A. Neville and H. S. Taylor.
Oxidation and Reduction by Organic Compounds, C. H. Milligan and E. Emmet Reid.
The Action of Alumina, Titania and Thoria on Ethyl and Isopropyl Acetate, Homer Adkins and A. C. Krause.
Catalytic Electrolytic Oxidation of Sulphur Dioxide, C. G. Fink.
The Decomposition of Ethyl Acetate Induced by Catalytic Nickel, Homer Adkins and P. W. Simmonds.
The Catalytic Influence of Foreign Oxides on the Decomposition of Silver Oxide, Mercuric Oxide and Barium Peroxide, James Kendall and Francis J. Fuche.

Papers at 2:30 P.M.

- A New Clock Reaction, G. S. Forbes, H. W. Estill and O. J. Walker.
The Volumetric Oxidation of Sulphide to Sulphate, H. H. Willard and W. E. Cake.
Research for the Undergraduate, Edward Ellery.
The Apparent Irreversibility of the Calomel Electrode, A. W. Laubengayer.
The Theory of Hydrogen Over-Voltage, D. A. MacInnes and W. R. Hainsworth.
The Hydrogen Electrode Under High Pressures, D. A. MacInnes and W. R. Hainsworth.
Potassium Ammonoaluminate and Ammonomanganite, Francis W. Bergstrom.
A Quantitative Study of Adsorption in Solution and at Interfaces of Sugars, Dextrine, Starch, Gum Arabic and Egg Albumen and the Mechanism of Their Action as Emulsifying Agents, G. L. Clark and W. W. Mann.
The Preparation, Properties and Molecular Volume Relationships of the Ammines and Hydrates of Cobalt Fluoride, Bromide, Nitrate, Carbon and Citrate, G. L. Clark and H. K. Buckner.

Emulsification With Soaps of Linoleic and Ricinoleic Acids, G. S. Clark and H. K. Buckner.

Notes on the Preparation of Pure Platinum, Edward Wichers.

Modified Method for the Determination of Iron and Vanadium After Reduction, E. F. Lundell.

The Free Energy of Dilution of Hydrobromic Acid; the Activities of Its Ions in Very Dilute and Concentrated Solutions, H. Miller Spencer and Albert G. Loomis.

Ultra-Violet Arc Spectrum of Yttrium, L. F. Yutema and B. S. Hopkins.

On the Viscosity of Gelatin Sols, R. H. Bogue.

The Structure of the Molecule of Water, Irving Langmuir.

The Purification of Helium by Means of Charcoal, L. Finkelstein.

The Importance of Diffusion in Organic Electrochemistry, Robert E. Wilson.

Observations on the Drying and Swelling of Gelatine Gels, S. E. Sheppard and F. A. Elliott.

Note on the Influence of Silver Salts in Catalyzing the Decomposition of Ammonium Persulphate Solutions, S. E. Sheppard and A. Ballard.

Further Developments of the Hydrogen Electrode, F. A. Elliott.

Note on Silver Soap Gels, Stafford Whitby.

Catalytic Effect in the Reaction Between Ketones and Halogens in Aqueous Solutions, F. O. Rice.

The Transference Numbers of Sulphuric Acid by the Concentration Cell Method, Alfred L. Ferguson.

The Influence of Gelatin on the Transference Number of Sulphuric Acid, Alfred L. Ferguson.

The Entropy of Monatomic Gases, Gilbert N. Lewis.

The Electrometric Titration of Uranium With Potassium Dichromate and Potassium Permanganate, D. F. Ewing and E. F. Eldridge.

The Heat of Coagulation of Ferric Oxide Hydrosol by Electrolytes, Frederick L. Brown and J. H. Mathews.

Some Quantitative Experiments on Coagulation of Colloids, Ray V. Murphy and J. H. Mathews.

The Alkalinity of Searles Lake Brine, Roger C. Wells.

The Vapor Density of Technical Phosgene, A. F. O. Germann and Vernon Jersey.

The Cryoscopy of Boron Trifluoride Solutions: V. Systems With Methyl Ether and With Methyl Chloride, A. F. O. Germann and Marion Cleaveland.

The Cryoscopy of Phosgene Solutions: I. System With Chlorine, A. F. O. Germann and Vernon Jersey.

Studies in Fluoride Equilibrium: I. Calcium Borofluoride, A. F. O. Germann and Gilberta Torrey.

Chromatic Emulsions, H. N. Holmes and D. H. Cameron.

Cellulose Nitrate as an Emulsifying Agent, Harry N. Holmes and Don Cameron.

A Theory of the Photographic Latent Image, Harris D. Hine.

The Interaction of Platinum Hydrochloric Acid and Hydrogen Peroxide, S. A. Braly and O. V. Schoefer.

Is There a Sharp Transition Point Between the Gel and Sol? Eugene C. Bingham.

The Validity of the Additive Fluidity Formula, Eugene C. Bingham and Delbert F. Brown.

The Emulsion Colloids as Plastic Substances, Eugene C. Bingham and William L. Hyden.

The Properties of Cutting Fluids, Eugene C. Bingham.

DIVISION OF INDUSTRIAL AND ENGINEERING CHEMISTRY

H. D. Batchelor, chairman; H. E. Howe, secretary.

On Wednesday morning the Division will attend the symposium on contact catalysis held by the Division of Physical and Inorganic Chemistry.

Symposium on Drying, 2 p.m. Charles O. Lavett, chairman
The Rate of Drying Solid Materials (Lantern), W. K. Lewis.

The Theory of Atmospheric Evaporation (Lantern), W. H. Carrier.

The Compartment Dryer (Lantern), W. H. Carrier and A. E. Stacey.

Direct Heat Rotary Drying Apparatus, R. G. Merz.

Tunnel Driers (Lantern), G. B. Ridley.

The Spray Process, R. S. Fleming.

Vacuum Drying (Lantern), Charles O. Lavett and D. J. Van Marle.

General Papers

Tests of Counter-Current Kelp Driers, G. C. Spencer and E. B. Smith.

The Preparation, Properties and Constitution of Liquid and Solid Water-Glasses, Louis Schneider.

Method for Treating Filter Cake Obtained in Refining Vegetable and Animal Oils, Charles Baskerville.

The Application of the Cottrell Precipitator to the Wood Distillation Process, L. F. Hawley and H. M. Pier.

Alcohol and Chemical Industries, J. M. Doran.

The Caustic Calcination of Dolomite and Its Use in Sorrel Cements, C. A. Bole and J. B. Shaw.

Valuation of Oil-Bearing Seeds by Free Fatty Acid of the Oil, Lehman Johnson.

The Detection of Carbon Monoxide (Lantern), C. R. Hoover.

Microscope Illumination With Reference to Brownian Movement and Combination Lighting (Lantern), A. Silverman.

The Relation of Structure to Free Alkali in Sodium Silicate Solutions (Lantern), William Stericker.

Compression Evaporation, A New Method of Concentrating Liquids, Developed in Europe Recently (Lantern), Gustav Carlsson.

Action of Lime on Greensand, R. Norris Shreve.

A Modification of the Acetate Method for Estimating Iron and Aluminum in Phosphates, F. P. Veitch and H. P. Holman.

The Water Resistance of Treated Canvas During Continuous Exposure to Weather, F. P. Veitch and T. D. Jarrell.

The Detection and Estimation of Coal Tar Oils in Turpentine, V. E. Grotlisch and W. C. Smith.

THE CELLULOSE SECTION

9 a.m.

Effect of Adding Various Chemicals to Wood, Previous to Distillation, L. F. Hawley.

The Removal of Free Acid From Nitrated Cellulose, With Special Reference to the Use of Saline Leaches, S. E. Sheppard.

Motor Fuel From Vegetation (Lantern), T. A. Boyd.

Possibilities of the Moist Tropics to Furnish Materials for Cellulose and Carbohydrates (Lantern), H. N. Whitford.

The Possibilities of a Future Fuel Supply From Our Forests, R. C. Hawley.

The Role of the Chemist in Relation to Our Future Supply of Liquid Fuel, Harold Hibbert.

The four last-mentioned papers will be discussed together under the general subject, "Our Future Supplies of Liquid Fuel." It is expected that representatives of the Standard Oil Co., U. S. Industrial Alcohol Co., Forest Products Laboratory and others will take part.

The Microstructure of Wood (Lantern), Allen Abrams.

Significance of the So-Called Lignin Tests, E. C. Crocker.

Some Commercial Possibilities of Corn Cob Cellulose, F. B. LaForge.

Nitrocellulose and Its Solutions as Applied to the Manufacture of Artificial Leather, W. K. Tucker.

Influence of Mixed Acids on the Character of Nitrocellulose (Lantern), W. J. Waite.

A Proposal for a Standard Cellulose to Be Available for Research, B. Johnsen.

A Discussion of Some Beater Furnish Reactions From the Standpoint of Colloidal Chemistry, Jessie E. Minor.

The Solubility of Cellulose Acetate in Chlorinated Hydrocarbons, Gustavus J. Esselen, Jr.

The Action of Dry Hydrobromic Acid on Cellulose and Related Derivatives, Harold Hibbert and Harold S. Hill.

The Oxidation of Cellulose, W. S. Holzberger.

European Practice in Cellulose Acetate and Dopes During the War, Philip Drinker.

The Influence of Temperature on Hemi-Cellulose Production, W. E. Tottingham.

The Chemical Changes Involved During Infection and Decay of Wood and Wood Pulp, Mark W. Bray and Joseph A. Staidl.

The Chemical Constitution of Soda and Sulphate Pulp From Coniferous Woods and Their Bleaching Qualities, Sidney D. Wells.

SECTION OF PETROLEUM CHEMISTRY

T. G. Delbridge, chairman; W. A. Gruse, secretary.

9 a.m., Room 112

Organization.

Petroleum Hydrocarbons That Cannot Be Distilled, C. F. Mabery.

Petroleum: A Raw Material for Our Chemical Industries, Sidney Born.

Some Chemical Considerations of Petroleum Refining, B. T. Brooks.

Viscosity-Temperature Curves of Fractions of Typical American Crude Oils (Lantern), E. W. Dean and F. W. Lane.

Determination of Gasoline in Natural and Casinghead Gas, Charles Skeeel Palmer.

Dechlorination of Chlorohydrocarbons, W. F. Faragher and F. H. Garner.

Viscosities of Motor Oils at High Temperatures. (By title), L. B. Lockhart.

Oil Shale, R. F. Bacon.

Iodine Numbers of Unsaturated Hydrocarbons and Cracked Gasolines (Lantern), W. F. Faragher, F. H. Garner and W. A. Gruse.

A New Method of Color Measurement for Oils, Leon W. Parsons and Robert E. Wilson.

Total Heats and Condensation Points of Kerosene-Air Mixtures, Robert E. Wilson and D. P. Barnard.

Reclamation of Used Motor Oils (Lantern), W. F. Parish.

Catalytic Oxidation of Petroleum Oils, C. E. Waters.

Accurate Determination of Moisture in Transformer Oils, C. J. Rodman.

DIVISION OF RUBBER CHEMISTRY

W. W. Evans, chairman; Arnold H. Smith, secretary.

9 a.m., Room 109

The first day will be devoted entirely to a discussion of the Tentative Procedure for the Analysis of Rubber Goods.

Thursday

Reports from Executive Committee, Abstract Committee, Accelerator Committee and Physical Testing Committee.

Some Effects of PbO and SO₂ in Zinc Oxide on Compounded Rubber (Lantern), Harlan A. Depew.

Contribution to the Knowledge of the Resins of Hevea Rubber (Lantern), G. Stafford Whitby and J. Dolid.

The Solubility of Gases in Rubber as Affecting Their Permeability, C. S. Venable and Tyler Fuwa.

The Analysis of Rubber Goods Containing Antimony Sulphide, S. Collier and M. Levin.

Reactions of Accelerators During Vulcanization. III. Carbosulphydryl Accelerators and the Action of Zinc Oxide, C. W. Bedford and L. B. Sebrell.

The Influence of Piperidine-piperidyl-dithiocarbamate on Vulcanization (Lantern), G. Stafford Whitby and O. J. Walker.

A Rapid Bomb Method for the Determination of Sulphur in Rubber Compounds, W. W. Evans and Ruth E. Merling.

The Direct Determination of Sulphur of Vulcanization, S. Collier and M. Levin.

Volume Increase of Compounded Rubber Under Strain (Lantern). With comments on the work of H. F. Schippel, Henry Green.

General Round Table Discussion. Topics are: Factory Control of Vulcanization. Testing of Crude Rubber as Received at the Factory. Reactions Between Sulphur and Various Softeners, and others.

DIVISION OF DYE CHEMISTRY

A. B. Davis, chairman; R. Norris Shreve, secretary.

9 a.m.

Contribution to the Estimation of H-Acid, Henry R. Lee.

A New Process for Alizarine, Charles W. Schaffer.

Bleaching of Dyed Cotton Fabrics, J. Merritt Matthews.

The Immediate Needs of Chemistry in America, William J. Hale.

Contribution to the Chemistry of Malachite Green, J. R. Minevitch.

New Developments in American Dyes and Coal-Tar Chemicals in 1920, G. R. DeLong.

Dyes Derived From Beta-Oxynaphthoic Acid and From J Acid With Reference to the Chemical Foundation Patents, A. Willard Joyce.

Quantitative Determination of Phenanthrene, Arthur D. Williams.

Alkali Fusions. III. Fusion of Phenylglycine o-Carboxylic Acid With Potassium Hydroxide and With Sodium Hydroxide for the Production of Indigo, Max Phillips.

Vapor Pressure Determinations on Naphthalene, Anthracene, Phenanthrene and Anthraquinone Between Their Melting and Boiling Points, O. A. Nelson and C. E. Senseman.

Nomenclature of Dyestuff Intermediates, J. W. Kinsman.

Thursday, April 28

9 a.m.—Division Meetings.

7 p.m.—Good Fellowship Meeting, Bausch & Lomb Dining Hall.

Friday, April 29

Excursions, 10 a.m.

Bausch & Lomb Optical Co.

Pfaunder Co.

Gas Plants—Rochester Gas & Electric Corporation.

Municipal Garbage Disposal Plant.

Municipal Sewage Disposal Plant.

Bastian Bros.

Excursions at 2 p.m.

Eastman Kodak Co., Kodak Park Works.

(a) General Excursion.

(b) Synthetic Organic Chemical Department.

Taylor Instrument Companies.

(a) Laboratory Equipment.

(b) Industrial Apparatus.

(c) High Temperature Apparatus.

Vacuum Oil Co.

Bartholomay Co.—Baskerville Refining Process.

Further details concerning the nature of these excursions will be available at the time of registration.

Ladies' Entertainment

A ladies' entertainment is planned for Tuesday afternoon in the Ad Club rooms. The local ladies will give a tea and musical in honor of the visiting ladies. The Goodfellowship Meeting is one at which every lady guest is expected to be present. Among other things there will be dancing.

The Chemical Industry From a Tariff Viewpoint

Speaking before a recent meeting of the Chemical Society of Washington, C. R. De Long, chief chemist of the Tariff Commission, discussed some of the more important questions which arise in tariff consideration of chemical commodities.

INDIRECT COMPETITION

In addition to direct competition offered by imports of the same chemical it is often necessary to consider indirect competition by similar commodities which are of a competitive nature. One of the most striking examples of indirect competition is afforded by the vegetable oils. Practically any vegetable oil may be used in the manufacture of soap and also, if properly refined, in the manufacture of food products, such as butter and lard substitutes. Taking the case of cottonseed oil: No direct tariff problem is presented by cottonseed oil itself, since it is produced in large quantities and a considerable surplus is exported. However, the indirect competition offered by soya bean and peanut oils is an important factor in the tariff consideration of cottonseed oil. The competition which vegetable oils—in the form of oleomargarine and butter substitutes—offer to the dairy interests is another important consideration in the tariff problems of the vegetable oils.

COMPENSATORY DUTIES

The problem of compensatory duty, or the adjustment of duties on raw materials and finished products, offers varied tariff problems. These duties are based on the theory that any duty placed on a raw material should be compensated for by a corresponding increase in duty on the finished product. Take, for example, the case of barytes and lithopone. Here we have a case in which the raw material for the manufacture of lithopone was almost exclusively imported before the war. During the war the manufacturers of lithopone were forced to develop domestic supplies of barytes in order to have an adequate supply of raw material. The commission has made a detailed investigation of the cost of manufacturing lithopone and of mining barytes in order to ascertain the extent to which barytes enters into the total cost of lithopone.

Along this same line a study of the relation between the duties on oil seeds and oils show that under the present tariff law there is no definite policy or similar treatment of this important group of commodities. In some cases both the oil seeds and the oils are free of duty. In other cases the duties on the seeds and the oils are so adjusted that there is a differential in favor of importing and crushing the seeds in this country, and in still other cases there is a differential in duties which favors crushing the seeds in foreign countries and importing the oils. In order to have adequate information for considering compensating duties on vegetable oils the Tariff Commission has made a detailed study of the yields obtained in crushing the various oil seeds.

There is a somewhat controversial theory that tariff duties should be based on the difference of cost of production at home and abroad on the assumption that thus a competitive market is increased. In addition to this function

costs often serve as an aid in arriving at compensatory duties, which has been previously discussed. Unsettled conditions both in the United States and in foreign countries have made it decidedly questionable whether costs of production have much meaning at the present time. With changing industrial conditions—such as decreases in wages and cost of raw materials—it is also a matter of doubt as to whether or not the cost of production can be obtained with any fair degree of accuracy. The commission, however, has made several investigations as to cost of production in the domestic chemical industry. These include, principally, the cost of producing certain intermediates and dyes, barytes, barium chemicals, lithopone, the cost of refining sugar and the cost of production of ferro-alloys.

In many of the cost investigations the commission has found that the cost varied widely in the same industry and there was very little uniformity in cost-finding methods. In the industries developed as a result of war conditions this situation may be attributed to stress in output without regard to costs or to proper methods of determining costs. These conditions were found particularly in the dye industry and in the manufacture of barium chemicals. It is to be regretted that a large number of chemical firms do not keep adequate cost records and that many of them simply balance their books once a year. About all they really know is whether they made or lost money. It is safe to say that the chemical industries as compared with other industries have been somewhat backward in the exchange of cost ideas and the discussion of problems which are common to all manufacturers. It is to be hoped that if the commission's investigations have accomplished nothing else they have started manufacturers to thinking more about costs and exchanging ideas in regard to cost methods. There is true in the case of the dye industry, which has had a committee studying uniform costs and has issued a comprehensive report on this subject. In addition, many firms have established adequate cost-finding methods as a result of the Tariff Commission's investigations.

The Tariff Commission can be of service to domestic manufacturers in presenting their cases to Congress. Very few manufacturers are willing to disclose their individual costs in a public hearing before committees of Congress. The commission has, however, found domestic manufacturers always willing to submit their costs to the commission in confidence, so that the commission can tabulate and compare individual costs and thus arrive at an average cost or at a method of presenting individual costs which would not reveal confidential information of the individual manufacturer.

TARIFF CLASSIFICATION OF CHEMICALS

An attempt to classify chemical commodities for tariff purposes presents many technical and difficult problems. Classification may be by specific mention, that is, enumeration by name. In this connection it must be remembered that trade and commercial designations prevail over scientific nomenclature and that details such as punctuation may affect court interpretations. In the past, specific mention of chemical commodities was necessary in order to obtain import statistics and therefore the more chemical commodities which were mentioned by name the more detailed were the imports of chemicals shown.

Another method of classifying chemicals is by the law of similitude. This method is probably more unfamiliar to the ordinary layman than any other. If an article is not mentioned by name in the tariff law, the next question to be decided is whether or not it is like some other article which is mentioned. The law of similitude requires that an article must be like another article in one of four particulars—namely, material, quality, texture or use. This law is further restricted in that it can be only applied to dutiable goods—that is, a chemical commodity cannot be exempted from duty because it is similar to an article specifically mentioned on the free list.

If an article is not free or dutiable, either by specific mention or by similitude, it must be classed under some general provision. The tariff laws contain provisions known as "basket clauses" such as "all other aluminum compounds" and "all chemical and medicinal compounds, preparations,

mixtures and salts." If an article is not dutiable or free under some such provision as a last resort to obtain revenue, customs officials usually class it under paragraph 385 as an unenumerated, unmanufactured article, or as an unenumerated manufactured article. In many of these general provisions in the tariff act the classification depends upon use. Such classification is one of the most difficult to administer. For example, at the present time tanning extracts are free of duty while all dyeing extracts are dutiable, although in many cases these products overlap in use.

SPECIFIC VERSUS AD VALOREM DUTIES

The question as to what kind of duties should be levied on any given commodity—that is whether specific or ad valorem (based on value)—is a controversial one. However, it should be pointed out that in particular cases either a specific or an ad valorem rate has certain advantages. General ad valorem duties are objected to on the theory that it offers a chance for undervaluation on imports and at the present time they would be assessed on depreciated currency, as under the present law all ad valorem duties are assessed on the foreign market value. On the other hand, it is evident that in the case of goods varying widely in value an ad valorem duty would bear more evenly on the different articles or different grades of a chemical commodity than would a specific duty.

RECLASSIFICATION OF CHEMICALS

Some of the difficulties of classifying chemicals from a tariff standpoint have been cited and the question arises as to how the difficulties may be overcome. As a result of the commission's study in the chemical industries it has collected much information which would be of service in solving many of these difficulties of classification. At the present time, the chemical division of the commission is engaged in a reclassification of chemicals in Schedule A and those chemicals in the free list. An attempt is being made to eliminate conflicts in language which have caused frequent litigation in the past; to eliminate old and obsolete terms in chemical commodities, and to substitute chemicals which have become of commercial importance since the passage of the act of 1913. Even with the information and experience which has been gleaned in the past three or four years, it is hardly possible to write a tariff classification and description of chemical commodities which will entirely eliminate possible litigation. Certain changes in language can be made, however, which will reduce litigation to a minimum. Such a report on reclassification of chemicals has been nearly completed by the Tariff Commission and is to be presented to the Committee on Ways and Means as an aid in the present tariff revision.

A.C.S. Committee to Visit Edgewood

The American Chemical Society's committee which is co-operating in an advisory capacity with the Chemical Warfare Service will spend April 22 and 23 at Edgewood Arsenal. The object of the visit is to obtain first-hand impressions as to the progress of the work and to discuss current problems with the scientific staff at the arsenal. By making the visit at that time, the members of the committee will have the advantage of knowing the latest developments in all phases of the work, making them better able to consult with many other chemists in regard to it at the Rochester meeting.

Award of Willard Gibbs Medal to Mme. Curie

The Chicago Section of the American Chemical Society will hold a function of unusual interest this year in the presentation of the Willard Gibbs Medal to Mme. Marie Curie on June 14. Plans are under way for staging a brilliant affair under the leadership of the chairman, Dr. W. Lee Lewis. Large committees of reception composed of members of the section, representatives of foreign governments and city officials are being organized. Mme. Curie on this occasion will deliver an address of interest at once to scientists and laymen.

Argument on Minerals Separation Supplemental Bill

On April 2 the United States District Court at Wilmington, Del., heard arguments on the supplemental bill through which Minerals Separation, Ltd., seeks to have Minerals Separation North American Corporation made a party plaintiff in the Miami suit. The testimony had previously been taken and various documents placed in evidence.

The controversy concerns an agreement of July 8, 1913, between Minerals Separation, Ltd., and Minerals Separation North American Corporation and relates to whether this agreement did or did not constitute a sale of the patents of Minerals Separation, Ltd., or whether it was nothing more than a transfer to Minerals Separation North American Corporation of the equitable rights in those patents, leaving Minerals Separation, Ltd., the legal owner. The debatable points for the most part appear to be legal technicalities as to whether a certain transaction constituted an actual sale through which ownership of the patents passed from Minerals Separation, Ltd., to Minerals Separation North American Corporation at a time prior to the filing of the Miami infringement suit. If decided in the affirmative, the Miami suit would be dismissed. The controversy also centers in the question as to whether the failure of Minerals Separation North American Corporation to make the required disclaimer as to the claims of its patent which were declared invalid by the U. S. Supreme Court may not affect the rights of Minerals Separation, Ltd., to bring suit under the patent.

Weeks Considering Nitrate Division's Report

The Secretary of War is giving personal consideration to the question of continuing the Fixed Nitrogen Laboratory which the Department is conducting at American University, Washington, D. C. A full report on the needs of such a laboratory has been submitted by Major J. H. Burns, who is in charge of the Nitrate Division of the Ordnance Department. Secretary Weeks advised the Washington correspondent of CHEMICAL & METALLURGICAL ENGINEERING on April 13 that he had not reached a decision in the matter. He also stated that he had not made up his mind as to whether it is better to try to maintain the nitrate plants at Muscle Shoals in standby condition or whether there is a possibility of devising some means for their operation.

American Oil Chemists' Society to Meet in Chicago

The annual convention of the American Oil Chemists' Society will be held May 16 and 17 in Chicago, with headquarters at the Congress Hotel. Among the prominent chemists who will address the meeting is Dr. C. L. Alsberg, of the Bureau of Chemistry. The entertainment committee, with L. M. Tolman, chief chemist of Wilson & Co., as chairman, has planned numerous excursions, besides the usual banquet, which will occur on Tuesday evening.

As there are many chemists in and near Chicago interested in edible and technical oils and fats, the attendance promises to be larger than usual this year.

Thomas B. Caldwell of Wilmington, N. C., the secretary of the society, will be glad to furnish anyone interested with further details.

Protective Tariff Asked for South's Minerals

A formal request for a protective tariff on a number of mineral products produced in the South has been asked by representatives of these industries who appeared recently before the sub-committee on metals of the Ways and Means Committee. Schedules which will insure the development of the following minerals were asked: Asbestos, barytes, bauxite, clay, gypsum, graphite, marble, monazite, manganese, mica, potash, pyrites, quicksilver, sulphur, talc and zinc.

The Southern Tariff Association assisted in presenting the case. It was declared that nothing short of adequate duties would enable the development of the great mineral resources of the South, particularly the non-metallic minerals.

Book Reviews

THE DETERMINATION OF HYDROGEN IONS. By W. Mansfield Clark. 318 pp., illustrated. Baltimore: Williams & Wilkins Co., 1920. Price, \$5.

The most striking advance in analytical technique of the last five years has been in the exact determination of hydrogen ion concentrations, and, concomitantly, one of the most significant contributions of chemistry to the biological sciences and to a host of chemical applications has been the clear distinction between "available acidity" and "effective acidity," also called "total" and "actual" acidities, though Clark uses none of these terms. The determination of total, available or "titrable" acidity by titration has long been common practice, though with difficulty in colored, turbid or "buffer" media. The determination of how much of this acidity is present as actual hydrogen ions, and therefore effective, is recent, and the methods developed have been invaluable.

In this development Dr. W. Mansfield Clark has played a leading part, and this book embodies the experience of a master. It is thorough, both in theory and in laboratory suggestions, precise, and replete with references. The bibliography alone (64 pages) justifies the book. The theory presented is complete and rigorous; no pains are spared to discuss every possible difficulty in the methods; insidious errors are elucidated.

A list of chapter headings will prove this point: Some general relations among acids and bases; outline of the chief calorimetric procedure; theory of indicators; choice of indicators; standard buffer solutions for colorimetric comparisons; approximate determinations with indicators; outline of the electrometric method; theory of the hydrogen electrode; potential differences at liquid junctions; hydrogen and calomel electrodes and electrode vessels; the potentiometer and accessory equipment; hydrogen generators, wiring, shielding, temperature control, purification of mercury; the relation of hydrogen electrode to reduction potentials; sources of error in electrometric measurements of p_H ; standard solutions for checking hydrogen electrode measurements; standardization of p_H measurements; supplementary methods; applications; bibliography.

Addressed to research workers in the biological sciences, the book admirably fulfills its purpose and equips them for the justly feared task of determining p_H to the third decimal. It makes usable the excellent precise apparatus developed by American manufacturers. Its strength in this aspect is, however, rather an obstacle to chemists. Except in biological media the third decimal of the p_H value is not significant, and the corresponding measurement of voltage to the fourth decimal is wholly unnecessary. While dangers and pitfalls are faithfully pointed out, no safe path is recommended. Full discussions of the effect on the fourth decimal of the purification of calomel and the size of calomel grains, etc., which form the mass of the book—protein errors, salt errors, and a host of others—give the unfortunate impression that the determination of hydrogen ions is a tremendous task and one to be undertaken only by those whose funds and time and intellect are unlimited.

This is unfortunate both because p_H measurements to the first decimal are actually among the easiest of all chemical determinations either by calorimetric or by electrometric means, and because such determinations when thus simply made give valuable information in almost numberless cases. It is not improbable that the majority of industrial acidimetric titrations, which give total acidity, should be replaced by measurements of the actual or effective acidity. Yet the needs of the industrial chemists are not considered in this book. The reviewer therefore regrets that Dr. Clark did not add a few brief chapters on simplified theories, methods and applications, for which there is such a demand. The fact remains, however, that he has produced a book that for many years will be indispensable to research workers.

GERALD L. WENDT.

Personal

HUBB BELL has left the Pittsburgh Testing Laboratory and is now with the United States Testing Co., Inc., 313 Hudson St., New York City.

RALPH W. BOYD has resigned as chemist of the metallurgical research department of the Colorado School of Mines and is now associated with the Desert Shale Oil Corporation of Salt Lake City.

WALTER E. DALY, secretary and treasurer of the Pioneer Alloy Products Co., will leave for Rio de Janeiro and Buenos Aires the first part of May.

F. P. GEYER, chief geologist of the Maryland Refining Co., Ponca City, Okla., has been elected a director of the company, succeeding J. Dawson Callery, resigned.

Major ADELNO GIBSON, who has been on duty with the General Staff, has been ordered to report to the chief of the Chemical Warfare Service.

Dr. FREDERICK GOWLAND HOPKINS, professor of biochemistry at Cambridge University, England addressed the students of Johns Hopkins Medical School, Baltimore, Md., on April 12.

B. F. JONES has resigned as president of the Republic Rubber Co., Youngstown, Ohio.

Dr. R. E. ROSE, director of the technical laboratory of the dyestuffs department of E. I. du Pont de Nemours & Co., Wilmington, Del., gave an interesting address on April 5 at Wilmington in connection with the showing of motion pictures of the company's dye works for the first time.

Dr. ALONZO E. TAYLOR, professor of physiological chemistry at the University of Pennsylvania, and JOSEPH S. DAVIS, assistant professor of economics at Harvard, have been named directors of the Food Research Institute, which is to begin work at Stanford University on July 1, under the direction of Dr. C. L. Alsberg, now chief of the United States Bureau of Chemistry.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, April 18, 1921.

The chemical market during the past week has shown no unusual activity. Individual transactions have been mostly of a small nature with a moderate exchange of carlots in some of the more important items. There was a better call noted for medicinal chemicals, but these were sold mostly in small quantities and the volume has not been of large dimensions. The general condition of the market with all its adversities, however, has improved.

Among some of leading factors opinions are quite cheerful regarding the outlook. This no doubt is due to a renewal of buying interest. Although March and April sales have been better than those in preceding months, no one is impressed with the idea that any rapid revival of business can take place. The long drawn-out interval of liquidation, with all its depressing influences, will not permit a quick recovery. There will be temporary intermittent periods of dullness and activity but indications favor an increase more than a decrease in business.

Manufacturers are finding more requests for *caustic soda* and *soda ash*. The latter chemical has been in fair demand for several weeks. Sales have been recorded to Mexico and South American countries and seem to be increasing daily. Domestic textile mills have bought caustic, while a better call for dense ash is being felt from the glass industry. The broadening out of the demand for these two big basic chemicals is very significant, as they are considered by many to be the best barometers to the chemical situation.

There have been reports of purchases of German *caustic potash* at 8@9c. per lb. by prominent consumers. The resale American grade, 88-92 per cent, is to be had as low as 7½@8½c. per lb. Domestic producers are still holding their price up to 12½c., but admit they cannot compete under the relatively high overhead expenses here. Foreign *muriate of potash* is being offered at prices which make it difficult for the domestic makers to sell, and it is understood that plants here have closed down at some points. Foreign *bleach* has been sold in large quantities at 2½c. per lb. N. Y. and *oxalic acid* for shipment from abroad has been offered at 16c. per lb. Paper mills have bought *bleaching powder* at 2¼@2½c. in large drums, although producers are asking as high as 2¾c. *Citric acid* has continued to show strength under higher cable advices from primary points abroad. Several inquiries have reached the market for *arsenic*, but actual business has not been large. *Cyanide of soda* has attracted attention, with the American grade in strong demand.

In general it can be stated that business conditions throughout show many unmistakable signs of improvement. There is in all probability a great deal of liquidation to be accomplished. There is still a vast amount of frozen credit that must be thawed out. The big thing that must be accomplished is the revival of our export business. There is much encouragement noted in Washington at results obtained by the War Finance Corporation on export credit.

GENERAL CHEMICALS

More activity for standard *bichromate of soda* on spot is reported by dealers. Sales went through at 7½c. per lb. and it is doubtful if this price could be shaded on any sizeable quantities. It is stated that a number of 5 and 10 ton lots have been sold and quite a little business could be placed at 7½c. per lb. if sellers would meet these figures. Holders are showing a disposition to tighten up offerings on first appearances of real business. White granular *sal ammoniac* is offered by importers as low as 6½@7½c. per lb. on spot. Makers are holding their prices around 10c. for this grade. *White arsenic* is quoted at 8@8½c. per lb., according to quantity and seller. Business has been slower than the season justified. Recent sales of large lots of *acetate of lime* at \$1.50 per 100 lb. have cleaned up the greater part of stocks offered at this figure, although there still remain some supplies that can be purchased at this level on a firm bid. Openly quoted prices are now around \$2 per 100 lb. The sale of this material at concessions has demoralized the acetic acid market to a great extent. *Muriate of potash* prices are lower on the spot following the offers of heavily distressed lots. Quotations around \$52@55 per ton are heard for prompt delivery. Lower prices are named for imported prussiates. *Red prussiate of potash* is quoted lower at 35@40c. per lb. *Yellow prussiate of potash* is offered freely at 26@28c. per lb. Manufacturers' prices on *soda ash* are held steady at \$1.72½ per 100 lb., basis 48 per cent, f.o.b. works, in single bags. The spot market for domestic material is around \$1.95@2.05 per 100 lb. Resale offerings of *nitrate of soda* are heard lower, in spite of recent advances announced by importers to \$3 per 100 lb. Spot material can be had as low as \$2.50 per 100 lb. It is hard at present to say which course the market will take, although resale stocks are known to be fairly heavy. Resale lots of *formaldehyde* have reached the market at 14c. per lb. and sales have been recorded from this figure up to 15c. It is stated that a considerable amount of small sales has been transacted for agricultural purposes.

COAL-TAR PRODUCTS

Trading in the coal-tar products market during the past week has continued without feature and with very slow demand. Buying has been on a strictly limited scale, with most consumers afraid to lower prices and consequently refusing to take on stocks of any magnitude. Manufacturers are looking forward with great fear to the action at the present session of Congress on the dye question which will probably either make them or break them. Producers seem to be awaiting the word of Congress before junking their plants or initiating extensive building operations.

Prices as a rule have held fairly steady in spite of the lack of interest. Resellers can be found who will cut any price quoted on the slightest show of interest from a prospective buyer, but this attitude is almost entirely absent from the producers' market, where it is felt that concessions should be given only in the face of firm business. Makers have reduced prices on *dinitrobenzene* and *dinitrochlorbenzene*. Producers of *beta naphthol* are holding their quoted price at 40@45c. per lb., although spot lots are still be had as low as 32@34c. per lb. Business has been very slow, and it is understood that while spot stocks are being gradually moved into consuming channels, enough is still available to last for some time at the present rate of movement.

SODIUM COMPOUNDS DURING 1919 AND 1920

According to figures compiled by R. C. Wells of the U. S. Geological Survey, Department of the Interior, the production imports and exports of sodium compounds all increased in 1920 over 1919. The following table shows the complete sales of the individual products sold in the United States in 1919 and 1920:

Product	1919	1920
	Short Tons	
Sodium acetate.....	778	1,020
Sodium bicarbonate.....	134,962	188,906
Sodium bichromate.....	26,526	25,973
Sodium bisulphite.....	11,819	22,059
Soda ash.....	981,054	1,242,490
Salsoda.....	80,090	62,857
Sodium hydroxide.....	311,388	382,680
Sodium nitrite.....	676	140
Sodium phosphate.....	14,760	30,615
Sodium silicate.....	300,138	304,503
Salt cake.....	134,685	184,946
Glauber's salt.....	42,087	44,479
Niter cake.....	83,402	308,638
Sodium sulphide.....	45,448	42,952

Sodium bichromate, nitrate and salsoda were the only compounds that showed considerable decreases in 1920. Several of the compounds made good advances over 1919 and sodium bicarbonate, bisulphite and phosphate made new records.

The following table gives the exports of domestic sodium compounds for 1919 and 1920. It will be noted that good increases were made in 1920. Japan, Canada and Mexico were the leading consumers of our exports:

Product	1919	1920
	Short Tons	
Sodium bicarbonate.....	.....	10,321
Soda ash.....	50,481	8,338
Salsoda.....	5,563	6,015
Sodium chloride.....	119,416	139,278
Sodium hydroxide.....	82,118	112,069
Sodium silicate.....	12,150	17,048
Sodium borate.....	.....	7,163

The Iron and Steel Market

PITTSBURGH, April 15, 1921.

After several weeks in which developments were distinctly unimportant the steel market has in the past week exhibited some very interesting movements. The independents, which had been quoting prices well below the Steel Corporation or Industrial Board prices, advanced their prices slightly and then the Steel Corporation reduced its prices, whereby the corporation and independents are on the same price level, a condition that has existed only occasionally since the period of Government control.

PRICES IN DETAIL

By an announcement made late on April 12 the Steel Corporation reduced its prices as follows: Bars, from 2.35c. to 2.10c.; shapes, from 2.45c. to 2.20c.; plates, from 2.65c. to 2.20c. Nails were reaffirmed at \$3.25, base, per keg, while plain wire was set at 3c. That had been the Industrial Board price, but in August, 1919, the corporation had advanced to 3.25c. Tin plate was reduced from \$7 to \$6.25, per base box, 100-lb. A week ago independent prices were 2c. on bars and 2.10c. on shapes and plates, in carload lots, while concessions below these prices were obtainable on larger lots. Nails had been \$3 in the independent market.

Yesterday the American Sheet & Tin Plate Co. decided upon its new prices for sheets, blue annealed being reduced from 3.65c. to 3.10c., black sheets from 4.35c. to 4c. and galvanized sheets from 5.70c. to 5c. The independent market a week ago was 2.80@2.90c. on blue annealed, 3.75c. on black and 4.75@4.80c. on galvanized.

Tubular goods, hoops and a number of other commodities remain to be acted upon by the Steel Corporation.

WAGES

With these reductions in prices the Steel Corporation does not reduce wages. The independents have made various reductions, beginning early last December, and in general are paying rates about 20 per cent below the old scale, maintained by the corporation. The corporation had been expected to reduce wages when it should reduce prices, but the present reductions are not as great as the corporation was expected eventually to make. Probably the corporation had hoped for a time that eventually one single reduction could be made that would put the market on a stable basis for a long period, but that plan had to be abandoned. Also, the corporation had been working on plans to eliminate the 12-hour day, it being presumably the intention to make the change in working conditions at the same time as the wage rates were changed, and this change is likewise deferred.

OPERATIONS AND ORDERS

The Steel Corporation's operations are now at about 40 per cent, on the basis of ingot production to capacity, having decreased from an average of 90 per cent in January. Independent mill operations are now at about 35 per cent of capacity. Practically all reports and estimates in the trade have understated the rate of independent mill operations since the first of the year, this being perhaps a psychological phenomenon. There is good reason to believe the independents operated at about 30 per cent in both January and February and at about 32 per cent in March.

The reductions by the Steel Corporation are likely to bring the corporation a good batch of "releases" against suspended orders and of specifications against contracts, whereby corporation operations may increase somewhat in the next few weeks, say to 50 per cent. Report has it that in advancing their prices the independents secured closing of a number of orders on quotations they had outstanding, and thus the independents may run slightly better in the next few weeks, without booking much additional business now.

It is idle, of course, to expect the price reductions of the Steel Corporation and the equalization in the market to produce much if any additional consumption of steel. A rough classification is that steel is bought by railroads for their own use, by investors for construction purposes, and by manufacturing consumers for making into wares which they sell. As to the railroads, they cannot be interested, since their present position is that they cannot pay for all the rails they had already ordered for this year. As to investors, they are waiting on better financial conditions and lower wage costs in construction work. As to manufacturing consumers, they must sell their wares if they buy steel, whatever the price of the steel.

PIG IRON

The pig iron market remains stagnant. There are stocks of basic iron in the hands of steel works which the steel producers would be willing to sell. Although only about a score of merchant blast furnaces are in operation in the whole country, there are merchant stocks of considerable size, since many furnaces accumulated iron before they went out. The foundries have been reducing their stocks, but their operations appear to have decreased materially in the past few weeks. Quotations, largely nominal, remain at \$25 for bessemer, foundry and malleable, at \$23 for basic, f.o.b. valley furnace, freight to Pittsburgh being \$1.96.

COKE

It is learned that the recent sale of a round block of Connelville furnace coke to the furnace at Portsmouth, Ohio, was at \$3.50 instead of at \$3.75, the price first reported, and another furnace interest has since bought about 1,000 tons at \$3.50, so that the market seems established at that figure, a price as low as can be expected and representing a very fair liquidation in this item of the cost of making pig iron.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.			\$0.40 - \$0.45	
Acetone.....lb.	\$0.13	\$0.13½	.13½ - .14	
Acid, acetic, 28 per cent.....100 lbs.	2.50	2.75	3.00 - 3.25	
Acetic, 56 per cent.....100 lbs.	4.00	4.25	4.50 - 5.50	
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	9.50	9.75	10.00 - 10.50	
Boric, crystals.....lb.	.13½	.14	.14½ - .15	
Boric, powder.....lb.	.15	.15½	.16 - .16½	
Citric.....lb.			.47 - .50	
Hydrochloric.....100 lb.	1.60	1.75	2.00 - 2.20	
Hydrofluoric, 52 per cent.....lb.	.13	.13½	.14 - .14½	
Lactic, 44 per cent tech.....lb.	.10	.11	.11½ - .12	
Lactic, 22 per cent tech.....lb.	.04½	.05½	.06 - .07	
Molybdic, C. P.....lb.	4.00	4.50	4.50 - 5.00	
Muriatic, 20 deg. (see hydrochloric).....lb.				
Nitric, 40 deg.....lb.	.06½	.06½	.07 - .07½	
Nitric, 42 deg.....lb.	.07½	.07½	.07½ - .08½	
Oxalic, crystals.....lb.	.16½	.17	.18 - .19	
Phosphoric, Ortho, 50 per cent solution.....lb.	.17	.17½	.18 - .19	
Picric.....lb.	.30	.32	.35 - .40	
Pyrogallic, resublimed.....lb.			1.90 - 2.15	
Sulphuric, 60 deg., tank cars.....ton				
Sulphuric, 60 deg., drums.....ton			14.00 - 15.00	
Sulphuric, 66 deg., tank cars.....ton	19.00	20.00		
Sulphuric, 66 deg., drums.....ton	22.00	22.50	23.00 - 23.50	
Sulphuric, 66 deg., carboys.....ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00	24.00		
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00	26.00	26.50 - 27.00	
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00	35.00	40.00 -	
Tannic, U. S. P.....lb.			1.00 - 1.10	
Tannic (tech.).....lb.	.50	.52	.54 - .57	
Tartaric, crystals.....lb.			.36 - .40	
Tungstic, per lb. of WO.....lb.			1.30 - 1.40	
Alcohol, Ethyl.....gal.			4.90 - 5.25	
Alcohol, Methyl (see methanol).....gal.				
Alcohol, denatur ed, 188 proof.....gal.			.36 - .40	
Alcohol, denatur ed, 190 proof.....gal.			.40 - .45	
Alum, ammonia lump.....lb.	.04	.04½	.04½ - .04½	
Alum, potash lump.....lb.	.05½	.06	.06½ - .07	
Alum, chrome lump.....lb.	.13	.13½	.14 - .14½	
Aluminium sulphate, commercial.....lb.	.02½	.02½	.02½ - .03	
Aluminium sulphate, iron free.....lb.	.03	.03½	.03½ - .03½	
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07	.07½	.07½ - .08	
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30	.32	.33 - .35	
Ammonium carbonate, powder.....lb.	.07½	.08	.08½ - .10	
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	.06½	.06½	.07 - .07½	
Ammonium chloride, granular (gray salamoniac).....lb.	.08½	.08½	.09 - .09½	
Ammonium nitrate.....lb.	.08	.08½	.09 - .10	
Ammonium sulphate.....100 lb.	2.75	2.85	2.90 - 3.00	
Amylacetate.....gal.			4.00 - 4.25	
Amylacetate tech.....gal.			3.00 - 3.25	
Arsenic oxide, (white arsenic) powdered lb.....lb.	.08	.08½	.09 - .10	
Arsenic, sulphide, powdered (red arsenic) lb.....lb.	.12	.12½	.13 - .14	
Barium chloride.....ton	60.00	65.00	70.00 - 75.00	
Barium dioxide (peroxide).....lb.	.19	.20	.21 - .22	
Barium nitrate.....lb.	.11	.11½	.12 - .12½	
Barium sulphate (precip.) (blanc fixe).....lb.	.04½	.05	.05½ - .06	
Bleaching powder (see calc. hypochlorite).....lb.				
Blue vitriol (see copper sulphate).....lb.				
Borax (see sodium borate).....lb.				
Brimstone (see sulphur, roll).....lb.	.40	.41	.42 - .45	
Bromine.....lb.				
Calcium acetate.....100 lbs.	1.75	2.00		
Calcium carbide.....lb.	.04½	.04½	.05 - .05½	
Calcium chloride, fused, lump.....ton	27.00	29.00	30.00 - 32.00	
Calcium chloride, granulated.....lb.	.01½	.01½	.02 - .02½	
Calcium hypochlorite (bleach powder) 100 lb.....lb.	2.40	2.60	2.75 - 3.00	
Calcium peroxide.....lb.			1.25 - 1.50	
Calcium phosphate, tribasic.....lb.			.15 - .16	
Camphor.....lb.			.63 - .65	
Carbon bisulphide.....lb.	.07	.07½	.07 - .08	
Carbon tetrachloride, drums.....lb.	.10	.10½	.11 - .12	
Carbonyl chloride (phosgene).....lb.			.75 - 1.00	
Caustic potash (see potassium hydroxide).....lb.				
Caustic soda (see sodium hydroxide).....lb.				
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08	.09	.09½ - .10	
Chloroform.....lb.			.38 - .40	
Cobalt oxide.....lb.			3.00 - 3.10	
Copper as (see iron sulphate).....lb.				
Copper carbonate, green precipitate.....lb.	.23	.24	.25 - .27	
Copper cyanide.....lb.			.50 - .62	
Copper sulphate, crystals.....lb.	.05½	.05½	.06 - .06½	
Cream of tartar (see potassium bitartrate).....lb.				
Epsom salt (see magnesium sulphate).....lb.				
Ethyl Acetate Com. 85%.....gal.			.90 - 1.00	
Ethyl Acetate pure (acetic ether 98% to 100%).....gal.				
Formaldehyde, 40 per cent.....lb.	.14	.14½	.14½ - .15	
Fusel oil, ref.....gal.			3.25 - 3.50	
Fusel oil, crude.....gal.			1.75 - 2.00	
Glauber's salt (see sodium sulphate).....lb.				
Glycerine, C. P. drums extra.....lb.			.17 - .17½	
Iodine, resublimed.....lb.			3.75 - 3.85	
Iron oxide, red.....lb.			.10 - .20	
Iron sulphate (copperas).....100 lb.	.75	1.00	1.10 - 1.25	
Lead acetate.....lb.			.11 - .13½	
Lead arsenate, paste.....lb.	.08½	.09	.09 - .10	
Lead nitrate.....lb.			.15 - .20	
Litharge.....lb.	.08½	.09	.09 - .10	
Lithium carbonate.....lb.			1.25 -	
Magnesium carbonate, technical.....lb.	.10½	.11	.11 - .12	
Magnesium sulphate, U. S. P.....100 lb.	2.75	3.00		
Magnesium sulphate, technical.....100 lb.			2.25 - 2.50	
Methanol, 95%.....gal.			.75 - .77	
Methanol, 97%.....gal.			.78 - .82	
Nickel salt, double.....lb.			.13 - .13½	
Nickel salt, single.....lb.			.14 - .14½	
Phosgene (see carbonyl chloride).....lb.				
Phosphorus, red.....lb.	.45	.46	.47 - .50	
Phosphorus, yellow.....lb.			.35 - .37	
Potassium bichromate.....lb.	.12	.12½	.12½ - .13	

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar) . . . lb.	\$. . . - \$. . .	\$0.30 - \$0.35
Potassium bromide, granular . . . lb.	. . . - . . .	.20 - .40
Potassium carbonate, U. S. P. . . lb.	.35 - .40	.45 - .50
Potassium carbonate, crude . . . lb.	.06½ - .07	.08 - .09
Potassium chlorate, crystals . . . lb.	.07½ - .08	.09 - .14
Potassium cyanide . . . lb.	. . . - . . .	.32 - .35
Potassium hydroxide (caustic potash) . . lb.	.08 - .08½	.09 - .10
Potassium muriate . . . ton	52.00 - 55.00	. . . - . . .
Potassium iodide . . . lb.	. . . - . . .	2.75 - 3.00
Potassium nitrate . . . lb.	.09½ - .09½	.10 - .12½
Potassium permanganate . . . lb.	.35 - .37	.39 - .40
Potassium prussiate, red . . . lb.	.35 - .37	.38 - .40
Potassium sulphate, yellow . . . lb.	.26 - .27	.28 - .29
Potassium sulphate (powdered) . . . per unit	. . . - . . .	1.75 - 1.80
Rochelle salts (see sodium potas tartrate)	. . . - . . .	. . . - . . .
Salammoniac (see ammonium chloride)	. . . - . . .	. . . - . . .
Sal soda (see sodium carbonate)	. . . - . . .	. . . - . . .
Salt cake . . . ton	. . . - . . .	32.00 - 34.00
Silver cyanide . . . oz.	. . . - . . .	1.30 - 1.35
Silver nitrate . . . oz.	. . . - . . .	.39 - .40
Soda ash, light . . . 100 lb.	1.95 - 2.10	2.15 - 2.40
Soda ash, dense . . . 100 lb.	2.20 - 2.30	2.40 - 2.60
Sodium acetate . . . lb.	.04½ - .05	.05½ - .06
Sodium bicarbonate . . . 100 lb.	2.50 - 2.60	2.70 - 3.00
Sodium bichromate . . . lb.	.07½ - .08	.08½ - .08½
Sodium bisulphate (nitre cake) . . . ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphite powdered, U.S.P. . . lb.	.05½ - .05½	.05½ - .06
Sodium borate (borax) . . . lb.	.06½ - .06½	.07 - .07½
Sodium carbonate (sal soda) . . . 100 lb.	1.90 - 2.00	2.25 - 2.50
Sodium chlorate . . . lb.	.08½ - .09	.09½ - .10
Sodium cyanide, 96-98 per cent . . . lb.	.19 - .20	.21 - .30
Sodium fluoride . . . lb.	.12 - .12½	.13 - .14
Sodium hydroxide (caustic soda) . . . 100 lb.	3.65 - 3.75	3.80 - 4.00
Sodium hyposulphite . . . lb.	. . . - . . .	.03½ - .04
Sodium nitrate . . . 100 lb.	2.50 - . . .	2.60 - . . .
Sodium nitrite . . . lb.	.06 - .06½	.06½ - .07
Sodium peroxide, powdered . . . lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic . . . lb.	.04½ - .04½	.05 - .05½
Sodium potassium tartrate (Rochelle salts) lb.	. . . - . . .	.27 - .28
Sodium prussiate, yellow . . . lb.	.12½ - .12½	.13 - .13½
Sodium silicate, solution (40 deg.) . . . lb.	1.25 - 1.35	1.40 - 1.50
Sodium silicate, solution (60 deg.) . . . lb.	.03 - .03½	.03½ - .03½
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.75 - 2.00	2.25 - 2.50
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.05½ - .05½	.06 - .06½
Sodium sulphite, crystals . . . lb.	.04 - .04½	.04½ - .05
Strontium nitrate, powdered . . . lb.	.16 - .16	.17 - .18
Sulphur chl. ride, red . . . lb.	.07 - .07½	.07½ - .08
Sulphur, crude . . . ton	20.00 - 22.00	. . . - . . .
Sulphur dioxide, liquid, cylinders extra . . lb.	.08 - .08½	.09 - .10
Sulphur (sublimed), flour . . . 100 lb.	. . . - . . .	2.25 - 3.10
Sulphur, roll (brimstone) . . . 100 lb.	. . . - . . .	2.00 - 2.75
Tin bichloride, 50 per cent . . . lb.	.18 - .19	. . . - . . .
Tin oxide . . . lb.	. . . - . . .	.40 - .42
Zinc carbonate, precipitate . . . lb.	.16 - .18	.19 - .20
Zinc chloride, gran . . . lb.	.11 - .11½	.11½ - .12
Zinc cyanide . . . lb.	.45 - .49	.50 - .60
Zinc dust . . . lb.	.12 - .13	.13½ - .14
Zinc oxide, XX . . . lb.	.08½ - .09	.09½ - .10
Zinc sulphate . . . lb.	.03½ - .03½	.04 - .05

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude . . . lb.	\$1.15 - \$1.25
Alpha-naphthol, refined . . . lb.	1.45 - 1.50
Alpha-naphthylamine . . . lb.	.38 - .40
Aniline oil, drums extra . . . lb.	.20 - .26
Aniline salts . . . lb.	.26 - .29
Anthracene, 80% in drums (100 lb.) . . lb.	.75 - 1.00
Benzaldehyde U.S.P. . . lb.	1.00 - 1.50
Benzidine, base . . . lb.	.90 - 1.00
Benzidine sulphate . . . lb.	.75 - .80
Benzoic acid, U.S.P. . . lb.	.65 - .70
Benzoate of soda, U.S.P. . . lb.	.65 - .70
Benzene, pure, water-white, in drums (100 gal.) gal.	.27 - .32
Benzene, 90%, in drums (100 gal.) . . gal.	.25 - .28
Benzyl chloride, 95-97%, refined . . . lb.	.28 - .30
Benzyl chloride, tech. . . lb.	.25 - .27
Beta-naphthol benzoate . . . lb.	3.50 - 4.00
Beta-naphthol, sublimed . . . lb.	.70 - .75
Beta-naphthol, tech . . . lb.	.33 - .45
Beta-naphthylamine, sublimed . . . lb.	2.25 - 2.40
Cresol, U. S. P., in drums (100 lb.) . . lb.	.16 - .18
Ortho-cresol, in drums (100 lb.) . . lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums . . gal.	.90 - .95
Cresylic acid, 95-97%, dark, in drums . . gal.	.85 - .90
Cresylic acid, 50%, first quality, drums . . gal.	.55 - .60
Dichlorobenzene . . . lb.	.06 - .09
Diethylaniline . . . lb.	1.20 - 1.25
Dimethylaniline . . . lb.	.48 - .55
Dinitrobenzene . . . lb.	.32 - .35
Dinitrochlorobenzene . . . lb.	.30 - .30
Dinitronaphthalene . . . lb.	.30 - .40
Dinitrophenol . . . lb.	.35 - .40
Dinitrotoluene . . . lb.	.25 - .27
Dip oil, 25%, tar acids, car lots, in drums . . gal.	.40 - .45
Diphenylamine . . . lb.	.60 - .70
H-acid . . . lb.	1.30 - 1.50
Meta-phenylenediamine . . . lb.	1.20 - 1.25
Monochlorobenzene . . . lb.	.14 - .16
Monochethylaniline . . . lb.	1.75 - 1.85
Naphthalene crushed, in bbls. (250 lb.) . . lb.	.08 - .08½
Naphthalene, flake . . . lb.	.08½ - .09½
Naphthalene, balls . . . lb.	.09½ - .10½
Naphthionic acid, crude . . . lb.	.70 - .75
Nitrobenzene . . . lb.	.12 - .15
Nitro-naphthalene . . . lb.	.30 - .35
Nitro-toluene . . . lb.	.16 - .18
Ortho-amidophenol . . . lb.	3.20 - 3.75
Ortho-dichlor-benzene . . . lb.	.15 - .20
Ortho-nitro-phenol . . . lb.	.75 - .80
Ortho-nitro-toluene . . . lb.	.17 - .20
Ortho-toluidine . . . lb.	.20 - .25
Para-amidophenol, base . . . lb.	1.75 - 1.85
Para-amidophenol, HCl . . . lb.	2.00 - 2.10

Para-dichlorobenzene . . . lb.	.15 - .20
Paranitroaniline . . . lb.	.90 - 1.05
Para-nitrotoluene . . . lb.	.85 - 1.00
Para-phenylenediamine . . . lb.	1.95 - 2.00
Para-toluidine . . . lb.	1.25 - 1.60
Phthalic anhydride . . . lb.	.50 - .60
Phenol, U. S. P., drums (dest.), (240 lb.) . . lb.	.11 - .13
Pyridine . . . gal.	2.00 - 3.50
Resorcinol, technical . . . lb.	1.75 - 1.85
Resorcinol, pure . . . lb.	2.25 - 2.30
Salicylic acid, tech., in bbls. (110 lb.) . . lb.	.22 - .23
Salicylic acid, U. S. P. . . lb.	.21 - .22
Salol . . . lb.	.85 - .95
Solvent naphtha, water-white, in drums, 100 gal. . . gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal. . . gal.	.14 - .16
Sulphanilic acid, crude . . . lb.	.30 - .35
Tolidine . . . lb.	1.35 - 1.45
Toluidine, mixed . . . lb.	.40 - .45
Toluene, in tank cars . . . gal.	.25 - .28
Toluene, in drums . . . gal.	.28 - .31
Xylidines, drums, 100 gal. . . lb.	.40 - .45
Xylene, pure, in drums . . . gal.	.42 - .45
Xylene, pure, in tank cars . . . gal.	.45 - .45
Xylene, commercial, in drums, 100 gal. . . gal.	.33 - .35
Xylene, commercial, in tank cars . . . gal.	.30 - .30

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark . . . lb.	\$0.24 - \$0.26
Beeswax, refined, light . . . lb.	.27 - .28
Beeswax, white pure . . . lb.	.40 - .45
Carnauba, Flora . . . lb.	.68 - .70
Carnauba, No. 2, North Country . . . lb.	.30 - .32
Carnauba, No. 3, North Country . . . lb.	.18 - .19
Japan . . . lb.	.19½ - .19½
Montan, crude . . . lb.	.07 - .08
Paraffine waxes, crude match wax (white) 105-110 m.p. . . lb.	.04 - .04
Paraffine waxes, crude, scale 124-126 m.p. . . lb.	.03 - .03
Paraffine waxes, refined, 118-120 m.p. . . lb.	.04 - .04½
Paraffine waxes, refined, 125 m.p. . . lb.	.04½ - .04½
Paraffine waxes, refined, 128-130 m.p. . . lb.	.05 - .06
Paraffine waxes, refined, 133-135 m.p. . . lb.	.06 - .06½
Paraffine waxes, refined, 135-137 m.p. . . lb.	.06½ - .06½
Stearic acid, single pressed . . . lb.	.11 - .11
Stearic acid, double pressed . . . lb.	.11½ - .11½
Stearic acid, triple pressed . . . lb.	.12 - .12½

Flotation Oils

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Pine oil, steam dist., sp.gr., 0.930-0.940 . . . gal.	\$1.70
Pine oil, pure, dest. dist. . . gal.	1.60
Pine tar oil, ref., sp.gr. 1.025-1.035 . . . gal.	.48
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla. . . gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990 . . . gal.	.75
Pine tar, ref., thin, sp.gr., 1.080-1.960 . . . gal.	.36
Turpentine, crude, sp. gr., 0.900-0.970 . . . gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990 . . gal.	.37
Pinewood creosote, ref. . . gal.	.55

Naval Stores

The following prices are f.o.b. New York for carload lots.

Rosin B-D, bbl. . . 280 lb.	\$4.90 - . . .
Rosin E-I . . . 280 lb.	5.15 - . . .
Rosin K-N . . . 280 lb.	5.50 - . . .
Rosin W. G.-W. W. . . 280 lb.	6.00 - . . .
Wood rosin, bbl. . . 280 lb.	6.25 - . . .
Spirits of turpentine . . . gal.	.58 - . . .
Wood turpentine steam dist . . . gal.	.57 - . . .
Wood turpentine, dest. dist. . . gal.	.56 - . . .
Pine tar pitch, bbl. . . 200 lb.	. . . - 7.00
Tar, kiln burned, bbl. (500 lb.) . . . bbl.	. . . - 14.50
Retort tar, bbl. . . 500 lb.	15.00 - 14.75
Rosin oil, first run . . . gal.	.45 - . . .
Rosin oil, second run . . . gal.	.48 - . . .
Rosin oil, third run . . . gal.	.60 - . . .

Solvents

73-76 deg., steel bbls. (85 lb.) . . . gal.	\$0.41
70-72 deg., steel bbls. (85 lb.) . . . gal.	.39
68-70 deg., steel bbls. (85 lb.) . . . gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.) . . gal.	.30

Crude Rubber

Para—Upriver fine . . . lb.	\$0.17 - \$0.18
Upriver coarse . . . lb.	.11½ - .12½
Upriver caucho ball . . . lb.	.14 - .14½
Plantation—First latex crepe . . . lb.	.18½ - . . .
Ribbed smoked sheets . . . lb.	.16½ - . . .
Brown crepe, thin, clean . . . lb.	.18 - . . .
Amber crepe No. 1 . . . lb.	.20 - . . .

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls. . . lb.	\$0.08½ - \$0.09½
Castor oil, AA, in bbls. . . lb.	.09½ - .10
China wood oil, in bbls. (f.o.b. Pac. coast) . . lb.	.08½ - .08½
Cocoonut oil, Ceylon grade, in bbls. . . lb.	.09½ - .10
Cocoonut oil, Cochinchina grade, in bbls. . . lb.	.10½ - .10½
Corn oil, crude, in bbls. . . lb.	.07½ - .08
Cottonseed oil, crude (f. o. b. mill) . . . lb.	.03½ - .04
Cottonseed oil, summer yellow . . . lb.	.06 - . . .
Cottonseed oil, winter yellow . . . lb.	.06½ - . . .
Linseed oil, raw, car lots (domestic) . . . gal.	.56 - .57
Linseed oil, raw, tank cars (domestic) . . . gal.	.50 - . . .
Linseed oil, in 5-bbl lots (domestic) . . . gal.	.59 - .60

Olive oil, commercial.....	gal	\$1.90	—	\$2.50
Palm, Lagos.....	lb.	.07	—	.07½
Palm, Niger.....	lb.	.06	—	.06½
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.05½	—	.05¾
Peanut oil, refined, in bbls.....	lb.	.10	—	.10½
Rapeseed oil, refined in bbls.....	gal.	.90	—	.95
Rapeseed oil, brown, in bbls.....	gal.	1.00	—	1.05
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07½	—	.07¾
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.04½	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.45	—	\$0.47
Yellow bleached menhaden.....	gal.	.47	—	.....
White bleached menhaden.....	gal.	.49	—	.....
Blown menhaden.....	gal.	.84	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	17.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.30	—	.....
Blanc fixe, dry.....	lb.	.05	—	.05½
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.16
Chalk, domestic, extra light.....	lb.	.05	—	.05½
Chalk, domestic, light.....	lb.	.04½	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04½	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	25.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07½	—	.08
Graphite, Ceylon chip.....	lb.	.06	—	.06½
Graphite, high grade amorphous crude.....	lb.	.02½	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.57	—	.....
Shellac, orange superfine.....	lb.	.60	—	.....
Shellac, A. C. garnet.....	lb.	.45	—	.....
Shellac, T. N.....	lb.	.45	—	.....
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	14.00	—	15.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	35.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	.....
Carborundum refractory brick, 9 in. less than earlot	1,000	1250 00	.....
..... earlot lots	1,000	1100 00	.....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	80-100	.....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	45-50	.....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	.....	55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	.....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	.....
Magnesite brick, 9-in. straight.....	net ton	90	.....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105	.....
Magnesite brick, soaps and splits.....	net ton	120	.....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	45-55	.....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	45-55	.....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	45-55	.....

Ferro-Alloys

All f.o.b. Works

Ferr-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, earlots.....	lb.	.15	—	.16
Ferrochrome per lb. of Cr. contained, 4-6% carbon, earlots.....	lb.	.16	—	.17
Ferromanganese, 76-80% Mn, domestic.....	gross ton	85.00	—	90.00
Ferromanganese, 76-80% Mn, English.....	gross ton	85.00	—	90.00
Spiegelisen, 18-22% Mn.....	gross ton	32.00	—	35.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50	—	.....
Ferrothion, 10-15%.....	gross ton	50.00	—	55.00
Ferrothion, 50%.....	gross ton	85.00	—	90.00
Ferrosilicon, 75%.....	gross ton	145.00	—	150.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45	—	.50
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	.....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00	—	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$10.00	—	\$11.00
Chrome ore, Calif. concentrates, 50% Cr ₂ O ₃	unit	.45	—	.50
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.45	—	.50
Coke, foundry, f.o.b. ovens.....	net ton	4.75	—	5.75
Coke, furnace, f.o.b. ovens.....	net ton	3.75	—	4.50
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00	—	16.00
Fluorspar, lump, f.o.b. Heathden, New Mexico.....	net ton	17.50	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.50
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.30	—	.35
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.14	—	.15
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.14	—	.15
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.13
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	—	3.25
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₂ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	.....
Zircon, washed, iron free.....	lb.	.03	—	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.75
Aluminum, 98 to 99 per cent.....	28.00 @ 28.5
Antimony, wholesale lots, Chinese and Japanese.....	5½ @ 5½
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and bl. cks.....	.35
Monel metal ingots.....	.38
Monel metal, sheet bars.....	.40
Tin, 5-ton lots.....	29.25
Lead, New York, spot.....	4.25 @ 4.35
Lead, E. St. Louis, spot.....	4.25
Zinc, spot, New York.....	5.10
Zinc, spot, E. St. Louis.....	4.60

OTHER METALS

Silver (commercial).....	oz.	\$0.58½
Cadmium.....	lb.	1.00-1.10
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.65
Cobalt.....	lb.	4.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00-75.00
Iridium.....	oz.	250.00 @ 300.00
Palladium.....	oz.	65.00 @ 70.00
Mercury.....	75 lb.	44.00-45.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	20.00
Copper bottoms.....	27.50
Copper rods.....	18.75
High brass wire.....	18.25
High brass rods.....	15.25
Low brass wire.....	20.25
Low brass rods.....	20.25
Brazed brass tubing.....	29.00
Brazed bronze tubing.....	34.25
Seamless copper tubing.....	22.00
Seamless high brass tubing.....	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	8.50 @ 9.00	18.50	16.00	10.50
Copper, heavy and wire.....	8.00 @ 8.25	16.50	9.50	9.50
Copper, light and bottoms.....	7.00 @ 7.50	14.50	9.00	8.50
Lead, heavy.....	3.25 @ 3.50	7.25	4.00	4.00
Lead, tea.....	2.15 @ 2.30	5.25	3.00	3.00
Brass, heavy.....	4.25 @ 4.50	9.50	7.00	10.00
Brass, light.....	3.00 @ 3.25	8.00	5.00	5.50
No. 1 yellow brass turnings.....	4.00 @ 4.25	9.50	5.50	6.00
Zinc.....	2.00 @ 2.50	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. of structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York			Cleveland		Chicago	
	One Current	Month Ago	Year Ago	One Current	Year Ago	One Current	Year Ago
Structural shapes.....	\$2.50	\$3.80	\$3.47	\$3.58	\$3.37	\$3.58	\$3.47
Soft steel bars.....	2.50	3.70	3.52	3.34	3.27	3.48	3.52
Soft steel bar shapes.....	2.50	3.70	3.52	3.48	3.27	3.48	3.52
Soft steel bands.....	2.85	4.65	4.22	6.25	.....	.....	.....
Plates, ½ to 1 in. thick.....	2.50	4.00	3.67	3.78	3.57	3.78	3.67

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

TEXARKANA—The Southern Acid & Sulphur Co. is planning for the reconstruction of the building of its plant destroyed by fire, April 1, with loss estimated at about \$22,000.

Connecticut

SOUTHINGTON — The Peck, Stow & Wilcox Co., manufacturer of tools has plans under way for the erection of three additions to comprise a 1-story hardening building 67 x 180 ft.; 1-story forge shop, 57 x 100 ft.; and 2-story grinding works, 56 x 156 ft. Pierce & Hutton, Southington, are engineers.

NEW HAVEN — The Columbia Enamel Co. is reported to be planning for the rebuilding of the portion of its plant, recently destroyed by fire.

Florida

MIAMI—The Dexter-Geare Corp. has acquired a local site for the erection of a new plant for the manufacture of monolithic concrete tile products, bricks, etc. Plans are being prepared.

Georgia

COVINGTON—Fire, April 8, destroyed a portion of the plant of the Covington Cotton Oil Co., with loss estimated at close to \$150,000, including machinery.

Illinois

CENTRALIA—The American Rubber Co., 1526 South Wabash Ave., Chicago, has awarded a contract to the Welch-McCarthy Constr. Co., 56 W. Washington St., Chicago, for the erection of its proposed new 2-story plant at Centralia, 80 x 360 ft., estimated to cost about \$150,000 with machinery. A power plant will also be constructed.

ARGO—The Corn Products Refining Co. has resumed operations at its local grinding plant, following a shut-down for several weeks. It is said that work will be resumed at the Pekin (Ill.) plant at an early date.

PEORIA—The United Paperboard Co. is completing plans for the rebuilding of its local plant, recently destroyed by fire. The new factory is estimated to cost about \$200,000 with machinery. C. E. Foster is secretary.

Maryland

FROSTBURG—The Big Savage Fire Brick Co. will resume work at once on its expansion program inaugurated in February and later discontinued. The work will include the erection of two brick and steel buildings, 150 x 300 ft. and 150 x 200 ft.; the first will be used for kiln service, storage and other features of operation, and the other for manufacturing purposes. Considerable new machinery and equipment will be installed, including 12 furnaces. The plant, on completion, will occupy about 1½ acres of ground. Employment will be given to about 100 extra operatives and it is proposed to increase production by 50,000 firebrick per day. The extension is estimated to cost about \$150,000. D. A. Benson is vice-president and treasurer.

BALTIMORE—The Cook-Nut Corp., Purity Bldg., Lexington and Paca Sts., has arranged for a stock issue of \$175,000, the proceeds to be used for the erection of its proposed new local plant for the manufacture of lard substitutes, cooking oils, etc. The plant will be located in the Canton section, and will be 4-story, 80 x 100 ft., estimated to cost \$125,000. Bids for erection will soon be asked. Walton R. Spruill is president, and John L. Swope, vice-president.

FAIRFIELD—The Prudential Oil Co. has commenced the erection of a number of additions to its plant.

Massachusetts

TAUNTON—The Weir Stove Co. is having plans prepared for the erection of a new 2-story foundry addition on Fourth St., 77 x 77 ft., estimated to cost about \$25,000. J. R. Anthony is head.

BOSTON—The American Glue Co., operating a number of plants in New England and in other sections for the manufacture of glue, gelatines, chemicals, etc., has arranged for a note issue of \$1,500,000, the proceeds to be used in connection with general operations.

Michigan

BATTLE CREEK—The American Stamping Co., manufacturer of stamped metal products, has awarded a contract to F. B. Cole, Battle Creek, for the erection of its proposed new 1- and 2-story plant, 110 x 225 ft. E. R. Sherman is president.

Minnesota

ST. PAUL—The Northwestern Spring Mfg. Co. is planning for the rebuilding of the portion of its plant, located in the Columbia Heights section, destroyed by fire, March 25, with loss estimated at about \$100,000, including equipment.

Nebraska

ANTIOCH—Fire April 2 destroyed a section of the plant of the American Potash Co. with loss estimated at about \$500,000 including machinery.

New Jersey

NEWARK—The Zeller Laquer Co., recently organized, has acquired a plant at Irvington, consisting of a number of 1-story buildings on a 3½-acre site, for the establishment of a new plant. The factory aggregates about 28,000 sq. ft. of floor area. The company is headed by Gustav Zeller and Richard Zeller, formerly connected with the Egyptian Lacquer Co., 5 E. 40th St., New York.

TRENTON—The Star Porcelain Co., Muirhead Ave., manufacturer of electrical porcelain specialties, has completed plans for the erection of a 2-story addition 30 x 100 ft. to cost about \$10,000. Herbert Sinclair is head.

TRENTON—The Ewing Rubber Co., Homan Ave., is planning for the rebuilding of the portion of its plant recently destroyed by fire.

New York

SYRACUSE — The By-Products Coke Corp., Milton Ave., is planning for a bond issue of \$4,000,000 and stock issue of \$5,000,000, to be used in connection with general operations.

ITHACA—The Board of Trustees, Cornell University, will soon take bids for the construction of a new 4-story chemical laboratory and instruction building, 70 x 270 ft., to be located at East Ave. and Rockefeller Hall, and estimated to cost about \$2,000,000. Gibb & Waltz, 110 North Tioga St., Ithaca, are architects.

BUFFALO—The Williams Gold Refining Co., 2978 Main St., will take bids at an early date for the erection of a 1-story addition, 50 x 60 ft., estimated to cost about \$12,000.

North Carolina

HAMLET—The Poole Turpentine Distilling Co. is planning for the erection of a new plant for turpentine and byproducts production.

Ohio

CLEVELAND — The Collinwood Shale Brick & Supply Co. has leased a plant from the Medal Paving Brick Co. for a period of five years, and plans for the operation of the property. The lease begins at a yearly rental of \$65,000 and terminates at \$100,000.

BRILLIANT—The Crystal Shade Co., Wheeling, W. Va., is planning for the immediate operation of a local glass-manufacturing plant recently acquired. Employment will be given to about 50 men for initial production.

Pennsylvania

PHILADELPHIA — The Federal Container Co. 25th and Locust Sts. manufacturer of corrugated paper containers, etc., has awarded a contract to W. W. Lindsay & Co., Harrison Building, for the erection of a new 2-story plant at 56th St. and Pashall Ave., 82 x 302 ft., estimated to cost about \$150,000 with machinery.

PHILADELPHIA — Fire, April 4, destroyed a portion of the fertilizer manufacturing plant of the Savannah Co., 37th and Tasker Sts., with loss estimated at about \$12,000.

BANGOR—The Bangor Paper Box Co. will take bids at once for the erection of a new 3-story plant, 35 x 100 ft., estimated to cost about \$25,000. M. H. Wheeler is head.

PHILADELPHIA—The Sun Co., Finance Bldg., operating local oil refineries, has arranged for a bond issue to total \$6,000,000, to be used in connection with general operations. J. Howard Pew is president.

PHILADELPHIA—The W. J. McCahan Sugar Refining Co., Front and Chestnut Sts., has taken title to property at 101-105 South Front St., for a consideration of \$75,000, to be used in connection with its local operations.

Oregon

PORTLAND — The Willamette Iron & Steel Co. has perfected plans for the erection of its proposed new plant on the shipyard property formerly occupied by the Foundation Co. The works will consist of a number of buildings, estimated to cost about \$250,000 with machinery. Permits to cover initial features of the project have been issued.

Tennessee

ELIZABETHTON—The Watauga Extract Co. is said to be planning for the rebuilding of the portion of its local plant recently destroyed by fire, with loss estimated at about \$15,000.

MEMPHIS — The Missouri Portland Cement Co. will complete a sand and gravel producing plant on Chelsea Ave., and put it into operation within the next sixty days. The plant will be equipped with an electrically-driven steel dredge. Offices are in the Union & Planters Bank Bldg., Memphis.

Texas

SAN ANTONIO—The International Petroleum Co. has awarded a contract to the Southern Steel Construction Co., San Antonio, for the completion of its oil refinery on South Presa St., near the city, recently purchased, in incomplete condition, from the Rogers Refinery. The plant will represent an investment of \$100,000, and will have an initial capacity of 1,000 bbls. of crude oil daily.

BRECKENRIDGE—The Consumers' Water & Gas Co., recently incorporated with a capital of \$500,000, is considering the erection of a new absorption gasoline plant. E. G. Dawes and O. L. Barr head the company.

TEXARKANA — The Diamond Spear Chemical Co., recently incorporated with a capital of \$40,000, will operate a local plant for the manufacture of chemical products. Clifton Spear and B. L. Mahon head the company.

West Virginia

CHARLESTON — The American Clay Products Co. has commenced the erection of a new plant in the vicinity of Teays, W. Va., for the manufacture of hollow tile and other burned clay products. The company recently increased its capital from \$5,000 to \$50,000 for expansion. C. L. Rice is president and treasurer.

ST. MARYS—The Western Glass Co. is arranging for the early resumption of operations at its plant, following a shut-down of about three months. It is proposed to develop normal output on a gradual scale.

NEW MARTINSVILLE—The Universal Concrete Produces Co. has commenced the construction of a new plant, 70 x 120 ft., for the manufacture of concrete blocks, bricks and kindred specialties.

WHEELING—The Northern Wheeling Bottle Co. will soon resume production at its local plant, giving employment to about 200 men.

Capital Increases, Etc.

THE SHASTA ZINC & COPPER CO., San Francisco, Cal., has filed notice of increase in capital from \$20,000,000 to \$25,000,000.

THE STANDARD BRICK CO., Charleston, W. Va., has filed notice of increase in capital from \$10,000 to \$150,000. Fred M. Staunton is president.

THE PEERLESS STAMPING CORP., Ypsilanti, Mich., has filed notice of increase in capital from \$10,000 to \$60,000.

THE APEX CHEMICAL CO., 61 Park Row, New York, N. Y., has filed notice of increase in capital from \$10,000 to \$60,000.

THE PRODUCERS' CHEMICAL CORP., 201 B'way, New York, N. Y., has filed notice of dissolution under state laws.

THE HURON CLAY PRODUCTS CO., Crosswell, Mich., has filed notice of increase in capital from \$50,000 to \$70,000.

THE EASTERN OIL REFINING CO., a Delaware corporation, has filed notice of organization to operate in New York with a capital of \$5,000,000. E. J. Suor, Buffalo, is corporate representative.

THE AMERICAN PAPER TUBE CO., Woonsocket, R. I., has filed notice of increase in capital from \$100,000 to \$600,000.

THE BRIGGS CO., Lansing, Mich., manufacturer of brick and other burned clay products, has filed notice of increase in capital from \$150,000 to \$400,000.

THE D'ARCY SPRING CO., Kalamazoo, Mich., manufacturer of steel springs, etc., has filed notice of increase in capital from \$75,000 to \$1,000,000.

New Companies

THE SARDONYX MFG. CO., Dallas, Tex., has been incorporated under Delaware laws with a capital of \$50,000 to manufacture soaps and kindred products. The incorporators are J. E. Bryant, E. Morley Page, Dallas; and William H. Herring, Houston, Tex.

THE NEW ENGLAND PAPER MILLS, INC., New York, N. Y., has been incorporated with a capital of \$25,000 to manufacture paper products. The incorporators are A. Braunstein, J. Hillman and M. Leffert, 198 B'way.

THE MIDDLESEX RUBBER CO., Reading, Mass., has been incorporated with a capital of \$50,000 to manufacture rubber products. George E. Jeandheur, 1277 Commonwealth Ave., Brighton, Mass., is president and treasurer; Michael F. Culliney and H. M. Clifford, Reading, are directors.

THE B. L. W. CO., 1542-44 Milwaukee Ave., Chicago, Ill., has been incorporated with a capital of \$20,000 to manufacture leather goods. The incorporators are Louis Winkler, David Berger and Samuel La Bow.

THE STILLWATER PAPER MILLS, INC., Stillwater, Pa., has been incorporated with a capital of \$10,000 to manufacture paper goods. F. N. Hamlin is treasurer.

THE ADRIAN CHEMICAL CO., Pittsburgh, Pa., has been incorporated with a capital of \$25,000 to manufacture chemicals and chemical byproducts. The incorporators are R. D. King, F. M. Adrian and George H. Wood, Pittsburgh.

THE FALCO CHEMICAL CORP., Buffalo, N. Y., has been incorporated with a capital of \$10,000 to manufacture chemicals and kindred products. The incorporators are T. Locon, F. H. Cofall and S. B. Pfeifer, Buffalo.

THE TIDEWATER GLASS CO., Wheeling, W. Va., has been incorporated with a capital of \$250,000 to manufacture glass products. The incorporators are George A. Blackford, and A. Seamon, Wheeling; and A. J. Gilleland, Martins Ferry, O.

THE WARREN BRICK & TILE CO., Detroit, Mich., has been incorporated with a capital of \$100,000 to manufacture brick, tile and other burned clay products. The incorporators are Abraham Budnitzky, Abraham Nordoloff and Louis Chernoff, 80 Glendale Ave.

THE PARIS PAPER BOX CO., Boston, Mass., has been incorporated with a capital of \$25,000 to manufacture paper containers and kindred products. The incorporators are E. Mochedlofer, Benjamin Nigrosh and Max Nigrosh, 183 Walnut St., Roxbury, Mass.

THE LEVIATHAN OIL CORP., Lockport, N. Y., has been incorporated with a capital of \$250,000 to manufacture refined oil products. The incorporators are A. A. Gloetzner, A. E. Lee and R. R. Singer, Lee, Ward & Riley, F. & M. Bank Bldg., represent the company.

THE AMERICAN PHOSPHATE CORP., New York, N. Y., has been incorporated with a capital of \$5,000 to manufacture fertilizers and kindred products. The incorporators are P. J. Dobson, L. N. Martin and W. J. Eldredge. Foley & Martin, 64 Wall St., represent the company.

THE INTER-OCEAN PAPER & BAG CO., 350 North Clark St., Chicago, Ill., has been incorporated with a capital of \$30,000 to manufacture paper products. The incorporators are Edward J. Sexauer, Samuel J. Howe and Bernhardt J. Ness.

THE SERVICE HEAT-TREATING CO., Detroit, Mich., has been incorporated with a capital of \$5,000 to manufacture heat-treating equipment for steel and other metals. The incorporators are Herbert F. Halpin, Robert Barker and Charles Reinacker, 2243 Hilliger Ave.

THE NATIONAL CHINA CO., Huntington, W. Va., has been incorporated with a capital of \$10,000 to manufacture chinaware products. The incorporators are S. Heimy, L. Leibovitz and L. Slutsky, Huntington.

THE EL GOBIERNO PETROLEUM CO., Los Angeles, Cal., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are Norman Bridge, J. C. Anderson and Olin Wellborn, Jr., Los Angeles.

GREENWALD BROS., INC., New York, N. Y., has been incorporated with a capital of \$6,000 to manufacture chemicals and affiliated products. The incorporators are M. Greenwald, E. S. Rifkin and A. Leichter, 141 B'way.

A. LUSSKIN, INC., New York, N. Y., has been incorporated with a capital of \$50,000 to manufacture chemicals and chemical byproducts. The incorporators are A. Lusskin, I. H. Kessler and I. Miller. H. A. Harkavy, 299 B'way., represents the company.

THE NASHVILLE ENAMELING CO., 42d Ave. and Charlotte Pike, Nashville, Tenn., has been incorporated with a capital of \$50,000 to manufacture enamelware products. The incorporators are Valentine Taylor, John R. Burrows and Herman Spitz, Nashville.

THE DETROIT PORUS INNER TUBE CO., Hamtramck, Mich., has been incorporated with a capital of \$100,000 to manufacture automobile tubing, rubber mats and other rubber products. The incorporators are Frank Moons and George S. Holstein, 3128 Elmwood Ave., Detroit.

THE GARDNER PAPER CO., Providence, R. I., has been incorporated with a capital of \$100,000 to manufacture paper products. The incorporators are LeRoy N. Gardner and Albert A. Adams, Providence.

THE AURORA STEEL & STAMPING CO., 375 High St., Aurora, Ill., has been incorporated with a capital of \$25,000 to manufacture steel and other stamped metal products. The incorporators are Benjamin P. Alschuler, Ralph C. Putnam and Glenn T. Johnson.

THE DUNMORE DRUG MFG. CO., Dunmore, Pa., has been incorporated with a capital of \$40,000 to manufacture chemicals, drugs and affiliated products. The incorporators are M. J. Dempsey, W. B. Weisberger and John J. Byrne, Dunmore.

THE STANDARD SHALE CHEMICAL CO., Columbus, O., has been incorporated with a capital of \$10,000,000 under Delaware laws to manufacture chemicals and byproducts. The incorporators are Selden D. Maddox, Columbus; W. E. Tochey, Middletown, O., and Louis M. Day, Chillicothe, O.

THE JET OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$250,000 to manufacture petroleum products. The incorporators are W. A. Brophy and S. W. Warrington, Los Angeles; and J. G. Burgess, San Diego, Cal. H. P. Goodwin, 233 Title Insurance Bldg., represents the company.

THE PENETRO CHEMICAL CO., Atlantic City, N. J., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture chemicals and chemical byproducts. The incorporators are Thomas J. and Raymond J. McCaffrey, and John B. Heon. Dr. L. H. English, 130 South Maryland Ave., represents the company.

THE R. & W. PAPER BOX CO., New York, N. Y., has been incorporated with a capital of \$5,000 to manufacture paper boxes and containers. The incorporators are R. H. Blum, E. Kaplan and A. Feldman, 283 Division St.

THE CHEBOYGAN TILE & BRICK CO., Cheboygan, Mich., has been incorporated with a capital of \$75,000 to manufacture brick, tile and other burned clay products. The incorporators are W. L. Hagadorn, A. M. Gerow and J. H. Clune, Cheboygan.

THE HUNTINGTON NATIONAL OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are S. C. J. R. and M. D. Woodward, and C. C. Closson, Los Angeles.

THE CAIRO COTTON OIL MILL, INC., Upper Sycamore St., Cairo, Ill., has been incorporated with a capital of 200 shares of stock, no par value, to manufacture oil products. The incorporators are M. L. and F. P. Fox, and F. L. Short.

THE CARAMEL COLOR CO. OF AMERICA, INC., Brooklyn, N. Y., has been incorporated with a capital of \$5,000 to manufacture chemicals, colors and affiliated products. The incorporators are R. Adler, B. Levine and A. S. Fischer, 3957 W. 7th St.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold its sixty-first meeting at Rochester, N. Y., April 26 to 29. Headquarters will be at the Hotel Rochester.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its spring meeting at Atlantic City April 21 to 23 inclusive. Headquarters will be at the Hotel Chalfonte.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17. Headquarters will be at the Congress Hotel.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

AMERICAN WELDING SOCIETY will hold its annual meeting April 27 to 30 in the Engineering Societies Building, New York City.

AMERICAN ZINC INSTITUTE will hold its annual meeting in St. Louis May 9 and 10.

BRITISH IRON AND STEEL INSTITUTE will hold its spring meeting May 5 and 6, at the Institution of Civil Engineers, Great George St., S. W. 1, London, England.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

HARVARD ALUMNI CHEMISTS' ASSOCIATION will meet Tuesday noon, April 26, at Rochester, N. Y., for luncheon.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stetters Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27 to 29.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: April 22, Society of Chemical Industry, joint meeting with American Electrochemical Society, Société de Chimie Industrielle and American Chemical Society; May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

CHEMICAL & METALLURGICAL ENGINEERING

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Consulting Editor
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Associate Editor
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Assistant Editor

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ALAN G. WIKOFF
R. S. M. BRIDE
CHARLES N. HULEBUT
Assistant Editor
CHESTER H. JONES
Industrial Editor
J. S. NEGRI
Managing Editor

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Number 17

Unconscious Disarmament

AT THE dinner given by the members of the Technical Association of the Pulp and Paper Industry Prof. MARSTON T. BOGERT of Columbia spoke of "Unconscious Disarmament," and the idea is worth remembering.

Suppose we go ahead and build big battleships that cost \$30,000,000 apiece but hold fast to the familiar conservative advice and let chemical industry piffle out. Suppose we heed the demands for their masters of such legislators as senator MOSES and let General PEYTON C. MARCH have his own way and give up our Chemical Warfare Service and organize the defense of our nation without the aid of chemistry. We can have a great navy and big guns and brass bands, and many soldiers drilling, and still be disarmed. We can be disarmed despite immense army and navy appropriations.

In some of the later bombardments of the war as high as 80 per cent of the shells shot contained gas. The German gas, all of it, was made in their dyeworks. The Germans are a war-lusty people, and their present inadequate licking has not taken the taste of it from them. As individuals nearly every one knows Germans who are honest and loyal and trustworthy to the end. As a nation they have shown themselves to be without honor, and that is the reason why, to use a German expression, they are *in Verruf*.

They have destroyed the French coal mines, turning them into great submarine lakes and filling their entrances with explosives, so that the greatest of them cannot be operated before 1932. But even without Silesia the Germans have far more coal than England and Wales. Their facilities for fixing nitrogen, present and under construction, are about twice their industrial requirements. The one use for these products besides industry is munitions of war. Their external debt is forty million dollars, while that of France is six billion dollars. They have no devastated areas, whereas that of France is the size of Massachusetts, Connecticut and Rhode Island combined, and before the war it provided one-fifth of the nation's income from taxes. Even if we do say it with a tinge of jealousy, the Germans' consumption of champagne is said to be greater than that of any other country, and champagne does not indicate poverty. The bets registered at one race meet are reported to have equaled the sum collected in the United States to relieve the starving children of Germany. If the Germans had fed their children and the Americans had bet on their racehorses on this one occasion, the results, so far as the starving children are concerned, would have been the same. We used to think we could make millionaires pretty fast in this country, but they seem to be beating us at that game, too.

Now, as Dr. BOGERT pointed out, the club gave way to

the bow and arrow; the arrow to the musket; the iron-clad succeeded the wooden battleship, and now the airplane and the submarine have succeeded the dreadnought. You do not need to strike a ship with a bomb to destroy it. A gas torpedo dropped to windward will kill everybody aboard. A thousand pounds of TNT dropped near a battleship will sink it. Chemical warfare, which has only just begun, makes it so easy to destroy a battleship and its crew that the question is arising whether it is worth while to build them at \$30,000,000 each. It is not even certain that the biggest navy will control the sea.

Let's take a little lesson from history. In the third century B.C. the Carthaginians ruled the Mediterranean. They had triremes and quinqueremes—i.e., galleys with, respectively, three and five banks of oars. Their naval maneuvers consisted chiefly in ramming the ships and breaking the oars of the enemy. In order to quell the piracy that prevailed they established a station at Messina, and that offended the Romans, and so the Punic wars began. The Romans built galleys provided with a boarding bridge with hooks, called a *corvus*, and manned their ships with soldiers. This was new and unconventional, and the Carthaginian naval authorities knew better. They were conservative in sea warfare and would not adopt newfangled notions. So they lost their navy, and in the end they lost their country so completely that the descendants of their people to this day live in darkness and even their skins are black. They were disarmed at sea by the *corvus*.

We may not like poison gas or submarines, but they are here and the Germans are masters of the arts of making them and using them. Surely we don't want to use them, and we hope it may never be necessary. But if the Germans can break up Poland and Czecho-Slovakia and get Russian man power to fight for them, they are even now prospectively the physical masters of the world.

There are also micro-organisms that are destructive, and it may be recalled that there was an official exportation of anthrax bacilli from Germany into Roumania during the war. It seemed a little too hazardous, even for the Germans, but there is the whole field of biochemistry to call on for means of destruction that has not been brought into general use as yet. We do not fear elephants and lions and tigers or any big animals, but those that are infinitely small have us beaten as soon as they are introduced. And suppose the German people, feeling strong again, should find that the whole world is unwilling to let them dominate. This may be construed into an attack upon the German Will—and we know that the Germans have no reservations in war.

There is just one way, and only one way, to insure against any enemy, and that is—not to think we are doing great things because we spend big money, and

not to heed the peeps of Senators and Congressmen who represent special interests, but to insist upon it constantly, urgently and without any argument or pettifoggery, that this country must and shall lead in science. Therein is our safety. It is the only physical guardian of our heritage of freedom. We owe this to the coming generations. To pass the dye bill is the first step.

Developments in the Army's Nitrogen Policy

ON THE subject of national nitrogen preparedness and the disposition of the Government's Nitrate Plant No. 2 at Muscle Shoals, this journal has consistently supported the position and advocated the views of the Chief of Ordnance and the officers of the Nitrate Division. This broad policy was originally determined and is still maintained on the ground that national welfare is paramount to private interest. We believe the position is sound, notwithstanding partisan pleading to the contrary. Nitrate Plant No. 2 was built for the Army in an emergency, and the cyanamide process was adopted because it was then, as it still is, the only process of nitrogen fixation which has been brought to commercial utility in this country. It was recognized when the plant was built that its disposition after the war might be a delicate problem involving a conflict of opinion between public and private interest. But having been built for the Army, and being subsequently regarded by the Army as necessary to the national defense, it seemed rational to take steps to secure it for that purpose.

After the Armistice, when the Army's plans for future preparedness assumed a magnitude commensurate with its recent experience in the World War, it seemed advisable and necessary to advocate continued Government ownership and operation of Nitrate Plant No. 2. It is true that this plan would have involved production of fertilizer materials, but that would have been only an incidental result and not the primary purpose. There were much broader plans behind the project looking toward research and experimentation that would give the United States the premier position in nitrogen fixation instead of the less than subordinate rank it now holds. Furthermore it was the avowed purpose of the Chief of Ordnance to control and operate the plant only until private capital should establish in this country a nitrogen-fixation industry on which the Army could rely in case of emergency. That purpose still prevails. All this, however, is now a matter of history, for the plan was defeated in Congress through the intervention of private interests. Even had it been acted on favorably, the legislation would have been ineffective in view of the decision of Congress to discontinue work on the Wilson dam and power plant at Muscle Shoals, on the completion of which the economic operation of the nitrate plant is dependent.

All of these items, together with a recent revision of the plans of the Army for raising and equipping a reserve force and putting it into action, lend a new aspect to the whole matter. Contemplating a smaller reserve force, it is felt that the present supply of Chilean nitrate will suffice for the production of munitions as rapidly as men can be trained and equipped—*provided* that Nitrate Plant No. 2 be put in stand-by condition and held ready for emergency. The first year's production of this plant would augment the Chilean nitrate reserve and suffice until new plants could be built. And

probably the latter could be accomplished as rapidly as further forces could be raised, trained and equipped. In view of these revised plans it is unnecessary to insist on Government operation of the plant at Muscle Shoals, but merely to put it in stand-by condition and hold it at the disposal of the Army.

There remain two other phases of the nitrogen problem which are of national concern: the completion of the Wilson dam and the continuance of the work of the Fixed Nitrogen Research Laboratory at American University. With the Secretary of War rests the future of these projects. As to the first he has announced that if he can find private business interests that will assure him of the commercial utility of the dam and power plant and will agree to take it over and operate it when completed, he will recommend to Congress the appropriation of the necessary funds, estimated at about \$30,000,000, for its completion. If he cannot assure himself on these points, he will not recommend an appropriation.

With the research work, however, we are more concerned. The laboratory has done excellent work and is well manned and directed. Its research has been of value not only to the Government but also to the future success of a private nitrogen industry in the United States. Some of its experiments have been more exhaustive and complete than any heretofore conducted in this country. Agriculture as well as warfare will profit from its investigations. Considering the fact that money is already available for work beyond July 1, to which date Secretary BAKER authorized the laboratory to continue its investigations, there appears to be no reason why the place should be closed. To do so would mean the great loss always incidental to scattering an excellent staff. We believe, therefore, that Secretary WEEKS should by all means authorize the continuance of the research laboratory. In a recent interview by the editor of CHEMICAL & METALLURGICAL ENGINEERING he was asked as to his policy in this matter and replied that while he had not as yet reached a decision, his "personal inclination would be to continue the work." This we hope will be his final decision.

Why Hire A Chemist?

THE Research Information Service of the National Research Council has just received a communication from a chemical manufacturing concern, the name of which we shall not mention for rather obvious reasons, which says: "We would appreciate it, and thank you, if you would kindly furnish us with a working formula for the manufacture of meta-nitraniline. We are aware that the base of this product is dinitrobenzene, but if you could furnish us with a formula for the manufacture of the above product from nitrobenzene and then follow as nearly as possible the continuation for the finished product of the meta, we would appreciate it." Of course they would!

This company, which, by the way, advertises itself as a firm of "manufacturing chemists," goes on to say that it has good information from certain industrial text books, but finds that these books do not give "clearly" what the company wants. It even has the frankness to say, "We are aware that if we had a qualified chemist this product could be worked out, as we know there is not much to it."

It is gratifying to learn that the Research Council in replying to this inquiry with appropriate frankness told

this company that it should go and hire a chemist or at least a consulting chemist for this particular task.

Absurdity reaches a maximum when a firm undertakes so complicated a task as dyestuff manufacture without the assistance of experienced and expert chemists. It is little wonder that American dyes at times come into bad repute if they are made by this sort of "manufacturing chemists." The firm no doubt can conduct the commercial end of the business which it advertises as "importer and dealer in dyestuffs and chemicals" without the intimate control that manufacturing processes require of a chemist. But until it, and others like it, learn to keep out of the manufacturing business unless it engages qualified employees to direct the work we can expect serious results for the industry as a whole.

Universities And Research

CIRCUMSTANCES prevented editorial discussion last week of the thoughtful contribution of Messrs. HOSKINS and WILES to the unsettled question of the relation of our universities to scientific and industrial research. Different solutions of the problem are being sought and advocated in different institutions, and we have recently added our own views in the matter, which are to the effect that the university laboratory is the place for scientific rather than industrial research, and that the consulting engineer rather than the university industrial fellow is the logical agency for the investigation of the technical problems of industry. Broad exceptions may be made to this general policy, but in its essence we believe it to be sound. Nevertheless we are glad to have the opposing views of Prof. ROBERT E. WILSON, director of the Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology, which we publish elsewhere in this issue.

As we read the communications of Messrs. HOSKINS and WILES and Prof. WILSON it seems likely that we can reach agreement on several points: First, that the appropriate place for pure science research is the university laboratory; second, that we need a great increase in this kind of research for the ultimate benefit and use of industry; third, that the university needs financial support for the execution of this work; and fourth, that since industry is the ultimate beneficiary of the results, it is the logical source of the needed support. At this point, however, our paths diverge, and the crux of the matter becomes the *modus operandi* whereby industry shall be induced and enabled to make the necessary contributions. Prof. WILSON would have it done by establishing industrial fellowships that would earn an adequate return for the service rendered. This takes no account, however, of one phase of the subject which we have emphasized before—viz., the unfair competition between the university and private consultants who, indeed, are the university's primary product. On this score the plan is indefensible, Prof. WILSON himself naïvely admitting the advantages which the university enjoys over the man who is making his livelihood by selling technical knowledge and service. The "Tech" plan undoubtedly has merit, but in our judgment it is not the best solution of the problem.

The proposal of Messrs. HOSKINS and WILES, on the other hand, is novel and full of promise, although the authors themselves recognize certain pitfalls in its execution and the safeguards that must be thrown about

it. The personal element of administration enters strongly into the success or failure of the scheme. They believe, however, that university scientific research can best be fostered and supported by patenting the discoveries of the research staff, granting to industry non-exclusive licenses for the use of the inventions, and applying the royalties therefrom to the further support of scientific research by paying salaries commensurate with the ability demanded and reasonably comparable with those paid for industrial work of the same caliber.

Students of this plan will be struck by its similarity to the one recently proposed for handling the patentable inventions of Government employees. In both cases we find scientists engaged in public or quasi-public work, making patentable discoveries as a direct consequence or byproduct of their researches. There is a marked difference, however, when it comes to administration of the resulting inventions. In the case of the Government the work is done at public expense and the results should be freely available to all without discrimination in granting licenses. In the university, according to the present plan, the invention becomes the property of the institution and its use may be licensed with propriety, though here also the authors of the idea recognize the necessity of preventing monopoly, the chief object in licensing being to assure an income for the continuation of research. As a whole the plan represents an advance over any thus far proposed and merits consideration and a fair trial, at least until a better one is suggested.

Never Built, But Building

INDUSTRIAL plants operating in the production of materials where chemical processes are involved are ever in a state of flux as regards the layout of machinery, apparatus and buildings. New findings through both research and accidents of operation are continually showing that a rearrangement of the flow or an addition of new features will effect savings in production which more than offset the cost for reconstruction of existing plant.

The construction foreman has become a permanent member of the staff of every important chemical manufacturing institution and is usually an important one. He is continually employed in adding towers, flues and buildings, or placing new apparatus designed to improve the plant. His repairs often amount to a complete rebuilding of old units. This condition is accounted for when it is borne in mind that the industry is developing at an enormous rate and on a broadening scale and that the value of scientific control is just coming to be recognized fully by the directors of those industries in which timeworn, so-called secret methods fail to meet new technical competition.

This changing of equipment does not always call for large expenditures to effect greater savings, but changes are nevertheless essential to continued economic health. When all industry awakens to this condition common to chemical industries—namely, that a change of mind is a sign of progress, and during times of business depression with consequent strenuous competition is absolutely necessary to the existence of many concerns—the return from such periods to normal conditions can never be long delayed.

There is material for thought then in the fact that chemical plants are never built, but building.

Readers' Views and Comments

Birkeland-Eyde Arc Process of Nitrogen Fixation

To the Editor of Chemical & Metallurgical Engineering

SIR:—The Norsk Hydro-Elektrisk Kvelstofaktieselskab of Christiania, Norway, which owns the big nitrogen plants at Notodden and Rjukan, wishes to make the following statement:

It appears from the stenographic report of the "hearing before the Committee on Agriculture and Forestry, United States Senate, on S. 3,390," that the president of the American Cyanamid Co., Frank S. Washburn, has obtained a hearing before the committee and that he has taken the opportunity at this hearing to try to reduce to nothing the importance of the arc process, particularly the Birkeland-Eyde process.

We wish to state in this connection that we do not, on principle, as a rule reply to erroneous or refutable statements about the methods used by our company. We therefore do not see any reason why we should, generally speaking, take any notice of Mr. Washburn's statements whatsoever, especially as it must be clear to everyone conversant with the development of the atmospheric nitrogen industry that Mr. Washburn's version of the facts is incorrect.

We think, however, it only proper to attend to Mr. Washburn's statement concerning the utilization of the arc process in America, and which he attributes to Sam Eyde (page 174 of the hearings). We have placed this matter before Mr. Eyde, who in reply maintains that he has never expressed himself to Mr. Washburn in the manner indicated. On the contrary, Mr. Eyde states that he has been striving for years to open the eyes of the American industrial and financial interests to the great advantage the Birkeland-Eyde process would proffer to America.

We further wish to point out the following statement, made by Mr. Washburn (page 129 of the hearings):

Now there is an enormous Norwegian plant, as you know. The representative of the banking interests which own that plant has been to see me quite lately, within the last two months; he was sent over here for the purpose of consulting on what practical use that plant might have. Out of this war they amortized the plant, the full cost of the plant, which was enormous.

No representative of the banking interests of our company has had a consultation of this kind with Mr. Washburn. Therefore this statement by Mr. Washburn is untrue.

As to the rest of Mr. Washburn's statements concerning the arc process and our plants, all we care to say is that we find it quite superfluous to reply to them at all.

HARALD BJERKE,

Director General,
Norwegian Hydro-Electric Nitrogen Co.,
Christiania, Norway.

To the Editor of Chemical & Metallurgical Engineering

SIR:—In reference to the criticism made by Harald Bjerke of the Norwegian Hydro-Electric Nitrogen Co. on the testimony of Frank S. Washburn before the Senate Committee on Agriculture and Forestry with reference to S. 3,390, I think Mr. Bjerke has attached undue

emphasis to certain isolated sentences which when removed from the context could easily lead to erroneous conclusions. Thorough and careful reading of Mr. Washburn's testimony shows that not only did he appreciate the value of the arc process by at one time negotiating for its American rights, but I know that even many years later he publicly conceded its commercial value, particularly for the production of nitric acid under certain economic conditions. I am certain Mr. Washburn has in no sense attempted to discount the arc process as a fundamental proposition, but rather to show that as the arc process is at present developed it can play no important part under existing conditions and power costs in the fertilizer industry of this country.

That Mr. Washburn is correct in this analysis I think has been adequately borne out by the recommendations of the various commissions and bureaus which formulated a governmental nitrogen program. No recommendations were made in any of these reports that we install such arc process, but the conclusion does appear in them that the arc process is inapplicable to American conditions. The fact that the arc process has made no headway in this country in the nearly twenty years of its existence, although several attempts at installation have been made, further bears out Mr. Washburn's conclusions in a most effective manner.

With reference to the statement of the representative of certain foreign bankers interested in the Norwegian plant, I was present at this conference and in fact held several conferences with this French representative and take issue with Mr. Bjerke as to the truthfulness of Mr. Washburn's statement in this respect.

As a controversy over such matters of fact are trespassing upon the courtesy of the editor of such a journal as this, I should be very pleased to take up the matter personally with Mr. Bjerke or his representative and place before him names, dates and subject matter of conferences held with the individuals referred to.

New York City.

W. S. LANDIS.

Prof. Milton Whitney and Nitrogen Fixation

To the Editor of Chemical & Metallurgical Engineering

SIR:—In connection with my statement in CHEMICAL & METALLURGICAL ENGINEERING for April 6, 1921, concerning the present status and future plans of the Fixed Nitrogen Research Laboratory I wish to call your attention to the fact that prior to the foundation of this laboratory governmental research on nitrogen fixation had been in progress for a number of years under the direction of Prof. Milton Whitney, Chief of the Bureau of Soils. It was due to Prof. Whitney's far-sightedness that the potential seriousness of the nitrogen problem to America was originally appreciated by the Government. His bureau started research along this line as early as 1911, and this work has continued until the present day.

At the time when the War Department became vitally interested in nitrogen fixation from the munitions point of view Prof. Whitney and his colleagues generously co-operated with the Ordnance Department,

and this co-operation was continued after the foundation of this laboratory. At the present time a portion of the work at the Fixed Nitrogen Research Laboratory is carried out under the direction of the Bureau of Soils and by investigators carried on their payroll. It is unfortunate that no mention of this assistance was made in the recent article which appeared in *CHEMICAL & METALLURGICAL ENGINEERING* describing the work of the Fixed Nitrogen Research Laboratory. The omission was due to the fact that the article in question was taken from a report made by the Director to the War Department, which dealt only with the immediate interests of the Ordnance Department.

In the future more emphasis will be put on other methods of nitrogen fixation, and as a matter of fact for some time the laboratory has been planning work on the cyanide process.

RICHARD C. TOLMAN.

Fixed Nitrogen Research Laboratory,
Washington, D. C.

Function of Educational Institutions in Research

To the Editor of Chemical & Metallurgical Engineering

SIR:—A recent editorial in your columns (Feb. 16), entitled "The Function of Educational Institutions in Research," expressed three opinions from which there can be no reasonable dissent. These may be concisely stated as follows:

1. The primary function of the university is to educate its students.

2. University laboratories are best fitted to carry out fundamental scientific research, as distinct from industrial research.

3. There is great need for more such scientific research.

However, in drawing from these premises the conclusion that university laboratories should in general not carry on industrial research one essential point appears to have been overlooked—namely, how are funds to be obtained to carry on this desirable large amount of scientific research? Assuredly the universities in their present financial condition cannot do so to any large extent, nor are the salaries and spare time of the university professors adequate to enable them to carry on any considerable amount of such work. Theoretically, the industries themselves might well support such fundamental research at the universities, but with a few notable exceptions they have not done so.

Under the circumstances, therefore, the most promising method of securing the funds required for purely scientific investigations appears to be to *earn* them. This can readily be done by carrying on industrial research for outside companies—not on a low cost basis such as is frequently employed, which is manifestly unfair to outside commercial laboratories, but on a basis which will enable the laboratory to carry on an almost equal amount of fundamental scientific work which is to be published. In other words, the charges should be fully equivalent to those charged by high-grade commercial laboratories for industrial research; but the amount which would normally go to profits, taxes, rent, etc., in such a concern would here be devoted to the scientific research of which there is so much need.

From an *educational* standpoint, as well, this method of procedure would appear to be justified. Certainly one of the most important functions of a university or technical school is to train men for *industrial* research, and no satisfactory method of giving such train-

ing has yet been found except to have the men *do* industrial research under competent direction and with adequate library and laboratory facilities. Such a university laboratory should never endeavor to build up a large permanent staff of experienced men but rather to keep a nucleus of such men, who also do some teaching, and have the main bulk of the research handled by men who remain for one, two or three years after graduation and then go into industrial positions—frequently with the companies for which they have been working.

The presence of such work in a university laboratory also has a beneficial influence in keeping the university in close touch with recent industrial developments and suggests a large number of thesis and graduate research problems which are much more attractive to the average student than the more typical university problems—especially compared with the mere determination of physical constants, which your editorial suggests as being one of the proper functions of a university laboratory.

Several university laboratories are already operating successfully on this basis—for example, the Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology, has grown within two years to number twenty-five full-time men, and work is being carried on for about fifteen large industrial concerns. The laboratory makes it a principle not to undertake analytical or purely plant problems, but only the more fundamental type of investigation, which bids fair to continue over a considerable period, as the laboratory believes it can render its best service to industries along these lines. It frequently works in close co-operation with the research laboratories of large industrial concerns in attacking problems of major importance. Handling this industrial research has made it possible to carry on about four times as much fundamental scientific work and to train six times as many men as would otherwise have been possible. Furthermore, several of the companies for which work is done have given permission for the publication of results secured at their expense.

Some such basis of carrying on industrial research in university laboratories would therefore appear to be justified on the very premises on which your editorial based its objections.

ROBERT E. WILSON,

Research Laboratory of Applied Chemistry,
Massachusetts Institute of Technology,
Cambridge, Mass.

Director.

Practical Jokers Among Workmen

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have just read with interest the article on "Practical Jokers Among Workmen" in the April 6 number of your magazine. I am sure that everyone interested in safety work will agree with the author.

I would like to point out that in two of the cases he mentions the accidents might have been avoided if the machinery had been properly guarded, in one case where a man's arm was torn off and in another where a woman's scalp was torn loose by moving belts. Modern safety practice requires that all belts with which it is possible to come in contact be protected by adequate guards.

Carelessness can never be completely prevented and guards should always be placed around moving parts that can in any manner cause accidental injury.

HORACE F. LUNT.

State Bureau of Mines,
Denver, Col.



T.A.P.P.I. BANQUET AT THE WALDORF-ASTORIA, NEW YORK, APRIL 15, 1921

Sixth Annual Meeting of T.A.P.P.I. Held in New York

Technical Association of the Pulp and Paper Industry Holds Convention at the Waldorf-Astoria to Discuss Pulp and Paper Technology and Plant Operation Problems

DURING the week of April 11 about one-tenth of the technical personnel of the American pulp and paper industry gathered in New York to attend the meeting of their association. In the presidential address Raymond S. Hatch drew attention to foreign appreciation of the value of T. A. P. P. I. by the institution of similar organizations both in Great Britain and France. President-elect George E. Williamson reported that rapid progress was being made in the preparation and publication of the series of textbooks on "The Manufacture of Pulp and Paper." Vols. I and II, dealing with the preliminary sciences, are now available and Vol. III, on the manufacture of pulp, will appear this fall.

The activities of the association are directed by fifteen committees. Reports and addresses on technical topics pass through them to Secretary Thomas J. Keenan, who publishes them in the *Technical Association Papers*. As limitations as to space require that only brief notes on the major topics be made here, the reader wishing more elaborate details is directed to the extensive report of the meeting in the April 14 issue of the *Paper Trade Journal*, pp. 189-263 and 335-339.

NEW HALL PROCESS OF GRINDING WOOD

A 50 per cent saving in sulphite pulp beater furnish is claimed in paper mills using the Hall process ground wood pulp. The surface of the stone is burred, giving grooves through which the fiber can escape before being reduced to wood flour. About 250 lb. of pulp per cord is gained at the same time. Experiments at the St.

Regis Paper Co. have been under way since 1914. Steam cooking has been found advantageous both in softening the wood and in giving a sterile pulp.

EFFECT OF VARIABLES ON BLEACHING EFFICIENCY

Bleaching powder was shown to give best results at temperatures up to 120 deg. F., with stock consistency around 7 per cent. Variations of around 40 per cent in bleach were obtained with lower temperature concentrations of pulp, using 10 lb. of powder per 100 of pulp. This is actually a function of bleach concentration and should be further studied with variations in acidity in bleaches made direct with chlorine and bases other than lime.

EVALUATION OF LIME BY CAUSTICIZING TEST

Some time ago Martin L. Griffin suggested that the soda ash value should be taken on the lime supplies to determine the causticity. As is well known, lime burned and sintered in an electric furnace is inert even to hydrochloric acid, and even kiln-burned lime can be dead-burned to a greater or less degree according to the magnesia and other flux content. Tests on lime with 93 per cent CaO were submitted, showing 86 per cent soda ash conversion, and limes with as low as 63 per cent conversion were mentioned, the equilibrium being a function of reaction time.

SHORTENING SULPHITE DIGESTION

The Forest Products Laboratory has recently run semi-commercial trials of forcing sulphite liquor into

the charge by preliminary air pressure. Rapid penetration was obtained so that digestion temperatures could be applied much sooner, with considerable saving in time. The combined SO_2 used was too low to give results that should be had with normal operation. High-pressure digestion is undoubtedly going to come more and more into practice and be limited only by safety considerations.

A STUDY OF CASEIN

The committee on coated paper gave a set of specifications and tests on casein, which should be free from lumps when dissolved in an alkaline soda salt such as borax or carbonate, be in a sterile condition free from mold or decomposition products, and bond china clay in a 6 to 7 per cent mixture to furnish the required coating adherence. Tests for solubility, strength, moisture, color, odor, acidity, insoluble matter, ash, alkali, starch, viscosity and grease were described.

SULPHITE COMMITTEE DISCUSSES SUPERHEATED STEAM

The discussion by the sulphite committee centered on the use of superheated steam. Trials in the past indicate that there are chemical advantages which are more or less offset by mechanical difficulties in the boiler house and steam delivery system. Insulation of digesters is being tried out in a few plants, and while no leaks have yet been reported, it is felt that no difficulty will be found in catching them. Partial insulation leaving the base exposed was not thought to be desirable, due to the temperature strain that would be induced, though one plant is trying it out.

LONGWORTH BILL INDORSED

The committee on dyestuffs reported that diminishing trouble was being experienced with paper colors and reported a resolution indorsing the Longworth bill which was voted upon and passed in the assembly.

BIBLIOGRAPHY

The committee on bibliography is preparing a reading list on sulphate pulp, marbled papers, dyeing of pulp, drying of paper, cigarette papers, analytical procedures and paper textiles. About twenty-five lists have been submitted in the past making all published facts available without effort in library search. Clarence J. West, chairman of the committee, is now located with the National Research Council at Washington and will be glad to receive and reply to any inquiries regarding bibliographies on pulp and paper subjects.

WATERWHEEL EFFICIENCIES

Prof. Charles M. Allen of Worcester Polytechnic Institute described the use of the Alden dynamometer in the water-power-driven ground wood pulp mill. He spoke of bad practice and cataloged case after case where poor efficiencies were being obtained on down to where the water turbine was in circuit with steam and actually being driven as a pump—consuming power instead of delivering it. All water-power equipment should be frequently tested to be maintained in an efficient condition.

USE OF WASTE HEAT IN VENTILATION

The Briner economizer and heat exchanger counter-currents the hot exhaust air from the paper rollers to the incoming supply, thus affording dry air from the

outside at any required temperature. A steam radiator is in circuit for use when sufficient heat is not obtainable from the exhaust due to shutdowns and interruptions in operation. A cold air shunt is also installed to make temperature regulation possible.

THE ALLEN WEIGHTOMETER

The Allen weightometer was described by E. J. Trimbe and is designed to weigh and record continuously anything from chips to liquor. Six triangular open pockets set in the form of a hexagon drum revolve in such a way that a set load releases each when filled and automatically unloads and records each filling during the revolution.

PAPER MOISTURE CONTENT INDICATOR

Dr. C. B. Thwing demonstrated a beam balance designed to show moisture percentage direct without calculation. The accuracy of the instrument depends on the constancy in the weight of stock which is calibrated against a dried gage piece. As the bond in paper is influenced in strength and other physical properties by the moisture content, it is essential that the moisture content should be tested in conjunction with these other tests.

NEW SULPHUR PLANT DESCRIBED

The Bureau of Mines moving picture of the Texas Gulf Sulphur plant at Matagorda, Tex., visualized the process by which this important raw material is mined in quantities sufficient to supply the markets of the entire world. The liquid sulphur is pumped for miles in steam-jacketed lines, stored in 170,000-ton vats and shipped from the port of Galveston, which is near by. The record capacity of this plant is reported as 2,500 tons per day of commercially pure brimstone averaging 99½ per cent sulphur. The purity is probably due to the gypsum source, which is free from selenium and arsenic.

BANQUET

Tuesday night was set aside for the annual feast at the Astor, which was so attractive that we are publishing the photograph by way of ornament. Judge Charles F. Moore was toastmaster and introduced each speaker with a little prelude tale. We are commenting editorially on the principal talk of the evening by Prof. Marston T. Bogert. Ellwood Hendrick aroused the greatest amusement with his chemistry and psychology of odor and smell. Philip T. Dodge presented his views on what degree of finish the raw recruit from the technical schools should have to be welcome in the mills of the International Paper Co. Mr. Dodge desires that paper technology and manufacturing practice be taught to the student, and of course this can be and is carried out after a fashion in a few technical schools, but the big question is: Has the manufacturer any right to push all the burdens of such education on to the schools? We would like to present the views of the technical men at the round tables, but think it enough to state that very few agreed with the speaker.

FALL MEETING

The next meeting will be held in September in Washington, where the Bureau of Standards and Government printing plants will be inspected. An excursion will be made to the plants in the Wilmington and Philadelphia districts at the conclusion of the meeting.

Residual Aluminum Compounds in Water Filter Effluents

Theoretical Considerations Indicating the Influence of the Hydrogen Ion Concentration on the Solubility of Aluminum Hydroxide—Various Conceptions of Aluminum Sulphate Reactions With Natural Alkaline Waters

BY ABEL WOLMAN* AND FRANK HANNAN†

ALUMINUM sulphate as a coagulant has been employed for such a long term of years in our water supplies that it would appear to be unnecessary to discuss at this late date any of the peculiarities of its reactions. That such discussion is desirable, however, is clear, when we view in retrospect the development of certain concepts of chemical transformations. As the fields of chemistry and physics become better explored there gradually appears a realization of the continual energy of reactions. The assumptions of rigidity and irreversibility of the interactions of substances need to be abandoned. With such assumptions, it becomes necessary also to discard some of the "fundamental truths" which no longer appear either "fundamental" or "true."

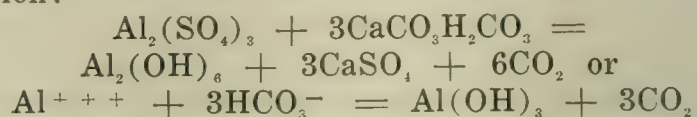
In a number of respects, orthodox conceptions of the action of alum in water seem to require some modification and extension. Such changes in viewpoint may be particularly desirable at this time, when discussion in waterworks fields has again reverted to the problem of residual alumina in filter effluents. For this reason the writers considered it a fruitful task to attempt in this paper to develop as briefly though as accurately as possible an understanding of the mode of action of alum as a coagulant. In such a development the causes of certain associated phenomena, such as disappearance of flock, positive reaction for alumina in filter effluents and imperfect coagulation with low alkalinity, may also appear. For purposes of clarity it is well to point out that in the discussion to follow we are not concerned with the passage, through filters, of undecomposed aluminum sulphate due to insufficient alkalinity or of flocculated hydrate through breaks in filter beds. In other words, our discussion refers to difficulties inherent in natural processes and not to those resulting from unintelligent application of chemicals or operation.

In order to provide for an orderly presentation of the subject, the writers have decided to devote this paper to theoretical considerations, with only such additional data as will be necessary to clarify some of the ideas presented. The experimental proof of some of the hypotheses here set forth is still lacking. One of the important purposes of this discussion is to call forth a greater amount of experimental work in this field than has so far been accomplished. A number of the facts should be tested out in routine practice, so that large-scale findings may substantiate or refute laboratory suggestions emanating from this and other fields. If such a program were carried out, the various phases of the alum problem might be satisfactorily solved. These phases include: (a) theoretical considerations, (b) experimental data, (c) conclusions, (d) significance of results (sanitary, physiological, etc.). Our contribution,

as we have stated before, is to be restricted to (a)—theoretical considerations. Perhaps in the course of time the supporting material for (b), (c) and (d) will be forthcoming.

ALUMINUM SULPHATE REACTION—USUAL CONCEPTION

The simplest and most popular conception of the reaction of aluminum sulphate with the natural alkalinity of water is given by the following typical equation:



This rigid transformation is usually accepted as approaching the average state of affairs when "normal" conditions obtain. The above equation has been responsible for the oft-repeated statement that "if sufficient raw water alkalinity is present, there is no excuse for the passage of aluminum compounds through filter beds." The simplicity of the reaction has been so frequently emphasized that the impression has been gained by the average filter plant operator that when the coagulum, $\text{Al}(\text{OH})_3$, is not instantly and continually formed, the treatment is either careless or faulty. When inquiry, however, among many operators elicits the information that such difficulty as ineffective flock formation and residual alumina in filter effluents are by no means rare occurrences even with plenty of alkalinity, it seems wise to search for causes in other places than poor operation.

Such a search demands at once a reconsideration of alum reactions. Since the study of such reactions has been retarded in the waterworks field by the general hesitancy to question orthodox beliefs, it is necessary to pursue our inquiry into other channels. When this is done, two important series of data appear. These series are in conflict as to the nature of the compounds resulting from alum reactions, but are in complete agreement as to the absence of rigidity of state of any particular aluminum compound. In other words, we must pass from a viewpoint in which alum reactions result in stationary phenomena to one in which they appear as mobile, delicate equilibria. With such a new viewpoint, the formation of an insoluble coagulum as $\text{Al}(\text{OH})_3$, when aluminum sulphate is added to water, becomes a desirability, but not necessarily an eventuality. Our problem now becomes to determine those factors which regulate the reaction in such manner that the desired result, an insoluble complete coagulum of $\text{Al}(\text{OH})_3$, is obtainable.

RECENT INTERPRETATIONS BASED ON HYDROGEN ION CONCENTRATION

The important characteristic of recent conceptions of $\text{Al}_2(\text{SO}_4)_3$ reactions is to be found in the realization

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† Toronto Water Filtration Plant, Toronto, Canada.

that the formation of $\text{Al}(\text{OH})_3$ is a reversible progressive reaction, dependent upon a number of conditions, the most important of which is probably the hydrogen ion concentration or p_H value of the solution in which one is working. The nature of the solutions obtained, however, when aluminum hydroxide is dissolved in the presence of acids or bases has been the subject of much discussion. The underlying hypotheses of these discussions may be divided into two classes. In the first case, the solution of $\text{Al}(\text{OH})_3$ is ascribed to processes of peptization or change in physical structure of $\text{Al}(\text{OH})_3$, but not to change in chemical composition. The second school of thought bases its understanding of the processes entirely upon the hypothesis that the changes taking place when $\text{Al}(\text{OH})_3$ is formed and redissolved are due to variations in chemical combination. The contrasting viewpoints emphasize changes in physical state as against changes in chemical combination. The salient features of each conception are outlined at some length below, in order to demonstrate that, whatever viewpoint is accepted, one must reach the conclusion that the complete formation of the insoluble $\text{Al}(\text{OH})_3$ in water is by no means as frequent an accomplishment as has been tacitly assumed.

CHANGES IN PHYSICAL STATE

The evidence supporting the hypothesis that $\text{Al}(\text{OH})_3$ may be redissolved in solutions through the increase of hydroxyl ions, because of a process of peptization or subdivision of particles, is by no means complete. Mahin, Ingraham, and Stewart,¹ for example, conclude that aluminum hydroxide should not be considered as amphoteric since they claim to have established by the measurements of the heat of solution of aluminum hydroxide in sodium hydroxide, of the quantitative relations between ammonium nitrate and sodium aluminate and observations made upon the electrolysis of sodium aluminate that the colloidal properties of aluminum hydroxide play a far more important part in conditioning its solubility in bases and acids than the possible formation of aluminates. In addition, Chatterji and Dhar² state:

"In the case of the action between sodium hydroxide and the hydroxide of copper, chromium, lead, zinc, aluminum and mercury, the following results are obtained. The conductivity of a solution of caustic soda did not appreciably change on the addition of hydroxide of chromium, aluminum, lead and mercury, while in the case of zinc the resistance of the caustic alkali solution appreciably increased when zinc hydroxide was dissolved in it. Hence we can conclude that the solutions of aluminum hydroxide, chromium hydroxide, lead hydroxide, mercury hydroxide and copper hydroxide are cases of true peptization and not of chemical combination. On the other hand, in the case of zinc hydroxide, we get more of chemical combination than of peptization. Or, in other words, the major part of the hydroxides of Al, Cr, Cu, Pb, Hg exists in sodium hydroxide solution as a colloid, while the major part of zinc hydroxide remains as a zincate. . . . Similarly the hydroxides of Al, Fe and Cr form colloidal solutions in acetic acid, while zinc hydroxide forms zinc acetate."

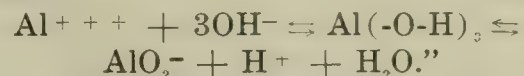
The above statements give a fair representation, it is believed, of the hypotheses presented by the adherents of the "peptization" theory. It is important to emphasize that these authors and others have demonstrated the ephemeral character of the insoluble $\text{Al}(\text{OH})_3$. They

support simply one explanation of the cause of the solution and precipitation of the hydroxide—namely, that due to change in physical structure because of some effect of hydroxyl ions. They disagree with the second class of workers, not on the fundamental idea of the instability of the insoluble $\text{Al}(\text{OH})_3$, but only on an explanation of the cause of this instability.

CHANGES IN CHEMICAL CONSTITUTION

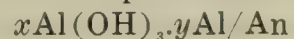
The basis of the explanation of the change of state of $\text{Al}(\text{OH})_3$ as due to a change in chemical constitution may best be indicated by the following quotation from Stieglitz:³

"Aluminum hydroxide dissolves in acids. From its solution in hydrochloric acid, an aluminum salt, aluminum chloride, $\text{AlCl}_3 \cdot 6\text{H}_2\text{O}$, is obtained. It also combines with strong bases, dissolving, for instance, in a solution of sodium hydroxide and forming an aluminate, NaAlO_2 According to the best knowledge we have on the subject, the molecule of aluminum hydroxide has the following structure or arrangement of its atoms $\text{Al}(-\text{O}-\text{H})_3$. It is readily seen that the cleavage of the molecules may produce either aluminum and hydroxide ions, characteristic ions of a base, or aluminate and hydrogen ions, characteristic ions of an acid:



Loeb⁴ further adds that "it is obvious that between the action of acids and of bases producing these two types of electrolytic dissociation there must be one hydrogen ion concentration in which aluminum hydroxide is practically neither able to form Al^{+++} nor AlO_2^- ions, and this would be the isoelectric point. The significance of this statement will appear later in the discussion.

Wolfgang Pauli⁵ recently strengthens this conception by concluding, as a result of an exhaustive physico-chemical analysis, that the aluminum hydroxide sols may be considered as complex salts of the composition:



where An is the anion of the salt used in preparing the sol.

The question naturally arises now as to what conditions determine the formation of the insoluble hydroxide and the soluble complex salts of aluminum. In the answer to this question should appear the clue to the cause of the puzzling features of present-day coagulation problems in water supply. Fortunately an abundance of experimental data are available in different fields. They are of sufficient interest and value to discuss at length in this paper. Their practical importance in indicating a solution of our specific problems will be outlined in a later section of this discussion.

In March, 1913, at the Milwaukee meeting of the American Chemical Society Hildebrand⁶ presented a paper on "Some Applications of the Hydrogen Electrode in Analysis, Research and Teaching." In this paper Hildebrand demonstrated definitely that aluminum hydroxide is precipitated by sodium hydroxide, while the solution of aluminum sulphate is still strongly acid, the hydrogen ion concentration during the precipitation varying roughly between 10^{-3} and 10^{-5} . He also shows that aluminum hydroxide goes into solution with an excess of alkali, in which the proportion of alkali used corresponds to the formation of $\text{NaAlO}_2 - n\text{H}_2\text{O}$. It is interesting to recall that Hildebrand supported the theory of the solution of aluminum hydroxide as an

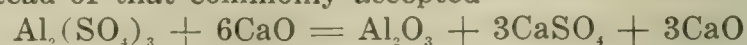
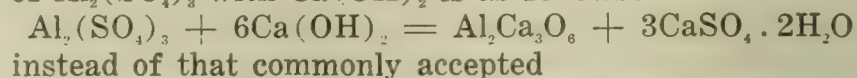
acid rather than as a colloid, as claimed by Mahin, Ingraham and Stewart.¹ Hildebrand bases his refutation of the above authors' contention upon the fact that the ultramicroscope fails to show the presence of a colloid in the solutions studied, although the ordinary solutions of aluminum hydroxide produced by dialysis show submicrons very plainly in the ultramicroscope. The conclusions reached by Hildebrand were later substantiated by Bancroft⁷, Blum⁸, Pauli⁵ and others.

The work of Blum⁸ is most significant in attempting to clarify some of the results frequently obtained in the application of aluminum sulphate to water. This author has made extensive studies of the reactions of the aluminum compounds with certain bases. His studies are interesting and valuable. From his experiments on the action of sodium hydroxide upon AlCl_3 he notes that precipitation of $\text{Al}(\text{OH})_3$ begins when p_H is about 3 and is complete before p_H is 7. He finds that for the transition state from p_H 7 to p_H 10.5 a dissolving of aluminum hydroxide in sodium hydroxide is progressively in action, until at the latter point the solution is almost entirely clear. The constitution of the compound contained in the solution at this latter point is indicated by Blum, but the details of this particular subject need not concern us at this time.

The results of Blum's experiments appear to indicate the existence of definite aluminates of the formulas NaAlO_2 and KAlO_2 (or multiples thereof) in solutions obtained by the action of alkalis upon aluminum hydroxide. More importantly for the particular subject with which we are now concerned, the experiments demonstrate beautifully that the amount of $\text{Al}(\text{OH})_3$ held in a given alkaline solution is a function of the alkalinity of the solution. This conclusion cannot be too greatly

between 6.5 and 7.5. What is this point of optimum precipitation in our different water supplies? Have we ever paid any attention to it? We must expect certainly that there are numerous points in coagulation in which re-resolution of $\text{Al}(\text{OH})_3$ is always in operation. The occurrence of aluminum compounds in filter effluents should be as common as it is now considered rare. Chance, and not mischance, in the past seems to account for its failure to appear.

Further important experimental work on the reactions and constitution of aluminum compounds may be found in the studies by Heyrovsky⁹ on the electro-affinity of aluminum, by Michaelis,¹⁰ and on the production and chemistry of satin whites by Cobenzl.¹¹ The latter adduces reasons for his belief that the reaction of $\text{Al}_2(\text{SO}_4)_3$ with $\text{Ca}(\text{OH})_2$ is as follows:



It is interesting to note that Cobenzl suggests that

TABLE I (ADAPTED FROM BLUM)
Precipitation of $\text{Al}(\text{OH})_3$ by NH_4OH at Various Hydrogen Ion Concentrations

Exp. No.	Approximate p_H	NH_4Cl Added g.	Al_2O_3 in Filtrate g.	Remarks
1	6.0	5	0.0010	
2	6.0	5	0.0012	
3	6.5	0	Appreciable	Coagulated poorly
4	6.5	5	0.0001	
5	6.5	5	0.0000	
6	7.5	0	0.0000	
7	7.5	5	0.0000	
8	7.5	5	0.0002	Macerated paper used
9	9.0	0	0.0004	
10	9.0	5	0.0004	

NOTE.—Table I shows that considerable aluminum hydroxide remains unprecipitated at p_H values, varying much from 6.5 to 7.5, as shown by filtrate readings in experiments 1, 2, 3, 8, 9, 10.

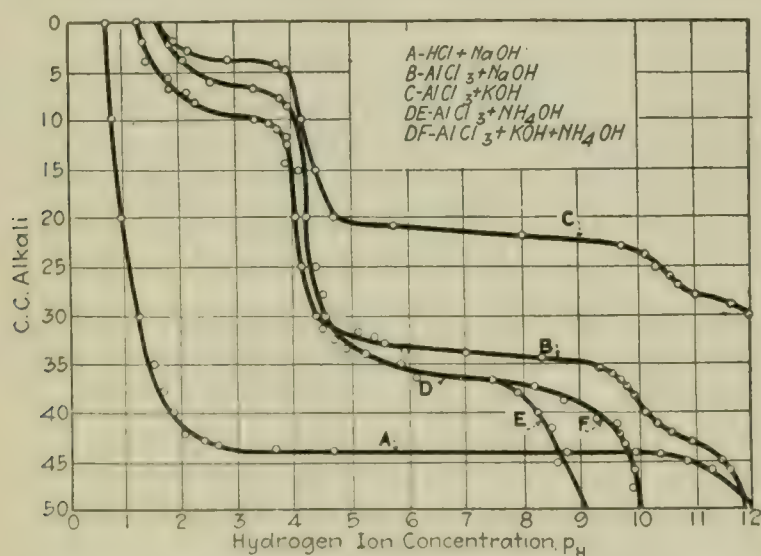


FIG. 1. EFFECTS OF H ION CONC. ON SOLUBILITY OF $\text{Al}(\text{OH})_3$. (AFTER BLUM)

stressed, since it appears to the writers of this paper to be the basis of a new and better understanding of the whole mechanism of alum coagulation.

The obvious resultant of the above tests is stated in brief by Blum:⁸

"In the case of amphoteric hydroxides, such as $\text{Al}(\text{OH})_3$, it is obvious that an excess of the base is to be avoided and it therefore becomes desirable to select that degree of alkalinity which will insure most nearly complete precipitation and at the same time avoid resolution of the precipitate." (The italics are ours.)

In Table I are shown certain data adapted from one of Blum's publications which show quantitatively that the precipitation of aluminum hydroxide by ammonium hydroxide is complete when the p_H of the solution is

calcium aluminate, when formed, is in a colloidal state, and the particle size may be regulated by the degree of alkalinity of the solution. May we not find it necessary to search for such complex configurations in our water supply reactions before scientific control is possible?

By way of digression, it is well to call attention at this point to the difference between "precipitation" and "sedimentation" concepts. It is possible to conceive that the points of optimum precipitation and of sedimentation need not coincide. As a matter of fact, there is considerable evidence to suggest that these points rarely coincide. Blum,⁸ for example, defines "precipitation" as the chemical formation of $\text{Al}(\text{OH})_3$. "This compound (especially in the absence of salts) may not actually coagulate or form a visible precipitate until from one-third to one-half of the alkali required for complete precipitation has been added. The point at which a visible precipitate occurred in the different experiments was found to be very variable." Likewise, Mukhopadhyaya,¹² working on the coagulation of arsenious sulphide sol by electrolytes, finds that settling or sedimentation plays an extremely small part in the coagulation of colloidal arsenious sulphide.

The subject of the effect of the hydrogen ion concentration upon the physical state of such amphoteric colloids as $\text{Al}(\text{OH})_3$ should not be left without making somewhat complete reference to the great amount of excellent work performed upon organic compounds of similar structure by Loeb.⁴ We can find no better method of clarifying the concepts we have attempted to present in this paper than by quoting at length from one of Loeb's papers dealing with analogies between solutions of gelatine and aluminum salts.

"Gelatine is an amphoteric electrolyte which when the hydrogen ion concentration of its solution exceeds the critical value $2 \times 10^{-5} N$ forms only salts of the type of gelatine chloride, gelatine sulphate, etc., while when its hydrogen ion concentration falls below this value it can form only salts of the form of metal gelatinates—e.g., Na gelatinate, Ca gelatinate, and so on. At the critical hydrogen ion concentration $2 \times 10^{-5} N$ —the isoelectric point for gelatine—it can exist only in the form of pure—i.e., non-ionogenic—gelatine. In this condition gelatine is practically insoluble, practically non-ionized, and is practically incapable of producing any osmotic pressure. Both types of gelatine salts, metal gelatinates as well as gelatine chloride, etc., are very soluble, are strongly ionized, and are capable of producing osmotic pressure. The writer's experiments, which are not yet all published, have shown that for each given hydrogen ion concentration there exists a definite equilibrium between non-ionogenic gelatine, gelatine salts and free acid. If we have 1 per cent solutions of isoelectric gelatine, the ionized or salt portion of the gelatine is practically zero. When we add increasing quantities of an acid—e.g., HCl—an increasing portion of the gelatine is transformed into gelatine chloride, while the portion of non-ionogenic gelatine is correspondingly diminished. The relative proportion of gelatine salt and non-ionogenic gelatine depends therefore upon the hydrogen ion concentration of the solution and increases in a characteristic way with this concentration. This hydrogen ion concentration of the solution is, of course, not identical with the concentration of the acid added to the solution, since part of this acid is in combination with the gelatine forming the gelatine salt. Since practically only that fraction of the 1 per cent gelatine solution which is transformed into a gelatine salt produces an osmotic pressure, it is obvious that the osmotic pressure of a 1 per cent solution of gelatine must change in a definite way with the hydrogen ion concentration of the solution. If we use different acids we find that different quantities of acid are required to bring a 1 per cent gelatine solution to the same p_H .

"When the hydrogen ion concentration is below the critical value 2×10^{-5} (or to use Sørensen's logarithmic symbol, when $p_H < 4.7$) a part of the non-ionogenic gelatine is transformed into metal gelatinate, and this part is the greater the more the hydrogen ion concentration falls below 2×10^{-5} . This is again a definite equilibrium between hydrogen ion concentration, gelatine salt and non-ionogenic gelatine.

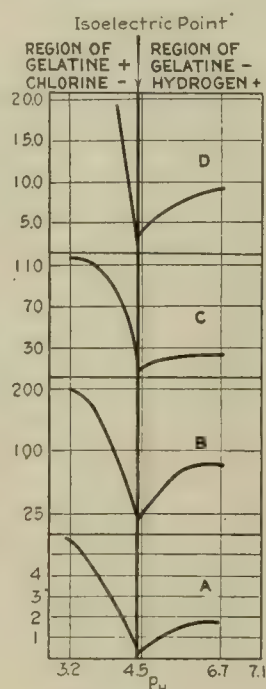


FIG. 2.
Chemical influence of
H Ion concentration
(after Loeb)*

*"Amphoteric Colloids," by Jacques Loeb, *Journal of General Physiology*, No. 1, Sept. 20, 1918.

Curves of the conductivity (A), osmotic pressure (B), swelling (C), and alcohol number (D) of gelatine previously treated with various concentrations of HCl.

In the region of the isoelectric point ($p_H = 4.7$) all the curves have a minimum. On the left of this point gelatine exists in the form of gelatine chloride (with high ionization), the curves rising more rapidly than on the right of the isoelectric point where the gelatine exists in the form of common gelatine which dissociates as a very weak acid.

Ordinates in curves

A—Conductivity 10,000 ohms.

B—Osmotic pressure

C—Total swelling

D—Alcohol number

"It is perhaps not without interest that the behavior of gelatine is paralleled by the behavior of amphoteric electrolytes of a crystalloid character—e.g., aluminum salts. Thus aluminum chloride exists only when the hydrogen ion concentration exceeds a certain critical value which seems to lie near that of the point of neutrality. When the solution becomes alkaline, metal aluminates are formed. Na aluminate as well as $AlCl_3$ is very soluble. At the isoelectric point neither salt can exist and the insoluble $Al(OH)_3$ is formed. The insoluble $Al(OH)_3$ has no osmotic pressure (or does not attract water) while solutions of both $AlCl_3$ as well as $NaAlO_2$ attract water powerfully. In the presence of $AlCl_3$ water molecules are apparently negatively electrified and in the presence of $NaAlO_2$ water shows positive electrification. The turning point for the sense of migration of water molecules seems to lie near or at the isoelectric point of aluminum—namely, p_H about 7.0. It would be very important if we could measure the permanent osmotic pressure of aluminum salts in collodion bags, but this is impossible since aluminum salts, with the exception of the insoluble $Al(OH)_3$, diffuse through collodion membranes. It is, however, possible to determine the influence of different aluminum salts upon the rate of diffusion of water through a collodion membrane and it is found that this influence obeys the two rules."

Material of a similar nature to the above, although by no means as extensive, has been accumulated by Patten and Johnson,¹³ Eckweiller, Noyes and Falk,^{13a} and Coulter.^{13b} Their results are confirmatory of those already presented.

SIGNIFICANCE OF PRESENT DISCUSSION IN REFERENCE TO PROBLEM OF ALUM COAGULATION IN WATER SUPPLIES

A survey of the facts and theories collected in the preceding portions of this paper has led the writers to formulate a hypothesis regarding the action of aluminum sulphate in water supplies which may properly paraphrase Loeb's conclusions as to proteins. The important features of this hypothesis are as follows:

Aluminum compounds may exist in three states, defined by their hydrogen ion concentration—namely, (a) as non-ionogenic or isoelectric $Al(OH)_3$, (b) metal aluminate (e.g., Na or Ca aluminate) and (c) alumino-acid salts (e.g., aluminum chloride, aluminum sulphate, etc.). Thus, in practically every water treated with alum, at any point other than the isoelectric point (which has not yet been determined for varying waters), an equilibrium may exist between hydrogen ions, metal aluminates and non-ionogenic or isoelectric $Al(OH)_3$. (If the p_H were lower than the isoelectric the Al ion would replace the aluminate. In water practice, however, such cases would be rare.) It is reasonable to suppose that just as often as not the p_H of a water is not correct to permit the complete formation of only $Al(OH)_3$. For this reason the occurrence of other aluminum compounds should not surprise one in filter effluents, for such compounds are soluble and need not be removed by the sand.

Some waterworks investigators have recognized the possibility of formation of aluminum compounds other than the insoluble hydroxide. In most instances, however, these possibilities have been ascribed both to insufficient alkalinity and to peptization. (Stein,¹⁴ Whipple.¹⁵) In this manner advantage has been taken of both the theories of peptization and of chemical combination. It appears from the preceding material that the

latter explanation alone may suffice if we do not neglect the important factor of the hydrogen ion concentration of the medium with which we are at work. At this point also it is important to suggest that *not only low alkalinity may be fraught with danger but too high hydroxyl ion concentration may not be so desirable* for proper and successful coagulation and for the complete elimination of soluble aluminum compounds. It seems, as a preliminary theory, that as one departs from the point or area of favorable hydrogen ion concentration in coagulation processes, one passes, in either alkaline or acid direction, into fields of re-solution of aluminum hydroxide. This conception, it is clear, is independent of the causes of such re-solution. It is important, therefore, to keep in mind the ever-present possibility of missing the favorable threshold area of coagulation and passing into the unfavorable dissolution areas. This interpretation of the action of aluminum sulphate is widely different from that hitherto accepted, in which the presence of delimited areas of effective flock formation was but little emphasized.

Does the literature of water purification disclose any data in confirmation of the above hypothesis of equilibrium conditions of alum reactions? It should be difficult to obtain such material, since it is only recently that

TABLE II (ADAPTED FROM MORISON)

Volumetric Estimation of Alum in "Solution" in Waters Treated With Various Doses of Aluminum Sulphate

Description of Sample	Approx. Parts per Million Aluminum Salts in Supernatant Water
Raw water + 25 p.p.m. alum..... 1 liter evaporated for experiment	1.47
Raw water + 40 p.p.m. as above.....	1.47
Raw water + 33.4 p.p.m. as above*	0.00
Raw water + 15.0 p.p.m. as above.....	0.90
Raw water + 40.0 p.p.m. as above.....	1.75
Raw water + 25 p.p.m. as above.....	1.47

* Also optimum clarification dose.

determinations of hydrogen ion concentration have been made in water. Hitherto only potential alkalinity and acidity have been determined, because of current methods of titration, while actual alkalinity or pH values have remained unknown. It is these latter conditions which are usually operative in conditioning our water supply reactions.

ZONES OF COAGULATION

Fortunately we have available an excellent series of experiments in water which does much to substantiate at least some of the possibilities of the suggestions outlined above. It is interesting to find that the author of these experiments, in the distant land of India, did not completely recognize the significance of the data which he reports. In April, 1916, Captain J. Morison¹⁰ of the Indian Medical Service reported upon a series of studies of the clarification of the water supply of Poona by means of alum. The results he obtained may be well interpreted in the light of the theoretical considerations previously presented. Morison's first experiments were made by adding increasing quantities of aluminum sulphate to the turbid water to be studied. He found that the clarification of the water with these different doses exhibited the familiar "zone phenomenon"—that is, "by increasing the dose of alum up to a certain point the clarification improves up to an optimum point where the settlement is excellent; any alum in excess of the optimum point again results in incomplete settlement. Increasing the doses of alum now gives less and less settlement, until a point is reached where the settlement

is no better than that of the untreated water. Further increments of alum produce settlement which finally becomes complete. The improvement, however, is not uniformly continuous. It is broken by waves of which as many as three have been noted." (Fig. 3.)

MORISON'S COLOR TEST

Morison,¹⁰ in addition, makes the important notation that "using now pure hæmatoxylin (Grübler) in a 1 in 1,000 watery solution . . . it was found that a red color was given by the natural water and by the water completely clarified by a dose of alum just sufficient to clear it. If this dose were not attained the water was turbid and gave a lavender or purple color with hæmatoxylin. If the dose were exceeded the clear solution gave either a reddish color which was rapidly decolorized, or a permanent bluish lavender; the latter color appearing when the dose of alum approximated or exceeded 2.2 times the alkalinity. This seemed a curious result. The hæmatoxylin, used to detect the presence of alum, showed that the alum was completely pre-

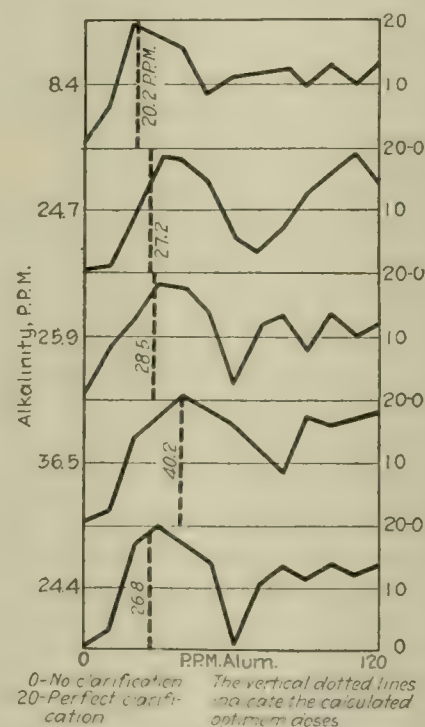


FIG. 3. CLARIFYING EFFECTS OF ALUM (AFTER MORISON)*

cipitated at a point corresponding to half the weight of alum necessary to react completely with the alkalinity of the water, and that both below and above this point, *in spite of there being in each case an excess of available alkali, there still remained some alum in solution.*" (Present authors' italics.)

Morison then concludes: "In the above experiments where the aluminum sulphate was present in quantities in which it ought to have been completely precipitated by the alkalinity of the water, certain of the aluminum hydrate remained in the supernatant fluid except when the optimum dose of alum was used." With this conclusion in mind, Morison then determined quantitatively the amount of alum present in such supernatant liquors and found that alum could always be detected when the doses were below the optimum point. At the optimum dose the alum, if present at all, was in minute quantities. Morison's figures are given in Table II. It is interesting to recall also that Morison found residual alum present in slow sand filter effluents in Poona, where alum-treated waters were being applied to slow

*"The Dose of Alum for the Clarification of Water by Precipitation," by Captain J. Morison, *Indian Jour. Med. Research*, vol. 3, No. 4, April, 1916.

sand beds. The results were not surprising. The converse of this has been observed by one of us, when on one occasion the alum application was eliminated completely from a mechanical filter for five consecutive days. The effluent nevertheless continued to give the alumina reaction with little or no reduction during the whole of this time.

Of even greater significance in connection with the present subject is the fact that Morison demonstrated that the hæmatoxylin test reacted with hard waters (356 p.p.m.) in a manner very similar to that described for the soft waters (25 to 50 p.p.m.). "Below the zone of settlement, hæmatoxylin gave a gradation of shades of lavender; at the optimum point a red color was produced; immediately above this point the hæmatoxylin was decolorized and, when the dose exceeded 610 p.p.m. (alum) the lavender color returned."¹⁶

IMPORTANCE OF p_H

A close study of Morison's curves and figures leads one at once to the conclusion that the phenomena he noted were entirely due to changes in hydrogen ion concentration, similar to those outlined in the earlier portions of this paper. The similarity between Morison's curves and those recently presented by Smith¹⁷ is so striking as to lend further emphasis to the controlling importance of p_H in determining coagulation phenomena. Morison¹⁶ was groping for this explanation when he suggested: "It would seem as if the precipitation of the colloids were not so much due to the neutralizing of the charge on one sol by that of another sol or by an electrolyte as to a certain balancing of the acid and basic ions in the solvent, which, when balanced, and possibly by a catalytic action, bring about the coagulation and the precipitation of the colloids." It is also of great interest to recall that not long after this statement Longley,¹⁸ in discussing the nature of color in water, says: "The removal of color by means of aluminum sulphate is influenced by the amount of alkalinity in the water. For a given water there is an alkalinity comparatively low and not many points above the neutral point where the coagulation seems to be best." Does not the work of Loeb, Blum, Morison and others supply us with the quantitative evidence for the general truth of these speculations? Although the present writers are unwilling as yet to subscribe fully to Morison's statement that the optimum dose, the so-called isoelectric point, has been shown in these experiments to be independent of the amount or the nature of the colloid present, yet there is sufficient accuracy of statement therein to warrant a complete change of viewpoint regarding coagulation processes. It will probably be found that the relationships are much more complex, as has been indicated by the work of Smith¹⁷ and of Raju.¹⁹

In the waterworks field Morison¹⁶ has supplied sufficient evidence of the probable existence of a point or zone of most effective coagulation. In the case of the water with which he was working this point coincided with the point of most satisfactory sedimentation. This coincidence, we believe, was largely a matter of chance, for it is our feeling that the zone of complete coagulation is determined by p_H conditions, while that of sedimentation will probably be dependent upon many other factors. Some slight experimental evidence for this belief is given below. Much more work remains to be done, however, before any real conclusions upon any portion of this interesting subject are to appear.

If the assumptions given above are in any way war-

ranted, we should be able to test their accuracy in the following manner: Theoretically the isoelectric point for $Al(OH)_3$ should be in the neighborhood of p_H 7.0. If we are experimenting, therefore, with a water having a p_H value of 8.0 to 8.6, we should be able to obtain better precipitation of $Al(OH)_3$ if we *acidify* such a water to bring it to a value nearer p_H 7.0. The heroic treatment of acidifying a water to improve coagulation is, of course, contrary to most canons of water purification. Let us see, however, what such treatment calls forth. The data presented are very meager, but they are at the same time interesting. The preliminary experiments are described below (experiments performed by Hannan):

PRELIMINARY EXPERIMENTS—ACIDIFICATION OF WATER

Dec. 15, 1920—Water used in this experiment obtained from slow sand filter effluent, untreated with alum, alkalinity (titratable) in the neighborhood of 90 p.p.m., p_H usually varies between 8.0 and 8.6.

Two samples of 1 liter each were taken of slow sand filtered water; added to each alum at rate of "1 grain per imperial gallon," the rate used in the mechanical filtration plant. To one of the above samples was added 0.8 c.c. normal sulphuric acid. At first the addition of acid had possibly a slightly clarifying effect, but after one hour had elapsed the acid-treated water was distinctly the more opaque. It preserved its lead in this respect up to 2½ hours, when 50 c.c. of each sample was filtered through a single thickness of Whatman No. 1 paper. On adding a drop of hæmatoxylin to each, the acid-treated was brown (probably with a little less acid it would have been the usual rose tint) at first, changing to a clear yellow with one or two drops of N/6 acetic acid. The other showed the usual alumina blue changing to brown with acetic acid; it also filtered more slowly. The alkalinity of the water was somewhat more than half used up between alum and acid. One could probably work with less acid. The required p_H seemed to be around 7.3. It is easy to see why this fact has escaped observation for so long a time. We have always been told that deficiency of alkalinity is the thing to be avoided. No one would be likely to try adding acid.

In the above samples, after standing twenty-four hours in tall cylinders with atmospheric exchange through cotton wool plugs, the acid-alum sample had not begun to settle, while the alum-only had flocked and settled. On filtration through single filter paper the acid alum was still quite alumina-free, while the other showed the usual blue with hæmatoxylin. Owing to loss of carbonic acid the p_H had moved up somewhat. The waters were transferred to glass-stoppered bottles. After forty-eight hours both samples had settled clear. Acid-alum sample still quite alumina-free, while the other as usual showed the blue.

Whether acid or alum is added, it is clear that the carbonic acid liberated determines the p_H . An essentially unstable system is thereby established. It is not surprising, therefore, that in the past contradictory results have been obtained, especially when the attempt is made to correlate with the original alkalinity and the alum dosage. The reader may gain a considerable light on this subject of carbonic acid- p_H system by reference to the work of Johnston,²⁰ Johnston and Williamson,²¹ McClendon,²² Massink,²³ Heymann,²⁴ Greenfield and Baker,²⁵ and Ross and Bagchi.²⁶

Dec. 27, 1920—An experiment was tried with the effluent of the mechanical filtration plant, which had,

of course, previously been coagulated as part of the usual system of purification. This test was naturally more severe than that described above. The sample was acidified and was left over night in a closed bottle. On the following morning it was filtered through paper. No reaction for Al was obtained in the filtrate. The experiment was not conclusive, for the check sample without acid, when filtered, showed a decidedly less pronounced reaction than usual, although by no means alumina-free.

Jan. 6, 1921—For the sake of brevity, we shall refer to the samples described on Dec. 15, 1920, as: *A*. Slow sand water—alum treated—acidified. *B*. Slow sand water—alum treated—not acidified. On Jan. 6 portions of these waters were again withdrawn. Filtration of the two samples showed the presence of alumina in both, but less in *A* than in *B*. On testing, *A* was found to have become alkaline. This would indicate that the p_H had risen again well above the isoelectric point, and therefore the alumina could not be filtered off, since it had gone into solution once more.

The flock in *A* was more compact and granular and had a faint brown tinge. The flock in *B* was slimy looking and with very indefinite boundaries. The supernatant water in *A* had no observable haze, while that in *B* had a trace of faint haziness (such as is often observed in mechanical filter effluents). The flock in *B* had no trace of brown tinge. The filtration of *A*, as before, was much more rapid than that of *B*.

Jan. 7, 1921—A preliminary series of experiments was carried out in order to shed some light upon the possibility of side reactions in use of alum in water.

TABLE III. POSSIBLE SIDE REACTIONS IN ALUM TREATMENT OF WATER

Sample Number	Slow Sand Effluent				Rapid Sand Effluent— Each Contained ½ g.p.g. Alum			
	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>	<i>A</i>	<i>B</i>	<i>C</i>	<i>D</i>
Amount water used, c.c.	250	250	250	250	250	250	250	250
Acid added (1 c.c. conc. HCl)	Yes	Yes	No	No	Yes	Yes	No	No
BaCl ₂ added (1 c.c. 10%)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Degree of precipitation	3	3	1	1	4	4	2	2
1—Minimum; 4—Maximum								

In each of four clean 500-c.c. bottles was placed 250 c.c. slow sand effluent; in each of four more similar bottles, 250 c.c. rapid sand effluent already treated at rate of 0.5 grain per imperial gallon. These various samples were treated as shown in Table III. The following tentative hypotheses appear:

(a) The sulphate in the slow sand water (known, it may be observed, to contain alumina, in a non-reacting form) is "masked" to a marked extent at the natural p_H .

(b) Of the added sulphate ions derived from the alum, a notable proportion is masked at the natural p_H .

(c) This effect would be explained if we assume that in the presence of OH-ion non-ionized calcium aluminosulphate is formed. This is known to be unstable in presence of H-ion.

Jan. 24, 1921—In each of six clean glass-stoppered bottles of 1 liter capacity, 1 liter of recently filtered slow sand water was added. Of these, *A1*, *A2*, received each 0.6 c.c. normal sulphuric acid. *B1*, *B2*, received 0.4 c.c. acid. *C1*, *C2*, received no acid. One grain per imperial gallon of alum added to each of the above six samples. Allowed to stand two hours after once thoroughly shaken. No difference in appearance of the six.

From *A1*, *B1*, *C1*, respectively, two successive portions of 50 c.c. were withdrawn and filtered through single thickness Whatman No. 1 paper. Tested for alumina in these six portions with one drop hæmatoxylin, fol-

lowed after a short interval by two or more drops N/6 acetic acid.

Results—*A1*, both portions alike; brownish shade before acetic acid, clear yellow after; no trace of alumina. *B1*, both portions alike; tint before acid hard to describe; there was, however, a faint trace of blue; after acid a clear yellow with just the faintest tinge of brown, which would probably escape detection without close comparison; a trace of alumina, certainly under 0.2 p.p.m. *C1*, both portions alike; blue before acid; brown after; heavy trace of alumina (0.3-0.5 p.p.m.).

Jan. 25, 1921—Withdrew a third 50 c.c. from *A1*, *B1*, *C1*, filtered through the same three papers as before, each through its own paper to avoid adsorption effects. Result same as before. In size of flock and rapidity of clearing, descending order was *A1*, *B1*, *C1*. In the undisturbed bottles the same order was observable—*A2*, *B2*, *C2*. These lagged behind their duplicates on account of agitation in the latter. Filtered off about half of what was left of *A1*, *B1*, *C1*, into Erlenmeyers of 600-c.c. size with view to further experiment.

Jan. 26, 1921—*A1* filtered and tested practically alumina-free. The water was filtered during the course of the day in small lots at a time. The faintest possible indication was obtained, due in all probability to the prolonged filtration in small lots having shifted the p_H .

Feb. 5, 1921—Unfiltered and filtered *A1* tested for alumina. Unfiltered gave strong reaction; filtrate none or negligibly small.

CONCLUSIONS

Theoretical considerations, supported by experimental results obtained in water work and elsewhere, appear to demonstrate fairly completely that the reaction of aluminum sulphate with the natural alkalinity of a water is a complex mobile transformation. The reaction seems to be delicately dependent upon the actual alkalinity of a water, its hydrogen ion concentration, rather than upon its potential alkalinity. The hydrogen ion concentration in turn is regulated to a large degree by carbon dioxide equilibria. Evidence so far accumulated seems to indicate that complete precipitation of $Al(OH)_3$ takes place at a hydrogen ion concentration somewhere near the neutral point, p_H 7.0, unless disturbing or buffer influences are operative. Outside of this zone of favorable alkalinity re-solution of insoluble flock occurs to a greater or less degree.

It seems clear, from the above considerations, that the appearance of aluminum compounds in filter effluents should not be accepted as due to faulty operation, according to orthodox interpretations, but to failures due to misunderstanding of the reactions involved. This statement is given in the nature of a hypothesis, to be substantiated by further experimental evidence. If the hypothesis is found to be true, the problem of residual alumina, not only in filter effluents, but in all coagulated waters, may be attacked from a new angle.

The writers have studiously avoided any reference to the sanitary, physiological or economic importance of the passage of soluble aluminum compounds through filters. That it has a great practical importance, however, the little data we now have apparently confirm. Owing to the controversial nature of the subject, it appears best to reserve discussion of this phase until more accurate and complete evidence is available.

In the meantime, the writers have presented here a modification of current theory as to alum action. If we are pressed as to its practical importance, we can only

respond with that learned Frenchman Charles Richet, who said, before the Physiological Congress in 1920, in Paris:

"Seek to understand things; their utility will appear later. First of all it is knowledge which matters."

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Legal Notes

BY WELLINGTON GUSTIN

Plea of Set-Off Good Where Company Sold Product Exclusively Contracted For by Another

The Supreme Court of Appeals of West Virginia recently decided some interesting points raised in the litigation brought by the Cook Pottery Co. against J. H. Parker and others, partners. (104 S. E., 52.)

The action was begun upon promissory notes of defendants, who filed two special pleas of set-off and a notice of recoupment against the pottery company. In each of the pleas defendants pleaded and relied on a contract between them and the company whereby plaintiff was permitted to manufacture a certain product, which was then owned and controlled by defendants, the same to be sold exclusively to the defendants, and to be invoiced to them at a named price, and with the further agreement on part of the plaintiff that it was to add to the aforesaid price the sum of 24c. per thousand to be credited to the account of defendants in reduction of their indebtedness. This agreement was for five years and as long thereafter as either party to it did not violate the provisions thereof, then to be canceled at the option of the party who had not violated the provisions thereof.

BREACH OF CONTRACT CLAIMED

In the first special plea the breach of contract claimed and the matter of set-off relied on by defendants was that prior to the action the pottery company had sold directly to other persons large quantities of the goods, and on all these goods defendants claimed royalty of 24c. per thousand, amounting to \$7,200.

In the second plea defendants relied on the same breaches of contract, but instead of the royalty or rent of 24c. per thousand on the goods manufactured and sold to others they claimed the right to offset against plaintiff's claim the difference between the contract price at which the goods were to be billed to defendants and the price at which they were actually sold by plaintiff to other persons, amounting to \$45,000, the profits realized by plaintiff in excess of the price at which they were to be manufactured, sold and delivered to defendants.

The court points out that the first objection made to both pleas is that the agreements are not alleged to be in writing, because if not in writing plaintiff would have a right to rely on the statute of frauds, requiring a writing. But a contract in writing need not be pleaded as such, for if the other party thereto wishes to avail himself of the defense of the statute of frauds he may urge it as an objection to receiving oral evidence of the agreement on the trial.

CLAIM FOR ROYALTY NOT UNLIQUIDATED DAMAGES

Again, it was contended that the matters set out in both pleas were not averred to have originated in or as growing out of the contract sued on, and that both amount to claims for unliquidated damages. It was said that an unliquidated claim for damages can not be set off against a liquidated demand, but if a plea of set-off pleads a claim not resting in uncertainty but is sus-

ceptible of accurate calculation as provided by the contract it may properly be filed, and is improperly rejected.

The first plea amounts to a demand for royalty at the rate of 24c. per thousand for the right to manufacture a product the rights to which are owned and controlled by the defendants. True, the quantity manufactured was not stated, but this was unknown, and it was averred that the quantity was sufficient to have aggregated at least the sum of \$7,200. The court says under these facts the amount was merely a question of computation, and the claim was no more unliquidated than if it had been for so many barrels of apples, bushels of corn or the quantity of any other commodity. Unliquidated damages are such as the contract furnishes no means of accurate estimation, but rest in the judgment or discretion of the jury. It is not necessary that the price should have been agreed upon when goods are sold. This fact does not render the claim unliquidated in the sense that it cannot be offset against the demand of the other party. This plea of set-off was held to be good in law. (8 Ann. Cases, 736.)

NO RIGHT TO PROFIT ON GOODS SOLD

The second plea averred a claim for damages, being the difference between the price at which plaintiff agreed to manufacture and sell the product to the defendants and the price at which the plaintiff itself sold them to others, an amount unascertainable from any facts alleged or known method of calculation. It was claimed that plaintiff manufactured and sold a particular quantity of the goods, but the court said defendant had no right to the profit made by plaintiff on the goods manufactured and sold by it. The measure of defendants' damages is what they could or would have made if the pottery company had kept its contract to make and deliver the goods to them at the stipulated price. But such cannot be made the subject of a plea of set-off against the plaintiff who brings his suit on a separate and distinct demand. The profits which defendants might have made on such goods if plaintiff had fulfilled his contract were too remote and speculative to be the proper subject of set-off. Therefore this plea of set-off was held not good. (51 W. Va., 523.)

CLAIM OF RECOUPMENT A VALID ONE

Further, the court held that defendants had the right to file and rely on their notice of recoupment. It was argued against this that the contract for sale and commissions had no relationship to the notes sued on, and that contract did not arise out of the same transaction. The notice alleged an agreement with J. H. Parker & Son in February, 1914, to continue a sale arrangement previously existing upon consideration that Parker would not go into bankruptcy, and that the defendant firm would assume and pay the liabilities of both to the plaintiff, and that the debts would be extended for such time as defendants should be able out of half their commissions earned to pay and satisfy the demands of plaintiff, preferring the open account against J. H. Parker, as stated. Part performance of this contract by defendants was averred and repudiation of it by the plaintiff.

Now the original notes of J. H. Parker were not a part of the same contract set out by defendants, but in so far as any part of the notes sued on entered into the new notes given by J. H. Parker & Son at the time the new contract was made, and when they assumed

the prior indebtedness as alleged, they became a part of the new contract providing for their payment by commissions to be earned, and the court said damages and loss of commissions sought to be recouped against plaintiff's demands by reason of the alleged breach of that contract must be regarded as a claim arising out of the same contract as the notes sued on, and the rule of law applies that when the claim of the defendant arises out of the same contract out of which the plaintiff's demand arose the demand of the defendant, though unliquidated, may be recouped against the plaintiff's claim.

Varnish Drying Patent Held Valid

In a suit brought by the Wenborne-Karpen Dryer Co. against the Rockford Bookcase Co. for infringement of a patent, the patent in question (1,186,477, granted to William M. Grosvenor, June 16, 1916) was held valid and infringed by the District Court of the Northern District of Illinois.

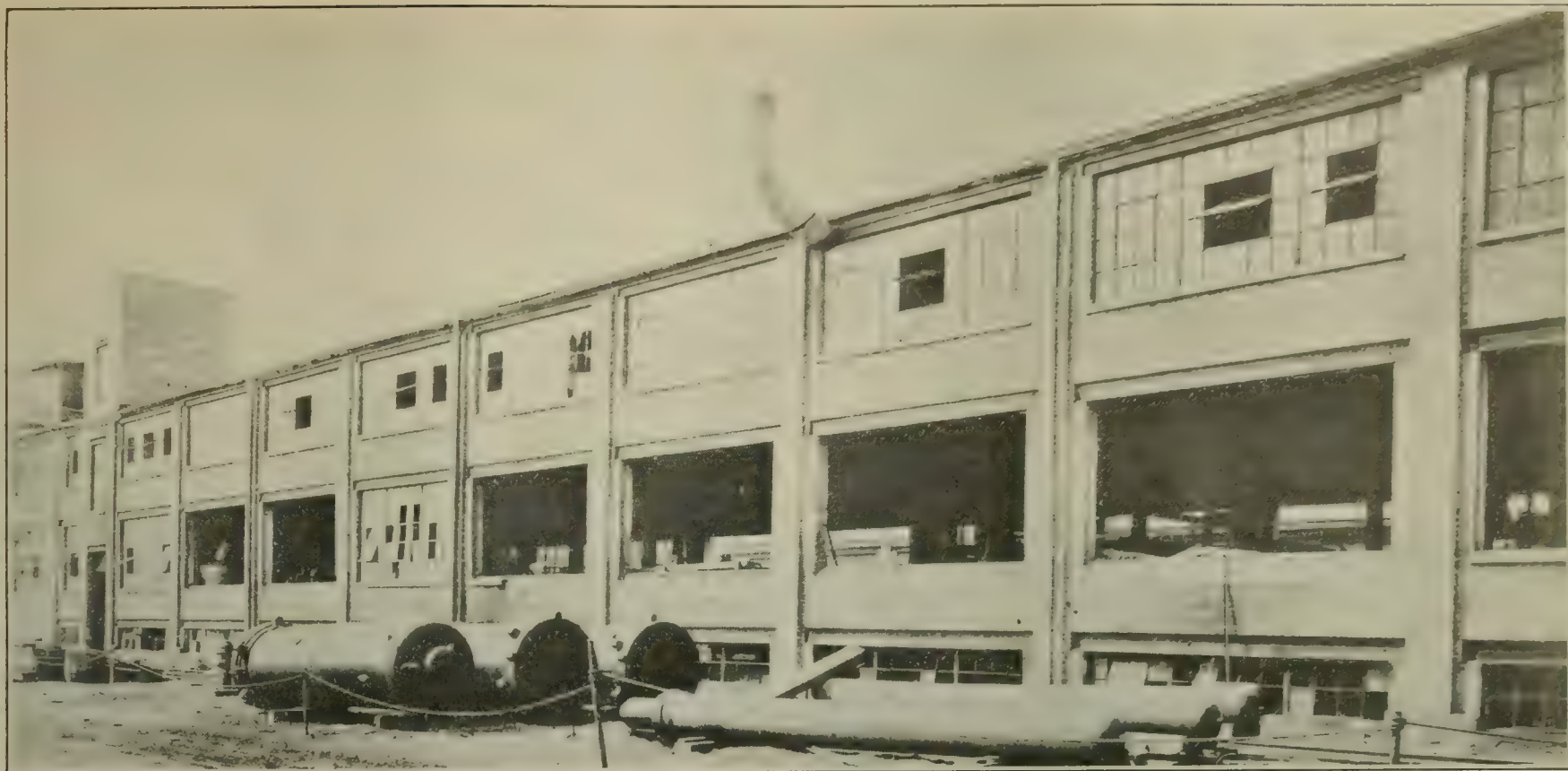
The patent covers a "process for drying and hardening siccative coatings," which consists of simultaneously adding heat and moisture to the air surrounding the siccative coatings. It was alleged by the defendant that substantially the same process has been used for years for the purpose of drying lumber. It was found that too rapid drying of the lumber resulted in the outside becoming case-hardened and steam vapor was therefore introduced into the drying chamber to retard the drying of the outside. As to this point, the court held that there was no analogy between drying wood and drying varnish, since the former is merely the physical process of evaporation, while the latter involves chemical action or oxidation. The phenomena are so different in nature that the discovery that the lumber drying was applicable to varnish drying constitutes a real invention, since the process is not only applied in a different art but with a new and different result. Before the appearance of the Grosvenor process, it was the consensus of opinion that moisture was one of the greatest obstacles to the rapid drying of varnish. For many years prior to the introduction of this process, it required from eighteen to forty-eight hours to harden thick varnish, whereas under the new process the same result was reached in from six to eight hours.

The court also held that the patent was not anticipated by an article on "Pigments, Paints and Painting" written by George Terry in 1893 or by the following patents in the prior art: Schultze, No. 519,352; Victorson, No. 507,512; Gathmann, Nos. 763,387 and 763,388.

The general manager of the defendant's factory admitted that the kiln room was equipped with steam radiators, a pet cock in the steam pipe "serving to let live steam into the atmosphere of the kiln" and an electric fan for the purpose of circulating the air. The claim that the thermometer and hygrometer were not consulted as in the patented process was held not to relieve the infringement.

Consumption of Mercury for Clinical Thermometers

The use of mercury in clinical thermometers does not seem to be a large matter, but the Bureau of Standards estimates that between 3,000 and 10,000 lb. of mercury is so used each year. The average clinical thermometer generally contains about 1 g. of mercury. It is on this basis and with the knowledge of the total production of "clinicals" that the estimate has been made.



An Explosion of Hard Rubber Dust

Results of Investigation of a Recent Explosion in Reduction of Hard Rubber Scrap Department of a Large Industrial Plant—Recommendations for Prevention and Precautions to Be Taken in Hard Rubber Grinding

By DAVID J. PRICE* AND HYLTON R. BROWN†

THE fact that practically any kind of combustible dust will explode with violence under favorable conditions when mixed with the proper proportion of air and ignited by a flame or spark has been known for some time. Several recent explosions in factories of the country have shown, however, that some dusts not considered readily combustible are explosive under favorable conditions.¹ An investigation has been made by the Bureau of Chemistry of the U. S. Department of Agriculture of a recent explosion of hard rubber dust in which eight men were killed, one other was injured and property was damaged to the extent of about \$25,000. This article has been prepared to call attention to some of the dangerous practices now followed in the grinding of hard rubber and to suggest methods of minimizing the danger of dust explosion.

REDUCTION OF HARD RUBBER SCRAP

In the case investigated the process followed in the reduction of the scrap rubber was quite similar to the system more or less generally used throughout the country. The scrap rubber is first broken up into pieces about the size of a pea. In some cases this material is heated in large tanks. It is then ground between steam-heated rolls known as refiners or in one of the various types of pulverizers. Sifters are used to sep-

arate any coarse particles from the rubber dust, and this coarse material is returned to the grinders. During this process large quantities of very fine dust are produced which tests have shown will explode violently under favorable conditions. Considerable sulphur dioxide gas is frequently produced during rubber grinding and in many cases no provision is made to remove this gas from the building. In such cases the atmosphere of the grinding department becomes a bluish color while grinding is being done.

EQUIPMENT ARRANGEMENT

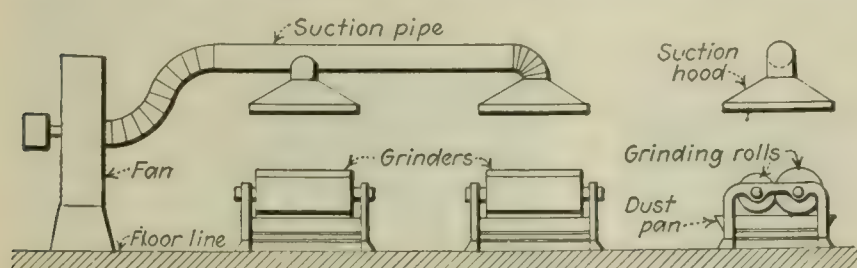
In the plant where this explosion occurred the grinding department was located in the basement of a two-story brick building. The space allotted to this work was about 60 x 120 ft. The basement was about 10 ft. deep but only about 6 ft. was below the ground level. Windows were provided above the ground line for light and ventilation. Various types of grinding machines were installed with the motors necessary to operate them. These motors were of different makes, but were all of the squirrel-cage induction type. All switches were of the oil-immersed type and the fuses were of the non-arcing type inclosed in covered steel boxes. The electric lights were of the drop-cord type of installation and were not provided with vapor-proof globes or guards. A suction system was provided to remove the dust from the building. The dust was drawn into hoods located over the grinding machines and then into the fan, whence it was blown through

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¹CHEM. & MET. ENG., vol. 24, No. 1, pp. 29-32, Jan. 5, 1921; vol. 23, No. 19, pp. 915-920, Nov. 10, 1920; vol. 24, No. 11, pp. 473-475, March 16, 1921.

a 24-in. galvanized pipe into a dust house located on the roof of the building. This pipe ran up the outside of the building and had two right-angle turns—one where the pipe came out of a basement window, and the other where it turned to enter the dust house on the roof. The dust house, which was of frame construction with corrugated metal sheathing, consisted simply of an expansion chamber with a number of muslin bags stretched on wooden frames through which

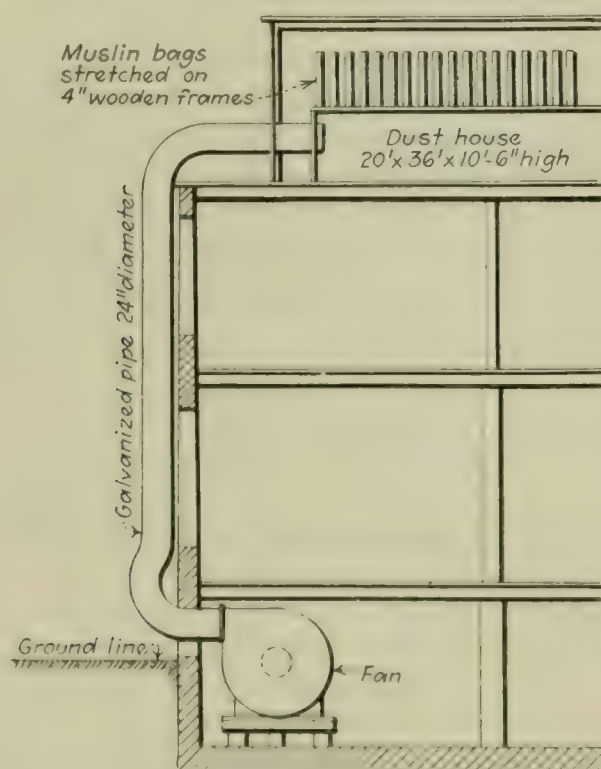


SIDE AND END VIEWS OF GRINDERS AND HOODS

the air escaped, while the dust fell to the floor of the dust house. The dust produced during the grinding was so fine that a large quantity was drawn into the collecting system, and this made it necessary to clean the dust house frequently.

EXTENT OF EXPLOSION

The explosion, which the evidence indicates originated in the basement, occurred about 4:45 a.m. The first explosion was quickly followed by a second one and some families living near the plant report hearing three distinct explosions. As shown in the photographs, the explosion evidently propagated to the first floor of the building, where the windows, doors and one corner of the brick wall were blown out. It also propagated through the suction system to the dust house, which



DUST COLLECTING SYSTEM

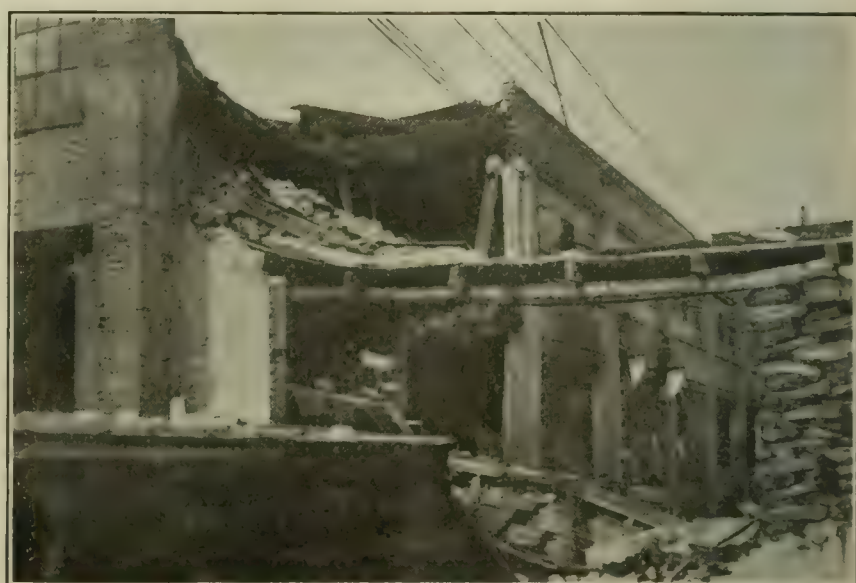
was completely demolished. The building was quite badly damaged by the explosions and the fire which followed, and windows were broken in other buildings of the plant. The fire department, which was called immediately, soon had the fire extinguished and assisted in rescuing the injured. Ten men were employed in the basement and only two escaped. One of the eight men was killed by the explosion and seven received burns from which they died later at the hospitals to which

they had been taken after the disaster. Several men were employed on the first floor above the section of the basement where the explosion occurred, but they were uninjured.

Two of the workmen were found in the southwest corner of the basement, where they had evidently been blown by the force of the explosion. This fact was taken into consideration during the investigation to determine where the explosion started and what caused it. While the evidence apparently establishes the fact that the explosion started in the basement, it has been impossible to determine definitely what caused the original ignition. Practically all evidence which would have assisted in establishing this point was destroyed by the explosion and fire. The two men who escaped from the basement were unable to give any information regarding the point of origin or cause of the explosion. From the effect of the explosion on various parts of the building and the equipment in the basement it is believed that the explosion started in or near one of the grinding machines.

THEORIES AS TO CAUSE OF EXPLOSION

A number of theories have been advanced as to the cause of the explosion: (1) The dust may have been



VIEW SHOWING DISRUPTED WALLS

ignited by sparks formed when some foreign material entered the grinding machine with the scrap rubber. It is known that pieces of metal are frequently found in scrap rubber, and explosions in other industries have been caused by sparks formed when metal entered the grinding machine. (2) An electric light may have been broken accidentally and the dust ignited by the hot filament. Experiments have definitely established the fact that explosions can be started in this way.³ In this explosion the wires and light fixtures were so badly burned or damaged by the explosion and fire that it was impossible to determine whether or not a broken light caused the ignition of the dust. (3) Static electricity often accumulates on moving machinery and unless the machine is properly grounded the charge is built up until it becomes strong enough to break down the air gap and jump to some other machine or a ground. Sparks formed in this way will ignite certain dusts, but in this case no static electricity had ever been noticed on any of the machines. It is therefore considered improbable that a static spark was responsible for the ignition of the dust. (4) A lighted match would ignite the dust. Since in this case eight

³Electrical Review, vol. 78, No. 5, Jan. 29, 1921, p. 180.

of the workmen were killed and the two others were unable to give any information as to the cause of the explosion, it is impossible to substantiate the theory that a lighted match started the explosion. (5) Explosions have been started by sparks in dust-collecting fans when the blades struck some metallic substance entering the fan or when the blades became loose on the shaft and struck against the fan casing.³ In the investigation of this explosion special attention was given to the condition of the fan after the explosion. It was found that the side of the fan casing where the suction pipe from the dust hoods entered the eye of the fan was blown completely off. The exhaust pipe from the fan to the dust house was blown apart at both elbows. The dust house on the roof of the building was completely destroyed, as shown in the photograph. It had been cleaned about midnight, or approximately four hours and forty-five minutes before the explosion occurred. It is estimated that at the time of the explosion the house contained about 125 lb. of dust.

ORIGIN OF EXPLOSION

The fact that so much damage was done to the fan and exhaust pipe would indicate that the explosion had built up considerable force by the time it reached this point in the system. It is believed that the explosion originated in or near one of the grinding machines and was caused by foreign material entering the grinder, by a broken electric light, or by a lighted match. The flames propagated throughout the basement, where the employees were severely burned, and extended to the first floor, where the windows and one corner of the wall were blown out. The flames entering the suction hoods flashed through the suction pipe to the fan, where they met their first obstruction and built up the pressure which blew out the weakest side of the casing—the one containing the inlet opening. The flames also propagated through the fan into the exhaust pipe, built up sufficient pressure at each bend to rupture the pipe and continued into the dust house on the roof of the building, where enough dust was present to cause an explosion which completely wrecked the house. It must be remembered that this is only a theory of what happened during the explosion built on the knowledge obtained during investigations of previous explosions in industries where the conditions and some of the installations were similar to those in the hard rubber grinding industry.⁴

RECOMMENDED PRECAUTIONS IN HARD RUBBER GRINDING

This explosion proves very conclusively that grinding hard rubber is a dangerous process and indicates very clearly some of the precautions which should be taken to guard against explosions. In other industries, particularly feed manufacturing, it has been necessary to give special attention to the prevention of explosions in the oat hull grinding department. It is believed that the methods adopted in this industry will be equally effective in preventing damage from dust explosions in grinding hard rubber:

1. The grinding department should be segregated from the remainder of the plant and if possible operated independently of other units.

2. The building containing the grinding department should be of heavy framework with light walls and roof so as readily to permit the release of pressure from the building should an explosion occur. Large window area serves this purpose very well and the modern daylight construction is recommended.

3. Good ventilation should be provided and where gases heavier than air are produced during the process the air should be drawn out of the room near the floor and fresh air admitted near the ceiling or roof.

4. Where fine dust is produced during the process an efficient dust-collecting system should be installed. The old-style dust room, where large clouds of dust are in suspension, should be eliminated if possible or



REMAINS OF THE DUST HOUSE

located at a safe distance from the main building. The dust should be collected as near as possible to the point of origin and conveyed through pipes with as few turns as possible to the collector, which should be located outside of the building or vented to the outside air. If sharp turns are necessary in the pipe line inside the building, it is often advisable to provide a vent at the bend leading to the outside air with a cap which will be blown off should any high pressure occur at this point. Drawing explosive dusts through a fan should be avoided if possible. A suction through the collector or an induced-air current is preferable.

5. Special precautions must be taken to see that no metal enters the grinding machines. This is the only way to guard against ignition of dust by sparks struck in the machines. A vent leading directly from the machine to the outside air often assists in preventing a disastrous explosion by providing a direct means of escape for the primary explosion within the machine.

6. In places where clouds of explosive dusts are produced electric lights should be inclosed in vapor-proof globes and properly guarded to prevent accidental breakage. All switches and fuses or electrical equipment in which sparks might be produced should be located in a separate room or at least inclosed in fire-proof and dustproof boxes.

7. Rules against smoking and carrying matches in sections of a plant where conditions are favorable for a dust explosion must be rigidly enforced and special attention given to the prevention of hot boxes on machinery operating in dusty atmospheres.

8. Cleanliness is the best general precaution to adopt for the prevention of dust explosions. A disastrous dust explosion cannot occur in a clean plant,

³CHEM. & MET. ENG., vol. 23, No. 19, p. 915.

⁴Proceedings of Conference of Men Engaged in Grain Dust Explosion and Fire Prevention Campaign Conducted by U. S. Grain Corporation in Co-operation with Bureau of Chemistry, U. S. Department of Agriculture, July, 1920.

because the flames cannot propagate unless dust is present to be mixed with the air in sufficient quantity. From 0.02 to 0.04 oz. of dust per cu.ft. of air is usually sufficient to form an explosive mixture. The plant should be kept scrupulously clean, especially overhead structures where dust accumulations could be thrown into suspension in the air by a sudden jar or shock.

The increase in the number of industries in which the danger of dust explosion is present makes it imperative to conduct further research and investigational work. The various explosive dusts ignite at different temperatures, and different amounts of the various dusts are required to form explosive mixtures with air. Perhaps some dusts not now considered dangerous will later be found to be explosive under certain conditions. It may be found necessary to design special equipment to reduce the danger of dust explosions in certain industries. The question of dust explosions in flour mills and grain elevators has been studied for several years by the Bureau of Chemistry of the U. S. Department of Agriculture and the results of this work have been published in bulletins which are available for distribution, but no provision has been made to continue these investigations during the present year. Since it is a question of vital importance to the industries of the country, it is hoped that some opportunity will be presented in the near future to resume the study of dust explosions in flour mills and grain elevators and extend the work to other industries where the same hazard exists.

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Plastic Gypsum Plaster

BY WARREN E. EMLEY

A GOOD job of wall plaster is composed of three coats, which are known to the trade as "scratch," "brown" and "finish." The scratch coat is next to the lath, the brown coat in the middle, and the finish coat is applied to the exposed surface to give the plaster a pleasing appearance.

The quality requirements put upon material for the finish coat are peculiar: It must be very plastic in order that it can be spread in a thin layer ($\frac{1}{8}$ in.) over the brown coat, which has set and is partially dry; and it must set in twenty or thirty minutes, in order that the plasterer may finish troweling it without moving his scaffold.

The scratch and brown coats may be made with either plaster of paris ($\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$) and sand or of lime and sand, but the finish coat must consist of both lime and gypsum plaster. The addition of lime has been thought necessary to give the proper degree of plasticity. As the weight of the finish coat is very small in comparison with the weights of the two other coats, the contractor must provide enough for all three coats and a small amount of lime for the finish coat mixture when gypsum plaster is used. It seems impossible to get good results with a ready mixed lime gypsum plaster. The lime must be soaked with water for at least twenty-four hours in order to develop its plasticity, and the gypsum cannot be soaked, because it sets upon the absorption of $1\frac{1}{2}$ mols of water of crystallization. This means that the materials must be prepared separately and mixed just before being used, thereby requiring extra labor and equipment.

The higher plasticity of lime gives superior sand-

carrying capacity. If lime and gypsum plaster are selling at about the same price, the fact that lime can carry three parts of sand for scratch or brown coat work, while the latter can carry only two, makes the lime plaster much cheaper. At the same time, the superior plasticity of the lime may reduce the labor cost of application of the plaster considerably below that of the gypsum plaster.

From the above statements it will appear that if a plastic form of gypsum plaster can be made without the use of hydrated lime, the differential in favor of lime, due to its greater sand-carrying capacity, will be overcome. Also it will not be necessary for the gypsum manufacturer to add lime or any other foreign material (except retarder) in the preparation of neat gypsum plaster. These results are greatly to be desired, not only by the gypsum industry, but also by the general public, because they would tend to decrease the cost of an important building material.

Accordingly, work was started on an attempt to make gypsum plaster as plastic as lime. The first successful experiment was completed on Sept. 13, 1920, and since that date sufficient work has been done to make sure of the practicability of the method. The problem may therefore be considered solved, in so far as it can be solved with laboratory equipment.

DEGREE OF SUBDIVISION OF THE HEMI-HYDRATE

The first thought was that plasticity is in some way dependent upon the degree of fineness, and that fine grinding might solve the problem. Fine grinding in itself is not new in the industry, and it would seem strange that any increase of plasticity due to it could have passed unobserved. Investigation has shown, however, that all attempts at fine grinding on a practical scale had been conducted in a buhr or tube mill. It has long been known that the half mol of water of crystallization can be "ground out" of gypsum plaster. When it is reduced in either of the above types of mills, the volume of air passing through the mill carries off the water vapor as fast as it is formed by the frictional heat. If the grinding is sufficient to liberate all of the water, the resultant product is soluble anhydrite. This is a peculiar form of anhydrous calcium sulphate and differs from the mineral anhydrite in its great affinity for water. So great is this affinity that a very short exposure to moist air is sufficient to change it back to the hemi-hydrate. When ground in the usual type of equipment and the frictional heat is not sufficient to liberate the water of crystallization, the size of the grains is not greatly reduced. If the anhydrite is formed, the final product soon absorbs water from the air and the crystals cake into larger aggregates that do not give a plastic plaster.

When calcined gypsum is subjected to grinding under such circumstances that the water is not permitted to escape from the system, an entirely new product results. No satisfactory explanation has yet been evolved, but the fact remains that the product is plastic. Up to a certain limit the degree of plasticity seems to depend upon the duration and speed of grinding.

The plasticimeter described in Bureau of Standards Technologic Paper 169 is not yet adapted to measure the plasticity of unretarded calcined gypsum; the material begins to set before the experiment can be completed. Use has therefore been made of the Carson blotter test, as described in the *Transactions* of the National Lime Manufacturers' Association for 1916.

This has proved quite satisfactory as a means of differentiating between the plasticities of finishing hydrate and masons' hydrate. When tested by this method, this "plastic gypsum" proves to be more plastic than the best lime putty.

BETTER STRENGTH AS WELL AS PLASTICITY

Besides improving the plasticity, the process also causes certain changes in other properties of the material. The increased fineness of the plastic gypsum naturally necessitates the use of more water to bring the paste to a given consistency. Yet, in spite of this excess water, the set material will average about 20 per cent stronger than that made from ordinary calcined gypsum. The process slows down the setting reaction somewhat. The time of set of one sample was changed from twelve to seventeen minutes by this kind of fine grinding. Commercial calcined gypsum usually deteriorates somewhat on storing. It tends to work "lean" and carry less sand. Samples of this plastic gypsum have been exposed to the air for four months without apparent deterioration of their plasticity.

The process has been applied with equal success to calcined gypsums from Nova Scotia, New York and Virginia. It would seem, therefore, that the original quality of the material is of little importance.

GRINDING WORK ABOUT DOUBLED

The laboratory results have been accomplished after calcination by grinding the material in a ball mill constructed so that the water vapor could not escape. Commercial calcined gypsum is always ground during the course of manufacture, either before or after calcination, so that the grinding required to make plastic gypsum does not entail the installation of an extra process. It would seem, however, that the grinding should be done after calcination rather than before to prevent the powder balling up in the mill.

It is probably not essential that a ball mill be used; a buhr mill or tube mill may be satisfactory if there is no loss of water by evaporation during the grinding. It is essential that the product as it leaves the mill shall contain approximately the same quantity of fixed water as commercial calcined gypsum does: 9 parts by weight of water to 136 parts of calcium sulphate, or about 6.2 per cent water.

The duration of grinding required to make plastic gypsum depends upon the kind of equipment used, the fineness and hardness of the material, and the degree of plasticity desired. This problem must be worked out individually by each manufacturer for his particular equipment and material. It is a simple matter to regulate the grinding until the Carson blotter test shows the material to have the desired degree of plasticity. Laboratory experiments indicate that the output will be considerably reduced, perhaps cut in half, if the same equipment is used to make plastic gypsum.

The new product, "plastic gypsum," was demonstrated at the annual meeting of the Gypsum Industries Association on Dec. 15, 1920, but the process of manufacture was not divulged. A patent, covering both the process and the product, has been applied for, and, if granted, will be given to the public for the free use of anyone in the United States. This description of the process is being released at this time in order to give additional protection to the public interest.

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Washington, D. C.

Tower Packing Efficiencies

By E. L. JORGENSEN

WHEN devices prove their usefulness in industry through years of service, they are readily accepted as standard and improvements are retarded until retrenchment becomes a matter of great importance. A careful analysis then often shows the way to improvements surprising in their simplicity and importance.

Opportunities for such improvements seem to exist in several branches of sulphuric acid manufacture. In studying construction costs for a chamber acid plant, it is of interest to learn that Glover and Gay-Lussac towers account for from 25 to 40 per cent of the capital expended, and only 5 to 6 per cent of the cost of the towers is for packing.

Considering that in these towers the packing performs all of the active work, the improvement of such packing seems worthy of careful study. If the effect of such packing can be increased, new towers could be built smaller or present towers could be increased in productiveness by re-packing.

GREAT VARIATION IN TOWER PACKING EFFICIENCY

Investigations conducted for this purpose indicate that the effectiveness of tower packings such as they are today can be improved in some cases as much as 100 times.

The factors that control the effectiveness of tower packing are the area of contact surfaces and the length of time of contact between these surfaces and the gases. The length of time depends on the effective space occupied by the gases. If in a cubic foot of packing space one-half of the volume is dead space occupied by packing and one-half active space occupied by gas, then each cubic foot of gas passing through per second will be exposed to the contact surface for one-half second.

EMPIRICAL CALCULATIONS

The influence of contact surface and of time of contact can be mathematically expressed as follows:

Capacity, $C_1 = 0.3706C$;

$C = s \times v$;

s = sq.ft. of contact surface per cu.ft. of packing space;

v = cu.ft. of active space per cu.ft. of packing space.

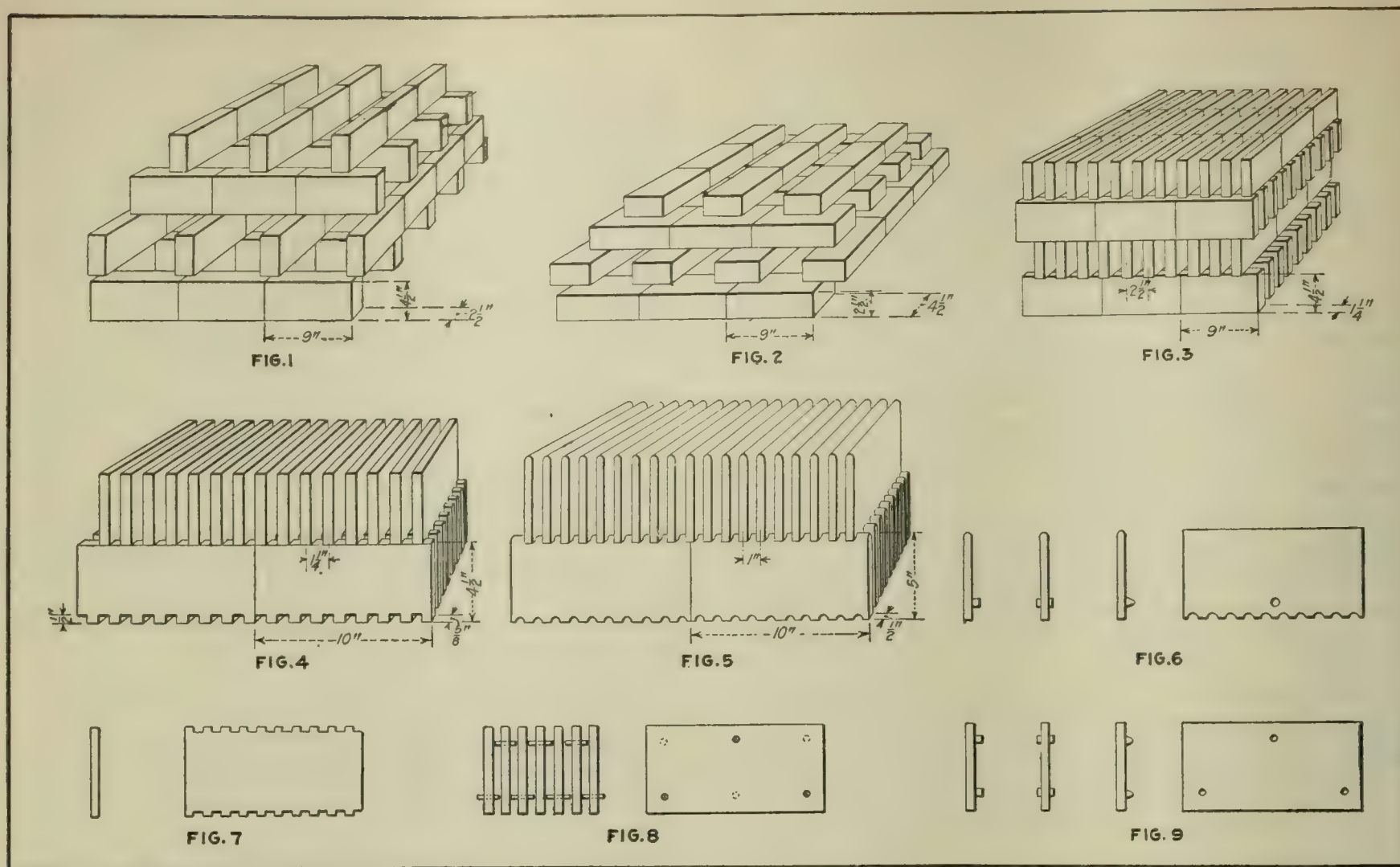
This formula has been applied to a number of tower packings in use today and to new forms of packing that have suggested themselves as a result of these investigations. The results are given in the accompanying table and the arrangements are illustrated in the figure.

In the table of values for C_1 , the factor 0.3706 is based on a well-known packing built as checkerwork of 9-in. straight brick placed 9-in. on centers. This serves to facilitate comparison.

When applying higher mathematics to the problem it is found that with packing made of plane-parallel bodies the maximum of effect is reached when the active space and the dead space, or the space occupied by the packing itself, are the same.

To increase the effect of towers of today without increasing their size or to reduce the size of a new installation it is necessary to resort to thinner shapes.

To facilitate the use of thinner shapes means of equal spacing and of maintaining stability must be provided.



ARRANGEMENT FOR TOWER PACKING

Fig. 1. 9-in. straight brick on edge 9-in. centers. Fig. 2. 9-in. straight brick flat 9-in. centers. Fig. 3. 9-in. split brick 2.5-in. centers. Fig. 4. Brick checkerwork. Fig. 5. $\frac{1}{2} \times 5 \times 10$ -in. tile. Fig. 6. Detail of tile provided with semi-circular, square, triangular or other type notches at foot and with top edge to correspond to the notches, also with knob for proper spacing. Fig. 7. Detail of tile with notches of any shape at head and foot for proper spacing. Fig. 8. Detail of tile with holes and dowels for proper spacing. Fig. 9. Detail of tile with knobs of any form for proper spacing.

To accomplish this a number of suitable interlocking devices are suggested, as shown in the illustrations.

Lunge in his book on "Sulphuric Acid and Alkali" states that coke-packed towers have only one-twentieth to one-fortieth the capacity of towers packed with so-called Lunge plates. Lunge plates upon mathematical analysis show a capacity of only 41.2 per cent of a packing made from 9-in. straight brick placed 9-in. on

If the channels or passages for gas are uneven, a rush of gas will go through the larger openings or channels, where the area of contact surfaces is smaller. The descending liquid will be diverted to the locality where the surfaces are largest and the gas passages and the pieces of packing are smallest. Carrying this reasoning to the extreme, the case may arise when all liquid passes through the smallest channels, completely filling them, and all gas through the largest channels, with the result that the effect of the tower is reduced to a minimum. This explains the small amount of work done by towers packed with coke or quartz.

This weakness exists in a number of tower packings in vogue today where gas passages are not of uniform size. A slight disturbance of the balance between flow of gas and contact surfaces is enough to cause great decrease in the effect of the packing.

Attention is invited to the figures given before, showing the high cost of towers and the low cost of packing, and to the figures of the table showing the possible improvements upon today's practice.

Records show the sulphuric acid production of the United States to have been equivalent to about 6,000,000 tons of 50 deg. Bé. acid per year. Taking the cost of the plants to produce this acid to be approximately \$120,000,000, the cost of towers for these would be about \$40,000,000.

These figures would seem to warrant most careful study and sincerest consideration for more effective packing for new towers as well as for the re-packing of existing installations, in all chemical industries where the contact between gases and liquids is of predominant importance.

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New York City.

CAPACITY OF TOWER PACKINGS BY MATHEMATICAL ANALYSIS

Fig.	Description of Packing	s	v	C	C ₁
1	9-in. straight brick on edge, 9-in. on centers.	3.7361	0.7222	2.6982	1.000
2	9-in. straight brick on flat, 9-in. on centers.	5.0664	0.5000	2.5332	0.940
None	9-in. straight brick on edge, 4.5-in. on centers.	6.650	0.4444	2.9553	1.095
None	9-in. straight brick on edge, 5-in. on centers.	6.1333	0.5000	3.0667	1.136
3	9-in. split brick on edge, 2½-in. on centers.	10.930	0.5000	5.4650	2.025
4	½-in. tile, 10x4½-in. with notches ½x2½ in. placed ½ in. on centers.	22.650	0.4688	10.617	3.935
5	½-in. tile, 10x5-in. semi-circular top and slots 1 in. on centers.	25.1274	0.4900	12.312	4.563
None	Spheres 6 in. diameter.	8.88	0.26	2.3088	0.86
None	Spheres 5 in. diameter.	10.656	0.26	2.7706	1.02
None	Spheres 4 in. diameter.	13.320	0.26	3.4622	1.28
None	Spheres 3 in. diameter.	17.760	0.26	4.6176	1.771
None	Spheres 2½ in. diameter.	21.322	0.26	5.5411	2.054
None	Spheres 2 in. diameter.	26.64	0.26	6.9264	2.567
	Lunge plates*	2.2312	0.50	1.1156	0.412
	Niederfuhr Glover tower pkg.†	5.1408	0.5764	2.9632	1.098
	Quartz and coke ‡.				0.02-0.04

* See Lunge: "Sulphuric Acid and Alkali," vol. I, part 2, pp. 661-2.

† See Lunge: "Sulphuric Acid and Alkali," vol. I, part 2, p. 872.

‡ See Lunge: "Sulphuric Acid and Alkali," vol. I, part 2, p. 664.

centers, and coke and quartz packing therefore have only 2 to 4 per cent of the capacity of the brick packing.

This brings out a third and even more important factor influencing the effectiveness of tower packings. The flow of gas must be even and equally distributed in all parts of the packing so as to give a perfect balance between contact surfaces and flow of gas.

The Problem of Reorganization of the Federal Government*

BY HERBERT C. HOOVER

THERE is one problem of the new administration that has received the attention and thought of the organized engineers of America for many years past. This is the problem of the reorganization of the federal government. The inadequacy, the wastefulness and the inefficiency of our federal organization was evident enough under pre-war conditions. These inadequacies, these inefficiencies, these wastes were exhibited to the country during the war at the cost of millions.

Congress has placed the problem in the hands of a very able Congressional joint committee. But if this joint committee succeeds in securing the imminently necessary results it will only be by full insistent support to it by public opinion. Many attempts have been made at reorganization before, but all of them have gone to the same crematory—the interminable differences in opinion among the executive and legislative officials over details.

To any student of federal organization one sweeping and fundamental necessity stands out above all others, and that is that the administrative units of the government must be regrouped so as to give each of the great departments more nearly a single purpose. The hodge-podge of aims in certain administrative branches is scarcely believable when we consider our national pride and skill in organization. Such functions as public domain, public works, assistance to veterans, public health functions, aids to navigation, to industry, to trade, purchasing of major supplies, are each and every one scattered over from four to eight departments, most of which are devoted to some other major purpose.

HOW TO PERFECT ECONOMIES

Economies can be accomplished from a public point of view by an elimination of the overlap in these different units of administration through unification into groups of similar purpose. The real economy to the nation, however, does not lie here, however great this may be, but it lies in their more effective functioning in their daily relation to the public. The extra cost imposed upon business in general in the determination of the relation of any particular business to the different functions of the government, with the unnecessarily duplicating interferences and demands, is a real charge on national wealth, probably as great in some directions as the actual costs of the administrations themselves.

Of equal importance with economy is to secure effective concentration of government effort into service to the community. No constructive vision or policies can be built around a national service directed by from two to ten Cabinet members, more especially when this particular purpose is a side issue to all of them. No better example of this exists than the deplorable handling of our relations to our veterans.

There are other reasons that render reorganization imperative. The changed economic situation of the world demands that the functions of the government in aid to commerce and industry be given more concentration and wider scope.

The enlarged activities of the government as a result of the war greatly affect certain departments. The

Treasury today as the fiscal office of the government must handle an annual budget of \$5,000,000,000 as compared with \$1,000,000,000 before the war. Activities of the Army have increased from a budget of \$200,000,000 to \$400,000,000; activities of the Navy have increased from a budget of \$125,000,000 to \$425,000,000. Thus the burden and responsibilities for the major purposes of these departments have been enormously increased. I believe it is the consensus of the gentlemen conducting these departments that in the interests of efficiency they should not be called to responsibility for the administration of at least some of the matters not pertinent to their major functions which clutter their departments.

We have also some confusion between executive, advisory and semi-judicial functions. One of the tendencies of government both local and national during the last twenty years has been to add executive functions to commissions and boards created primarily for advisory or regulatory purposes. It requires no argument with our business public that the executive functions cannot rise to high efficiency in the hands of government boards where from the very nature of things each member has a separate responsibility to the public and is primarily engaged in a semi-judicial function.

Furthermore, during the last few years there has been a great growth of independent agencies in the government reporting directly to the President until his office is overburdened almost beyond the point of endurance. The original and sound conception was that the executive functions should be reported up to the President directly through his Cabinet officials. Not only do these outside functions today overburden the President but they render co-ordination with executive departments extremely difficult. It is neither possible nor advisable to place all these outside organizations into the departments, but much could be done to mitigate the situation.

One of the great steps in federal reorganization is the erection of a budget system, with its necessary reorganization of the Congressional committees. There can be no doubt as to the early accomplishment of this great reform, but it will not serve its real purpose until the departments have been reorganized so that they represent a common purpose. Without this Congress will never have before it budgets showing the expenditure of the government in its relation to any particular function.

TRIALS OF THE MARINER

I have daily evidence in the Department of Commerce of all these forces. The question of governmental aids to navigation is not by any means one of the principal functions of our government, but it must be a sore trial to the hardy mariner. He must obtain his domestic charts from the Department of Commerce, his foreign charts from the Navy Department and his nautical almanac from the Naval Observatory—and he will in some circumstances get sailing directions from the Army. In a fog he may get radio signals from both the Navy and Commerce, and listen to foghorns and look for lights and buoys provided him by Commerce; if he sinks his life is saved by the Treasury. He will anchor at the direction of the Army, who rely upon the Treasury to enforce their will. His boilers and lifeboats are inspected by the Department of Commerce; his crew is certificated by one bureau in Commerce, signed off in the presence of another and inspected at

*Address delivered at the dinner given in Mr. Hoover's honor by the Philadelphia Engineers Club, April 16, 1921.

sailing by the Treasury and on arrival by the Department of Labor.

It is possible to relate the same sort of story in our governmental relations to industry to our domestic and foreign commerce.

The moral of all this is that economy could be made by placing most of these functions under one head, not only economy to the government but to the mariner. Congress would know what it spends in aid to navigation and the government could develop definite policies in giving proper assistance, and lastly could remove from the hardy mariner's mind his well founded contempt for the government as a business organization.

The economic changes in the world, growing out of the war, and their reflex upon our trade and industry make it vital if we are to maintain our standards of living against increasing ferocity of competition that we shall concentrate and enlarge our national effort in the aid, protection, stimulation and perfection of our industrial and commercial life. There can be no real Department of Commerce or commercial policies to these broad purposes so long as the instrumentalities of the government bearing on these questions lie in half a dozen departments.

The Magnesite Industry in 1920

THE production of magnesite in the United States in 1920 increased 94 per cent in quantity over that of 1919. The entire output was made by two states, California and Washington. California mined 63 per cent more magnesite in 1920 than in 1919 and more than eight times as much as it mined seven years ago. Washington increased its production 109 per cent over that of the preceding year, making by far the largest output it has yet made.

According to the United States Geological Survey the total production of magnesite in the United States in 1920 was 303,767 short tons, which was valued at approximately \$2,748,150. The following table shows the production by states:

CRUDE MAGNESITE PRODUCED AND SOLD OR TREATED IN THE UNITED STATES, 1913-1920

Year	California		Washington	
	Quantity (Short Tons)	Value	Quantity (Short Tons)	Value
1913	9,362	\$77,056	.....	.....
1914	11,293	124,223	.....	.....
1915	30,499	274,491	.....	.....
1916	154,259	1,388,331	715	\$5,362
1917	211,663	2,116,630	105,175	783,188
1918	84,077	761,811	147,528	1,050,790
1919	50,020	504,973	106,206	743,442
1920	81,782	1,083,262	221,985	1,664,888

Most of the output of California was calcined and used as plastic material, only a small part being natural ferromagnesite, used as a refractory lining of steel furnaces on the Pacific Coast. On the other hand, practically all the magnesite mined in Washington was dead-burned into synthetic ferromagnesite and used as a refractory lining of furnaces and smelters.

The largest producers in California were the Tulare Mining Co. and the Sierra Magnesite Co., at Porterville; the White Rock mine, operated by Frank R. Sweasy, in Napa County, and the property of the Western Materials Development Co. on Red Mountain, operated by C. S. Maltby.

The Northwest Magnesite Co., of Chewelah, Wash., was the largest producer in the United States. It shipped in 1920 more than 90,000 tons of dead-burned ferromagnesite, most of which was sent to steel com-

We want no paternalism in government. We do need in government aids to business in a collective sense. In a department we do not want either to engage in business or to regulate business. We need a department that can give prompt and accurate diagnosis from both a foreign and domestic point of view of economic events, of economic tendencies; of economic ills; that can promptly and accurately survey economic opportunity, economic discrimination and opposition; that can give scientific advice and assistance and stability to industry in furnishing it with prompt and accurate data upon production, supplies and consumption; that can co-operate with it in finding standards and simplifications; that can by broad study promote national conservation in industry and the elimination of waste; that can study and ventilate the commercial side of our power possibilities; that can study and advise national policies in development of rail, water and overseas transportation; that, in fact, covers, so far as government functions can cover, the broad commercial problems of trade, industry and transportation.

This can be accomplished more by co-ordination of existing governmental facilities than by increased expenditures.

panies and manufacturers of refractory products east of the Mississippi. The American Mineral Production Co., of Valley, Wash., sold its output crude to the Northwest Magnesite Co., whose quarries are near by. The Western Materials Co. operated the Double Eagle magnesite mine, near Valley, and shipped the calcined product to the American Refractories Co.

At the end of December, 1920, all the operations in Washington were stopped, principally, it is believed, on account of a lack of orders from the steel companies, many of which were idle or were not working full time. Some of the California producers were considerably discouraged at the end of the year on account of the high cost of labor and supplies, the high freight rates, and the competition of foreign material.

The imports of magnesite in 1920, reported by the Bureau of Foreign and Domestic Commerce as calcined, not purified, amounted to 43,154 long tons, valued at \$780,078. These imports came from the following countries:

MAGNESITE IMPORTED INTO THE U. S., 1920

Quantity (Long Tons)		Value	Quantity (Long Tons)		Value
Austria	.....	\$4	Scotland	190	13,720
Germany	713	28,566	Canada	6,028	184,060
Italy	21,185	241,220	Mexico	500	6,300
Czecho-Slovakia	3,829	126,827	Venezuela	2,300	11,500
Greece	4,000	38,418	Australia	34	417
Turkey in Europe	3,528	70,540	Straits Settlements	.....	4
Netherlands	819	54,991			
England	28	3,511			
				43,154	\$780,078

The magnesite imported from Italy was mined in Austria, and that from Czecho-Slovakia was obtained from the former Hungarian deposits. That imported from Mexico came from Santa Margarita Island and was calcined near San Diego, Cal. A shipment from Greece received in November was the first sent from that country since 1916. The arrival of 2,300 tons from Venezuela in September, 1920, was a notable event, as the recorded imports of magnesite from that country are meager.

Although the quantity of magnesite imported in 1920 was nearly three times as great as in 1919 it was only about one-seventh of the quantity commonly imported before the war.

Structure of Tungsten Steels

Review of Honda and Murakami's Work, Presenting Their Principal Conclusions as to the Structure and Constitution of Tungsten:Iron:Carbon Alloys—Reactions Between Iron Tungstide and Iron and Tungsten Carbides Are Responsible for Great Complexity

THE effects of tungsten in steel have been studied by many investigators, among them being Osmond,¹ Carnot and Goutal², Sir Robert Hadfield³, Böhler,⁴ Guillet,⁵ Swinden,⁶ Arnold and Read,⁷ and Honda and Murakami.^{8,9} The last-named investigators have carried out by far the most complete study of such alloys, and it is their work that will be largely here reviewed. As a result of their work with magnet steels containing from 0.35 to 0.60 per cent carbon and 4.8 to 6.2 per cent tungsten they reached in the main the following conclusions:

1. The presence of two carbides, Fe_3C and WC , in magnet steel as found by Arnold and Read is very probable. They can exist separately or as a double carbide, depending upon the heat treatment. After once heating to 800-900 deg. C. and slowly cooling, the two carbides exist as a double carbide.

2. Above A_{c1} this double carbide decomposes into its components, both dissolving in austenite and so remaining up to about 900 deg. C. On further heating the tungsten carbide dissociates into carbon and tungsten, both remaining in solid solution, while the tungsten dissolved in the austenite forms an iron tungstide Fe_2W . Degree of dissociation increases with rise in temperature, being practically complete at 1,100 deg. C.

3. By normal cooling from above 1,100 deg. C. the A_1 , A_2 and A_3 transformations are lowered to a temperature below that of the normal A_1 point by the retard-

In their later and more complete study of tungsten steels,⁹ as well as in the investigation of magnet steels, Honda and Murakami largely used magnetic analysis, though this was supplemented by microscopic examination and such other tests as thermal expansion, thermal analysis, etc., where desired. In this investigation the magnetic transformations of cementite and of the double carbide of iron and tungsten occurring respectively at 215 and 400 deg. C. are of considerable interest and importance, for if the magnetization-temperature curve for a tungsten steel shows abrupt changes in the neighborhood of 215 and 400 deg. C. it is evidence that the steel contains respectively cementite and the double carbide, both in a free state.

MAGNETIC ANALYSIS

Applying magnetic analysis then to a series of iron:carbon:tungsten alloys containing from about 0.20 to 30 per cent tungsten and from 0.10 to 1.6 per cent carbon Honda and Murakami found:

I. That in steels containing a given quantity of tungsten—

- A_{r1} and the double carbide transformations increase in magnitude with increase in carbon content.
- The temperature required to lower the A_1 transformation is raised with increase in carbon content.
- The completely lowered A_{r1} transformation has a definite value independent of the carbon content.

II. That in steels containing a given quantity of carbon—

- A_{r1} decreases in magnitude as tungsten increases, vanishing with high tungsten content.
- With increase in tungsten, the retarded A_{r1} is gradually lowered, up to about 9 per cent W. It remains constant with further increase in the tungsten content.

III. That the rate of cooling has a marked effect on the critical ranges. Rapid cooling from below the lowering temperature lowers A_{r1} , while extremely slow cooling from above this temperature does not affect the position of this transformation.

CONSTITUTION

Based on this work, a structural diagram has been constructed which is shown in Fig. 1. Steels showing three transformations at 700 to 770 deg. C., 400 deg. C. and 215 deg. C. are represented by a dot inside a circle, those with two at 700 to 770 deg. C. and 400 deg. C. by a cross, and those having a single transformation at 750 to 780 deg. C. by a dot. Free constituents (as bracketed) in each of the six regions are given in the tabulation directly above the diagram. Magnetic transformations at 700, 400 and 215 deg. C. reveal respec-

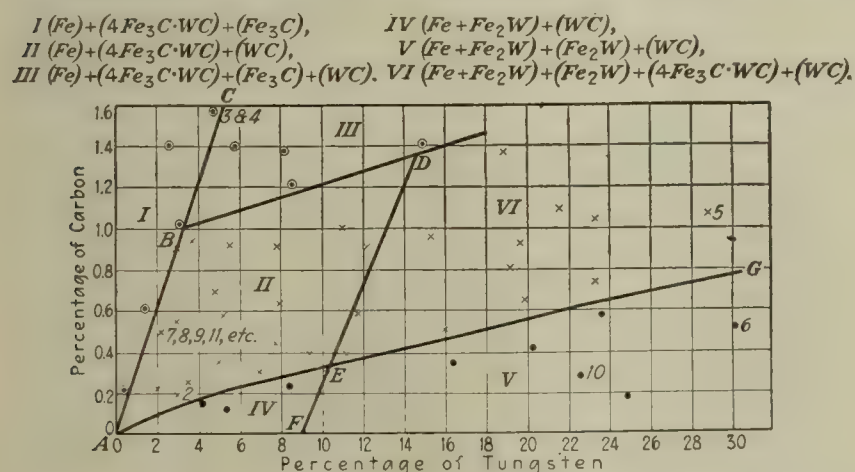


FIG. 1. STRUCTURAL DIAGRAM FOR TUNGSTEN STEELS

ing effect of the tungstide (Fe_2W) dissolved in the austenite. At about 550 deg. C. the retarded A_3 transformation begins to take place and with it the ferrite (with dissolved Fe_2W) separates from the solid solution. This continues for about fifty degrees till the concentration of the remaining mother solution reaches such a value that the A_1 transformation takes place at this temperature.

¹J. Iron & Steel Inst., 1890, No. 1, p. 61, 1903; No. 2, p. 106.

²Compt. rend., vol. 125 (1897), p. 213; vol. 128 (1899), p. 208.

³J. Iron & Steel Inst., 1903, No. 2, p. 59.

⁴Wolfram und Rapid Stahl, 1903.

⁵Rev. Met., 1904, p. 263.

⁶J. Iron & Steel Inst., 1907, No. 1, p. 291; 1909, No. 2, p. 223.

⁷Proc. Inst. Mech. Eng., 1914, March 20.

⁸Sci. Reports, Tohoku University, vol. 6 (1917), p. 53.

⁹Sci. Reports, Tohoku University, vol. 6 (1918), p. 235.

tively the presence of ferrite, double carbide and free cementite, characteristic of steels coming in region I. With increase in tungsten, the free cementite decreases and finally is just sufficient to form the double carbide, when it disappears as a free constituent. As tungsten is further increased the proportion of tungsten carbide (non-magnetic) becomes excessive and it appears in the free state in steels of region II. But two magnetic transformations are obtained at 700 and 400 deg. C.

Steels high in proportions of tungsten and carbon contain free cementite, double carbide and tungsten carbide, for all of the latter does not combine with the cementite to form double carbide. This group of steels, III, may be distinguished from group II by magnetic

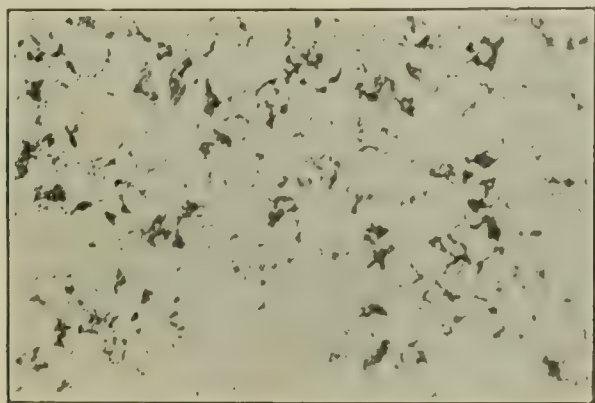
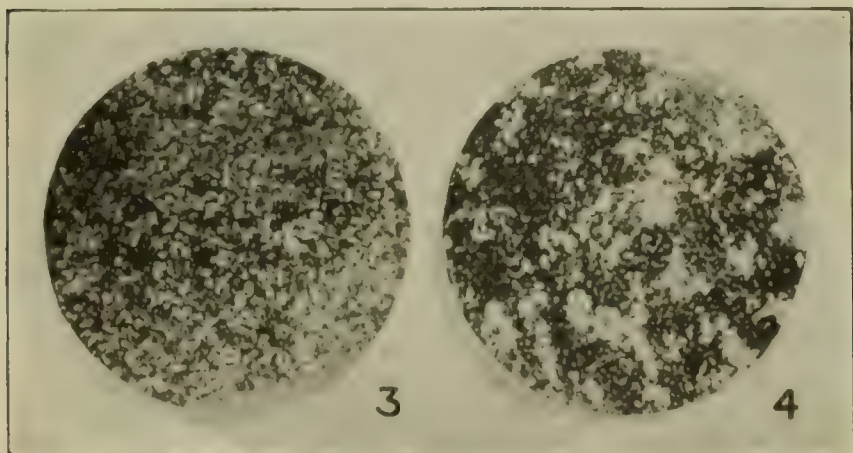


FIG. 2. STEEL CONTAINING 2.88 W, 0.19 C, SLOWLY COOLED FROM 860 DEG. C. $\times 120$

analysis. They show three transformations, occurring at 700, 400 and 215 deg. C.

Steels low in carbon with more tungsten than is required to form tungsten carbide (WC) contain iron tungstide, according to Arnold and Read⁷ which is dissolved in ferrite in concentration equivalent to about 9 per cent tungsten. They belong to group IV. Steels in group V have higher tungsten content and more than can be held by the ferrite, so that they contain free tungstide.

Steels of group V with higher carbon form group VI and contain tungstide dissolved in ferrite, free tungstide, double carbide and tungsten carbide. The formula for the double carbide as determined by Honda and Murakami is $4\text{Fe}_3\text{C} \cdot \text{WC}$. Likewise the authors ascribe, after careful study, the lowering of the A_1 transformation in general to the displacements of the eutectic A_1 transformation caused by the tungstide dissolved in ferrite. Since the latter dissolves the tungstide to a concentration equivalent to 9 per cent tungsten the lowering of A_1 will increase with increase in tungsten up to this concentration above which the excess tungsten remains undissolved and, therefore, does not affect the lowering.



FIGS. 3 AND 4. STEEL CONTAINING 4.72 W, 1.57 C
Fig. 3. Slowly cooled from 900 deg. C. Fig. 4. Slowly cooled from 900 to 750 deg. C. and then quenched.

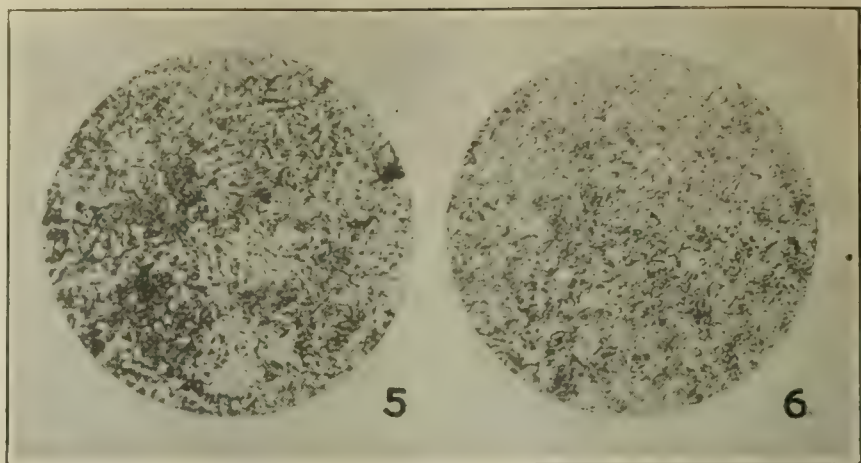


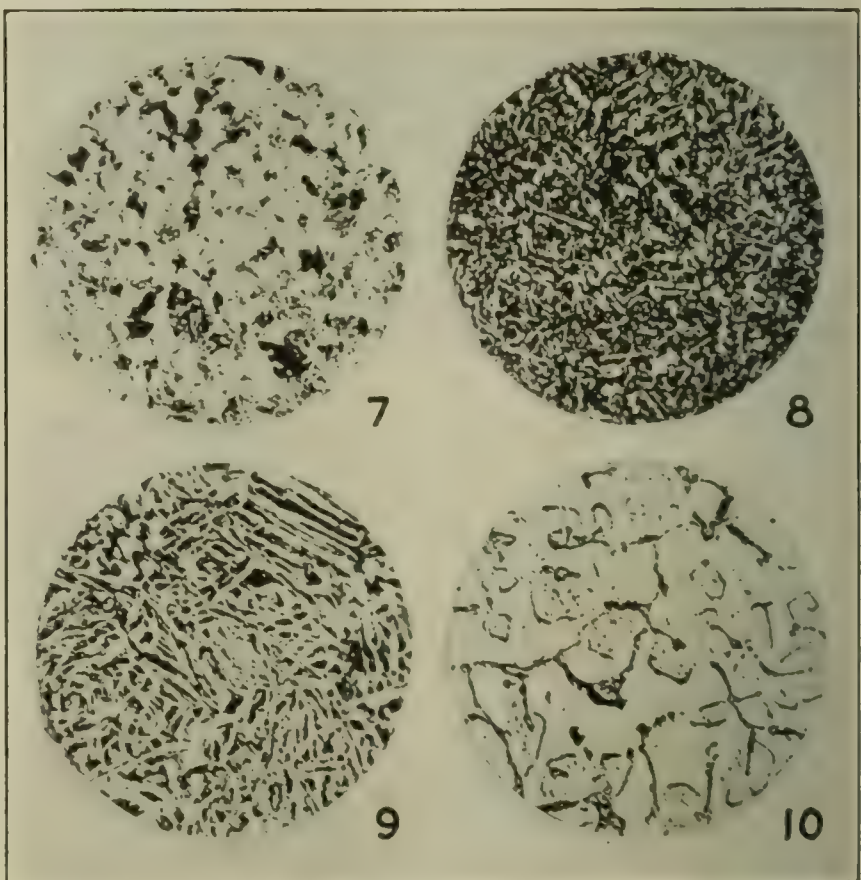
FIG. 5. STEEL CONTAINING 28.7 W, 1.07 C, SLOWLY COOLED FROM 900 DEG. C.

FIG. 6. STEEL CONTAINING 30.04 W, 0.51 C, SLOWLY COOLED FROM 900 DEG. C.

The rate of cooling markedly affects the position of A_1 . Rapid cooling from the lowering temperature or below causes a depression in A_1 while slow cooling from the lowering temperature or above through 700 deg. C. results in the normal A_1 taking place. On normal slow cooling from about 900 deg. C. or other suitable temperature the following reaction occurs:



The higher the initial temperature and the lower the carbon the more this reaction proceeds from left to right. On heating a steel, with lowered A_1 , to above



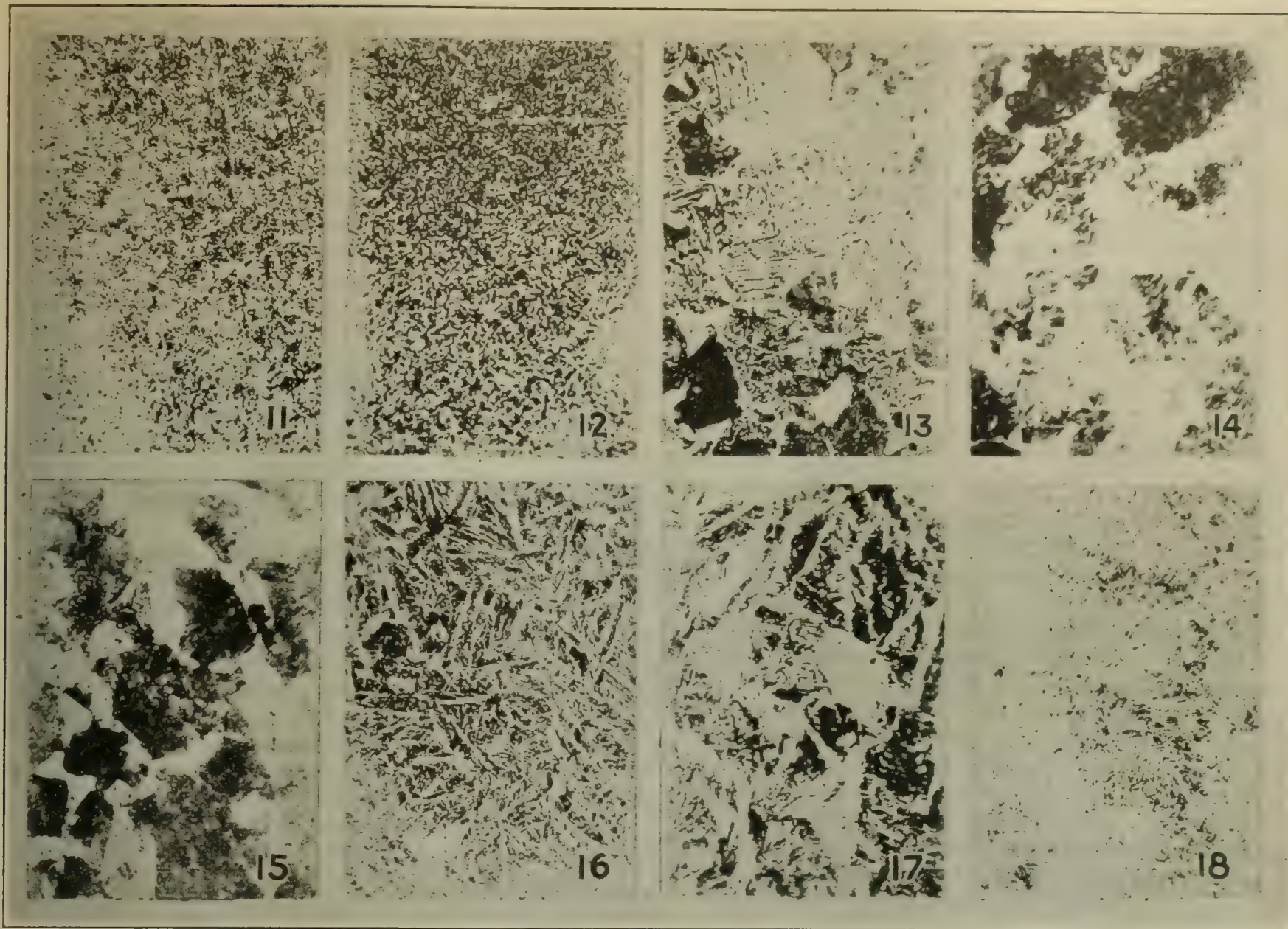
FIGS. 7, 8 AND 9. STEEL CONTAINING 2.06 W, 0.50 C, SLOWLY COOLED FROM 901, 952 AND 1,005 DEG. C., RESPECTIVELY

FIG. 10. STEEL CONTAINING 22.5 W, 0.27 C, COOLED FROM 1,300 TO 1,100 DEG. C. AND QUENCHED. ETCHED WITH SODIUM PICRATE

A_1 , the reverse reaction takes place, so that on slow cooling the double carbide is again formed.

MICROSTRUCTURE

Normal structure of a tungsten steel may be regarded as meaning that obtained by heating to 850-900 deg. C. for twenty minutes and then cooling at the rate of approximately $\frac{1}{2}$ deg. C. per minute. The normal



FIGS. 11 TO 18. STRUCTURE OF 2.06 W, 0.50 C STEEL. ALL $\times 120$ EXCEPT FIG. 17

Fig. 11. Slowly cooled from 900 deg. C.

Fig. 12. Quickly cooled from 900 deg. C.

Fig. 13. Cooled during 20 min. from 1,100 to 700 deg. C.

Fig. 14. Cooled during 40 min. from 1,100 to 700 deg. C.

Fig. 15. Cooled during 51 min. from 1,100 to 700 deg. C.

Fig. 16. Slowly cooled from 1,100 to 550 deg. C.

Fig. 17. Same as Fig. 16, but magnified 360 dia.

Fig. 18. Quickly cooled from 1,200 deg. C.

structure of hypo-eutectoid steels of low tungsten content belonging to regions I and II are similar to those found in plain carbon steels, consisting of granular ferrite and eutectic matrix,¹⁰ the latter not having the characteristic lamellar appearance of the pearlite of carbon steels (Fig. 2). Increase in tungsten content decreases the proportion of the latter and the ferrite becomes finer than in steels of similar carbon content without tungsten.

Steels coming within region III and hyper-eutectoid steels in region I have primary austenite which does not appear as a network, but as globules, which resemble the ferrite (Fig. 5). They may easily be distinguished from the latter, however, by their coloration in sodium picrate solution. The white globules in Fig. 6 are cementite (colored by treatment with sodium picrate). They are not the double carbide considered by Guillet⁵ to be present in low-tungsten steels of high-carbon content, as the magnetization-temperature curve shows only the A_0 transformation and not that of the double carbide.

Though the steels of region IV contain some carbon, they do not show a eutectic matrix. Probably the carbon exists as WC, with which ferrite does not so combine.

Steels of regions V and VI contain iron tungstide in globular form, but have no ferrite even when the carbon

content is low (Fig. 6). Those of region VI in addition show a eutectic matrix as illustrated in Fig. 5.

Figs. 7, 8 and 9 show the effects of raising initial temperature on the normal structures of a steel containing two per cent tungsten and one-half per cent carbon. Both acicular and granular ferrites appear in Figs. 7 and 8, the former only being present in Fig. 9. Comparison with magnetization-temperature curves for this steel shows that where the normal transformations occur granular ferrite is obtained, and that the steels with lowered transformations show acicular ferrite. Specimens showing both normal and lowered ranges show both types of structure. Granular ferrite is pure iron set free above 700 deg. C., while the acicular type—iron containing tungstide in solid solution—is set free at the lowered A_0 transformation. The formation of such acicular ferrite is due to the simultaneous presence of dissolved tungstide and carbon in iron. The background of these micrographs is considered to be a eutectic of two constituents, first, ferrite containing tungstide and second, cementite. Eutectic structure is shown in Figs. 17 and 18.

By heating steels of region III and hyper-eutectoid steels of region I to about 1,200 deg. C., structural changes similar to those found in hyper-eutectoid carbon steels occur, the cementite appearing as network instead of globules. The globular form of cementite obtained in the normal structure of tungsten steels is ascribed to

¹⁰All etchings are alcoholic nitric or picric acid.

the presence of tungsten carbide. At or above 1,200 deg. C. this WC reacts with iron to form tungstide and cementite. The latter then separates, on cooling, in a network similar to that in ordinary carbon steels.

In a steel containing 4.72 per cent tungsten and 1.57 per cent carbon, cooling from 1,200 deg. C. followed by quenching at 750 or at 650 deg. C. (to find the separation of cementite on cooling) results respectively in production of austenitic-martensite and a network of free cementite, thus showing that Fe_3C separates below 750 deg. C. On the other hand, when cooling from 900 deg. C. cementite has already separated at this temperature (Fig. 4). Dissolved tungstide has therefore a retarding effect on the separation of primary cementite.

The effect of rate of cooling on a steel containing 2.06 per cent tungsten and 0.50 per cent carbon belonging to region VI of Fig. 20 is shown in micrographs of Figs. 11 to 18 inclusive. Very slow cooling from 900 deg. C. results in globular ferrite (Fig. 11), while with more rapid cooling from the same temperature acicular ferrite appears (Fig. 12).

The structures resulting from cooling through 720 to 670 deg. C., from 1,100 deg. C. in twenty, forty and fifty-one minutes are shown in Figs. 13, 14 and 15. They consist of large granular ferrite in network and acicular ferrite in mesh in Fig. 13, less of the latter in Fig. 14 and its final disappearance in Fig. 15, which consists of large granular ferrite crystals and a eutectic matrix. Thus on very slow cooling through 700 deg. C. the tungstide in solid solution reacts with Fe_3C to form free iron and tungsten carbide, a hypothesis confirmed by the magnetization-temperature curve showing both normal Ar_1 and double carbide transformations.

Figs. 16 and 17 are the structures resulting after normal slow cooling from 1,100 to 600 deg. C. followed by very slowly cooling to 540 deg. C. The structures consist of acicular ferrite and a eutectic matrix, showing that a temperature of 600 deg. C. is too low for the change to granular ferrite. Fig. 18, representing the structure of the same steel quickly cooled from 1,200 deg. C. to room temperature, shows fine acicular ferrite.

The effect of rate of cooling is not so marked on steels of region III and hyper-eutectoid steels of region I of Fig. 1, and has little or no effect on those belonging to regions IV, V and VI.

Calcareous Marl Produced in 1920

Reports made to the United States Geological Survey show that 97,487 short tons of calcareous marl, valued at \$322,329, was produced in the United States in 1920. These figures represent an increase of 6.6 per cent (6,050 short tons) over the quantity produced in 1919, but a decrease of 1.5 per cent (\$4,955) in the total value of the product. The average price per short ton was \$3.31 in 1920 and \$3.58 in 1919.

Most of the marl sold in 1920 was used in agriculture, in the same manner as pulverized limestone and agricultural lime, but some was used as a filler in patent fertilizer. In Arkansas, where the product included chalk, a small quantity was sold as whiting, which brought a higher price than the agricultural material.

Nearly one-half of the total output—42,510 short tons—was produced in Virginia and was valued at \$143,373. The other producing states were Arkansas, California, New York, North Carolina, Ohio, South Carolina and West Virginia.

The Treatment of Acid and Alkali Burns*

By A. K. SMITH, M. D.†

THE wounds caused in tissues by acids and alkalis are not strictly burns according to the accepted definition of a burn. Rather such chemicals belong to a class of materials known as escharotics or caustics, substances which when applied to living tissue cause its death and produce an eschar or slough. The strong caustics are sulphuric acid, nitric acid, potash, chloride of antimony, chloride of zinc, acid nitrate of mercury, bromine, chromic acid, lime and hot iron.

Applied to the skin, they immediately unite with it, killing the tissues to a depth proportionate to the strength and quantity of the caustic. Their burn is self-limited and immediately the caustic has exerted its strength by union with the tissues it is no longer destructive.

The burns may be conveniently classified just as burns from heat are classified: A first-degree burn in which only the epidermis is destroyed or inflamed; a second-degree burn extending into the true skin and causing its destruction or inflammation; and a third-degree burn which not alone destroys the skin but also extends into the underlying tissues. The treatment naturally varies with the degree of the burn.

The most important branch of treatment of these caustic burns is prophylaxis or preventive measures, and under this head come all the safety methods observed and the appliances used to render immediate aid in case of accidental spills.

You will notice hot iron classed as a caustic, and many of these innocent-looking liquid acids or solutions of caustic alkalis are quite as harmful as the hot iron.

FIRST AID FOR BURNS

First aid, to be of any great value, must be immediate aid. Probably the most valuable is the shower bath, and of course it must be used before any attempt is made to remove clothing, and every effort must be made to get a large volume of water between the caustic soaked clothing and the skin. Directly after drowning the caustic, saturated watery solution of bicarbonate of sodium may be mopped on the burned area in the case of acid burns, and a 2 per cent solution of acetic acid similarly used in the case of alkali burns. After this has been liberally carried out the patient should be placed in a physician's care.

In simple first-degree burns mopping the burned area with dry gauze and the application of a bland, clean ointment, such as boric acid ointment or burn ointment—which is made of bicarbonate of soda and petrolatum—or oxide of zinc ointment may be used by spreading a liberal layer on gauze and holding it in place with a gauze bandage. Such a dressing relieves the pain and is sufficient with renewal of dressing occasionally.

In second-degree burns the wound should be cleansed of all loose rolled up epidermis, mopped with a mild antiseptic, such as boric acid solution, and an ointment applied on gauze, held in place by a rather loose gauze bandage.

In this degree of burn blisters are encountered.

*Paper presented before National Safety Congress, Milwaukee, Wis., Sept. 29, 1920.

†Manager Medical Section, E. I. du Pont de Nemours & Co., Wilmington, Del.

Small blisters, unruptured, are let alone and larger blisters, where tension is likely to cause pain, are opened by first sterilizing the area with a 3½ per cent alcoholic solution of iodine and a liberal incision is made with a sterile knife near the edge of the blister, allowing its top to collapse and remain. The ointment used in dressing these cases should be absolutely clean, sterile and mildly antiseptic, and should have a melting point that will insure its non-separation on standing in the surgery and still be of such consistency that it will spread with ease.

CARE IN DRESSING AND CLEANING BURN WOUNDS

The dressings are renewed as the judgment of the physician dictates, more often at first, when discharges are profuse; and later at as long intervals as possible, in order to allow healing to progress without disturbance.

The epidermis must grow over wherever it has been destroyed, and this growth takes place from the sound edges of the wound only. The newly formed epidermal cells are exceedingly delicate and are easily torn loose by the removal of a dressing, and it is for this reason that dressings should be changed only when absolutely necessary.

Third-degree burns are cleansed of all loose detritus and dressed with a sterile ointment as in second-degree burns. After three or four days the ointment dressing is replaced by a wet gauze dressing, using a sterile, normal, salt solution. The dressing must be kept wet by repeated applications of the salt solution.

A slough forms in these cases, necessitating a long wait until the sound tissue loosens and throws out the dead material, and all this must take place before healing takes place to any extent.

The use of wet dressings leaves the wound in a very favorable condition for skin grafting, should it become necessary.

The long time required for healing in these cases is due to the slow separation of the slough, and after that has taken place granulation tissue must fill up the sloughed-out spaces and a new epidermis grow to cover the entire area.

Healing may be hastened by a careful removal of portions of the slough when redressings are being made; also by keeping down excessive or exuberant granulation tissue growth; and, most important of all, by skin grafting.

The making of numerous small pin-point grafts, some of which will grow, will reduce the time of ultimate closure of the wound. In some cases larger grafts, by the Thiersch method, may be preferable.

Shock may be an accompaniment of second- and third-degree burns. It should be combated by a hypodermic of morphine, and the earlier it is given the better.

The patient is wrapped in hot blankets and surrounded with hot bottles or hot bricks. Care should be taken to cover the warming bricks or bottles with flannel or other material to prevent burning the patient. Salt solution may be introduced into the system by one of the various methods to increase the volume of blood. Ordinary stimulants given by the stomach are of little value in this condition.

TREATMENT FOR BURNS OF THE EYES

Burns of the eyes by caustics are given first aid by douching the eye with a watery solution of bicarbonate of soda in the case of acid burns and a 1 per cent or

2 per cent solution of acetic acid in alkali burns, after which a piece of boric acid ointment about the size of a pea is put under the eyelid and carefully worked into all corners by gentle manipulation on the outside of the eyelid. Further treatment of the eyes can best be done by an eye specialist.

In giving this, our treatment for caustic burns, I am aware of the various other treatments used in burn cases, many of which are not without good points; but I believe that the treatment as outlined will give the patient quicker relief from pain and quite as rapid a recovery and with as little scarring as any other method.

A Gas-Generating Apparatus

BY ARTHUR W. BULL

IN SPITE of the many descriptions of gas generators found in the literature there are few satisfactory designs for the continuous supply of rather large quantities of gas, especially for hydrogen sulphide, where the offensive odor necessitates a gas-tight apparatus. The ideal hydrogen sulphide generator would be completely automatic; capable of delivering any desired quantity of gas at constant pressure; efficient in the consumption of acid and iron sulphide; odorless; and simple in design. The apparatus shown in the accompanying figure fulfills these conditions with one exception—namely, the gas is delivered with a slight fluctuation in pressure if the demand is discontinuous. For most purposes this is a negligible feature.

No startling innovations are claimed for the apparatus. It is rather a combination of previous ideas resulting in an improved generator using the principles of both the acid spray and the Kipp type.

DESCRIPTION OF THE APPARATUS

A represents the acid container. For this purpose a constant level device of some kind must be used. A portion of an earthenware Parsons apparatus¹ was employed in the original apparatus, but a Mariotte bottle like A' or the arrangement of Browne and Mehling² can be used. The acid enters a small bottle B containing a layer of mercury. This layer acts as a check valve and prevents gas from escaping through the fresh acid. The distance XY must be as short as possible to prevent a siphoning effect. F, the gas outlet, leads to a gas-washing bottle not shown. C and E are tubulated bottles of convenient size and located at the same level. Ten-liter bottles were used, but these were considerably larger than necessary for supplying thirty students with hydrogen sulphide for qualitative analysis. D need only be a 2- to 4-liter bottle. C contains iron sulphide with a layer of broken glass or porcelain at the bottom. Old glass stoppers are excellent. The connecting tubes G should be of 12- or 14-mm. tubing. E is closed by a two-hole stopper with an outlet to the drain. The small bottle H, containing a thin layer of mercury, prevents the escape of hydrogen sulphide from the sludge and at the same time allows an admission of air to break the siphon IJ.

The apparatus is assembled with A empty at any convenient height greater than the desired gas pressure, above E and C. The minimum pressure of gas, in inches of water, desired at F is then decided upon. Six inches is satisfactory for most work. Water is added at E and

¹J. Am. Chem. Soc., vol. 25, p. 231 (1903).

²J. Am. Chem. Soc., vol. 28, p. 838 (1906).

air is allowed to escape through *F* until water just reaches the iron sulphide in *C*. *F* is then closed and *E* is filled with water. *F* is carefully opened and water is allowed to flow from *E* to *C* until the difference between the levels in the two bottles equals the desired minimum head in inches of water. *F* is then closed; *A* is filled with dilute acid and the mercury layer in *B* is adjusted until the pressure of the acid column is just sufficient to overcome the back pressure of the mercury column in *B* and the air pressure in *C*. This is best accomplished by adding slightly more mercury than necessary and then carefully raising *L* until the dilute acid begins to drop on the sulphide. A short rubber tubing insert at *N* facilitates this operation. After the mercury layer is correctly adjusted *F* is opened and the apparatus is ready to function. No further adjustments are necessary and operation is entirely automatic. To obtain hydrogen sulphide open cock *F*. To stop operation close *F*. When assembly is completed the rubber stoppers

the acid is effected. A titration of the sludge in *E* showed that 96 per cent of the acid had been utilized.

A freshly broken piece of iron sulphide was treated with dilute hydrochloric acid until a vigorous evolution of hydrogen sulphide was secured. It was then rinsed with distilled water and immediately immersed in a sample of the sludge. Only a very faint evolution of gas was observed. The sludge is automatically removed through the gas-tight connection with the drain. The difference in specific gravity between fresh acid and the sludge prevents dilution of the partly used acid in *D*.

The chief advantages of the new apparatus are:

1. Its operation is entirely automatic.
2. It uses acid with 96 per cent efficiency.
3. There is no chance whatever for the escape of gas into the room.
4. The apparatus is simple and easily made.
5. Extreme variations in demand are quickly met.
6. Gas can be generated at extremely high rates considering the size of the apparatus.

In case a high gas pressure is necessary, it can be secured by raising bottle *E* and reducing the mercury layer in *B*. The apparatus can of course be used for other gases than hydrogen sulphide.

Morse Hall,
Ithaca, N. Y.

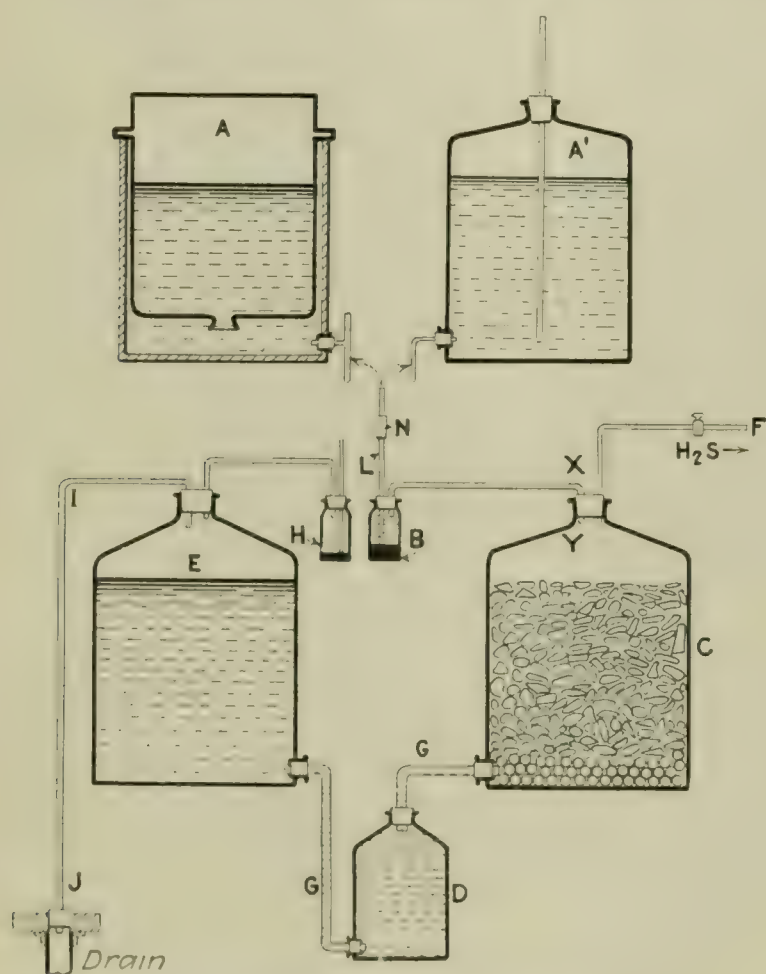
'Time-Punch Feature of Temperature Recorder

It is one thing to settle upon a specific working temperature as being most efficient in a given heat-treating process, but it is quite a different thing to maintain that temperature. No matter how accurate a heat-recording instrument may be, it can do no more than indicate fluctuations of temperature. The human element, untrustworthy at best, must be relied on to see that these fluctuations do not go beyond definite limits. If they do, the whole end and object of a recording thermometer is defeated. To meet these conditions the Schaeffer & Budenberg Manufacturing Co., Brooklyn, N. Y., has devised a time punch as an attachment to its recording thermometers which reduces the uncertainty of the human element to the lowest possible minimum. Making his rounds to inspect the temperature record, the operator in charge of temperature-control now registers the hour and minute of his visit by means of the time punch. Every time a temperature reading is taken he presses a little button and simultaneously a hole is punched in the margin of the revolving chart.

FACTOR OF CHANCE PRACTICALLY ELIMINATED

It can readily be seen that the factor of chance is in this way practically eliminated, because the operative knows that he is being checked. If he shirks his duties, the little punch holes will be conspicuous by their absence. The punch holes are either there or they are not there. If they are not in evidence, he has neglected to "ring up." If they appear at regular intervals and the chart still shows undue variations, there is undisputable evidence of his incompetence. Laxity or carelessness on the part of the operative, particularly where he has direct charge of the firing, is instantly made apparent. A superintendent may now give directions that temperature readings be made at regular intervals, with the knowledge that his instructions will be carried out.

The value of the time punch is apparent in any plant where accurate temperature control forms a part of routine processes.



GAS-GENERATING APPARATUS

should be securely wired in place and given a coat of paraffine. Sulphuric acid can be used very satisfactorily but it must be greatly diluted to prevent crystallization of ferrous sulphate. The extent of dilution is dependent on the minimum temperature to which the apparatus will be subjected. If this temperature is 10 deg. the acid should not be stronger than 1:14. If 20 deg. is the minimum, the dilution is 1:11. Hydrochloric acid can be used diluted 1:1 or 1:2.

ADVANTAGES OF THE APPARATUS

When in operation, fresh acid drips down upon the iron sulphide until gas is generated at a rate greater than the demand. The level in *C* then drops and that in *E* rises, the increased pressure quickly shutting off the acid supply. No new acid will be admitted until the former supply, working on the Kipp principle, is unable to generate the required amount of gas. Because of the great surface of iron sulphide exposed to the action of the acid in this way almost complete neutralization of

Synopsis of Recent Chemical & Metallurgical Literature

Effect on Electrical Porcelain of the Replacement of Free Silica by Alumina and Zirconia.—The March *Journal of the American Ceramic Society* contains a paper by Robert Twells and C. C. Lin on the effect on electrical porcelain of the replacement of free silica by alumina and zirconia. Since it has been suggested that free silica may be detrimental to the mechanical and the dielectric strengths of electric porcelain, a series of sixteen batches was prepared in which various proportions of the free silica were replaced, weight by weight, by alumina, zirconia or combinations of both, and bars and disks, after burning at cone 8½ to 9, or at cone 12, were tested for shrinkage, transverse strength, impact strength, heat resistance, absorption of moisture and dye penetration. The results show that resistance to sudden temperature changes can be greatly improved by substituting zirconia, that the danger of overburning can be greatly decreased by substituting alumina and that the mechanical strength can be increased by substituting either or both; but in the case of dielectric strength no improvement was obtained by substituting for the free silica.

Rock-Drill Steel.—At the winter meeting of the American Institute of Mining and Metallurgical Engineers, an important symposium on Rock-Drill Steel was held. N. B. Hoffman, metallurgist of the Colonial Steel Co., noted that at the present time a large proportion of drill steel produced in America is manufactured into hollow rods. The process consists of first rolling or forging the ingots to suitably sized billets, approximately 4 x 4 x 24 in., which after thorough annealing are taken to drilling machines and a hole drilled through the long axis of the billet. Next one end of the billet is plugged, the cavity filled with a suitable refractory material, after which the other end is likewise plugged and the billets are ready for rolling. After rolling and cropping, the filling material is removed, and the bars are carefully inspected for physical defects. Solid drill steel is rolled direct; the billets are neither annealed nor drilled.

Some brands of hollow drill steel, especially products of foreign manufacture, are produced by a slightly different process, since the billets are pierced and rolled on a mandrel. The process has been observed on several occasions to produce numerous incipient cracks radiating from the hole in the bar, and ultimately producing a point of failure.

In forging the drill from a straight rod, the hammer end is heated to a high heat and upset to form a collar, after which it is allowed to cool. In most cases the strains set up by forging are severe; Mr. Hoffman personally believed after all forging has been finished, it would pay to thoroughly anneal and heat-treat the entire bar before hardening and tempering the point, at least where the drill has heavy duty such as working in deep holes and hard rock.

When hardening tools, especially multipointed bits, the blacksmith will often get one point harder than the other; consequently in use one point will wear down faster than the other, thus causing the drill to strike an uneven blow. Such things as these make for failures which cannot fairly be blamed upon the steel maker. What is needed today is a drill steel which will withstand impact and at the same time retain a sharp cutting edge—that is, a steel with a tough stiff body, and a point, when forged and hardened, that will be both hard and tough. A large number of tools of like character and the nature of whose work requires similar properties are now being made of alloy steels and used in the industries, to a very great extent displacing ordinary carbon steels, for instance a vanadium steel with a carbon content of 0.75 to 0.85 per cent, manganese 0.25 to 0.35, phosphorus under 0.020, sulphur under 0.030 and

vanadium 0.18 to 0.23, which has proved eminently satisfactory as a chisel steel. A steel of this type properly manufactured will be far superior to the ordinary carbon steels, while at the same time is one whose price range should not prove prohibitive.

Much of the cutting efficiency of a drill depends upon proper heat-treatment, and many drills are broken from being quenched at too high a heat, while others quenched at too low a heat do not harden properly and consequently dull quickly, but the driller, trying to get some duty from the dull bit, often breaks it due to the lack of the cushioning effect of slight penetration into the rock at each blow.

This heat range in the ordinary carbon drills is confined to rather narrow limits. The vanadium steel taken as an illustration has a far greater safe hardening and forging range, making it more nearly foolproof. It will harden nicely at 1,440 deg. F. but will also harden well and satisfactorily at 1,550 deg. F. retaining its quality of hardness and toughness in either case.

Influence of Manganese on the Tensile Properties of Malleable Iron.—The influence of manganese on the tensile strength and elongation of malleable iron has not been well defined; the general belief has been that 0.4 per cent manganese would be a maximum content for a good malleable iron. Dr. E. Leuenberger was studied this problem experimentally and describes the results of his work in the March 3 issue of *Stahl und Eisen*.* His samples were white iron

TABLE I.

Sample	Mn	C	Si	P	S
1	0.13	3.06	0.45	0.071	0.041
2	0.26	2.6	0.41	0.078	0.042
3	0.38	3.18	0.32	0.089	0.042
4	0.66	2.58	0.44	0.075	0.044
5	0.78	3.11	0.44	0.078	0.054
6	0.80	2.76	0.47	0.068	0.044
7	0.94	2.76	0.39	0.068	0.050
8	1.05	2.58	0.51	0.056	0.054
9	1.12	2.9	0.41	0.087	0.038
10	1.32	2.82	0.33	0.072	0.038
11	1.52	2.99	0.45	0.076	0.044
12	1.74	3.30	0.36	0.097	0.040

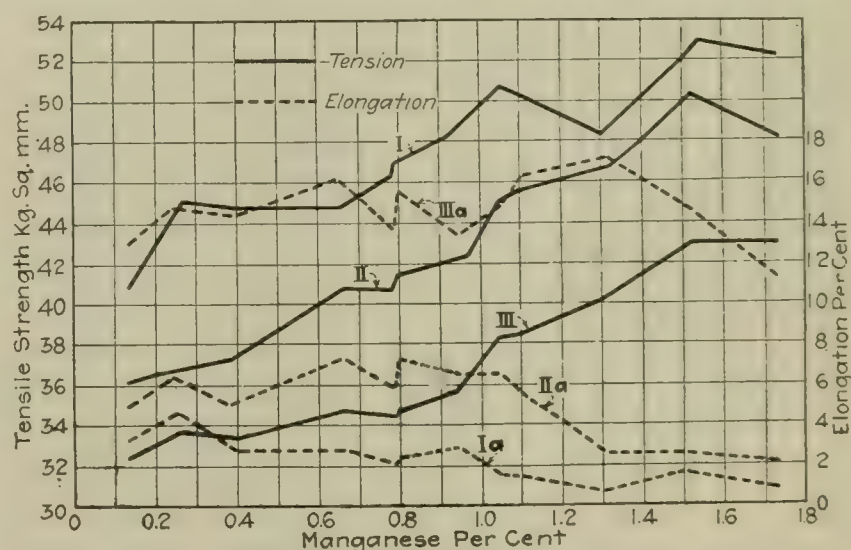


FIG. 1. INFLUENCE OF MANGANESE ON TENSILE STRENGTH AND ELONGATION OF MALLEABLE IRON

(1 kg./sq.mm. = 1,422.3 lb./sq.in.)

Curves I and Ia heating at 980 deg. C. for 95 hr.

Curves II and IIa heating at 980 deg. C. for 130 hr.

Curves III and IIIa heating at 980 deg. C. for 260 hr.

averaging 2.89 per cent carbon, 0.41 per cent silicon, 0.076 per cent phosphorus and 0.041 per cent sulphur, to which be added varying quantities of manganese in the form of a 50 per cent ferromanganese.

Twelve different analyses with manganese content varying from 0.13 to 1.74 per cent as noted in Table I were heated to 980 deg. C. in an oil-fired furnace for 95, 130 and 260 hours and tested in tension.

The test pieces were cylindrical bars 12 mm. in diameter. Six tests were made in each experiment and the resultant average was accepted as correct. These results are plotted

*"Einfluss des Mangans auf die Festigkeitseigenschaften des Schmiedbaren Gusses," *Stahl und Eisen*, March 3, 1921; p. 285.

in the accompanying figure in which the curves I and Ia, II and IIa, III and IIIa represent respectively the tensile strength and elongation of the samples heated for 95, 130 or 260 hours.

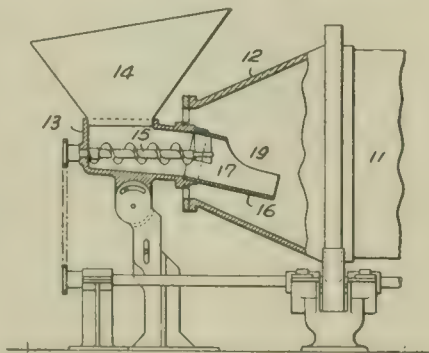
The conclusions derived are: (1) Manganese much above 0.4 per cent is permissible. (2) The tensile strength increases with increased percentages of manganese. (3) Elongation is not affected appreciably by increasing the manganese content up to about 1 per cent, but decreases with higher percentages. (4) The tensile strength decreases when the time of heating increases. (5) The elongation increases with the time of heating. (6) The longer the time of heating the higher the percentage of manganese needed for a given elongation.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Feeding Device for Sulphur Burners.—Referring to the figure, 11 designates the revolving drum of a sulphur burner having a frusto-conical end 12 into which the feeding device projects. The feeding device comprises a hollow body 13 carrying a supply hopper 14 and a feed screw 15. A spout 16 is provided at the discharge end of the body 13 and projects a short distance into the burner but not beyond the frusto-conical end 12. The spout comprises a cylindrical body, 17 having at one end a finished portion 18 which fits accurately within the body 13. Approximately two-thirds of the length of the projecting portion of the spout is cut away above the horizontal diameter, as indicated at 19, so that the discharge



end of the spout is an open trough. This spout is considerably shorter than the spouts heretofore used so that it projects only a comparatively short distance into the burner. The open discharge end offers no resistance to the escape of sulphur so that the sulphur, which is advanced by the feed screw, does not linger in the spout. The fact that the spout is open and exposes the sulphur to the heat of the burner is compensated for by the reduced length so that the sulphur melts very little, if at all, in the spout. The unrestricted opening allows any masses of partly melted sulphur to escape without blocking the spout. The sulphur is fed through a spout according to this invention in a substantially continuous and uniform manner and with much less power expenditure than heretofore. (1,370,627; FRED B. CHAPPELL, of Glens Falls, N. Y., assignor of one-half to Glens Falls Machine Works; March 8, 1921.)

Vanadium Catalyst for Oxidation of Sulphur Dioxide.—A catalyst which effects conversion of sulphur dioxide and oxygen into sulphur trioxide with an efficiency of 96 per cent is obtained by distributing a vanadium compound on a very finely divided carrier not exceeding 60 microns in diameter. Pumice, kieselguhr, precipitated silicic acid, stannic oxide or stannic hydroxide may be used. The following method of preparation is given as an example: Mix 316 parts of kieselguhr (either as it occurs in nature or after trituration) which may previously have been heated to a red heat, with an aqueous solution of 50 parts ammonium vanadate and 56 parts of potassium hydrate; thereupon evaporate off so much of the water that the remainder can be formed into granules; place this result

in a furnace and heat at 480 deg. C. with gas containing sulphur dioxide and oxygen (such as can be obtained from a pyrites burner) and then, if desired, continue the heating for some time in a current of air; the product of this operation is a catalytic agent which is ready for use. (1,371,004; FRANZ SLAMA and HANS WOLT, of Ludwigshafen-on-the-Rhine, Germany, assignors to General Chemical Co.; March 8, 1921.)

Washing Vulcanized Fiber.—Vulcanized fiber made by treating paper with zinc chloride solution is washed free from zinc chloride in solutions of diminishing concentrations until pure water is reached. It requires three to four weeks to wash fiber $\frac{1}{8}$ in. thick. Such a lengthy process is necessary to prevent blistering and at the same time the economical recovery of the zinc chloride is made possible. The danger of blistering is minimized and the time required for washing is considerably reduced by the use of a process devised by OSCAR LINDER, of Chicago, Ill. The fiber is immersed in a zinc chloride solution in the cathode compartment of an electrolytic cell provided with a diaphragm. During electrolysis zinc separates at the cathode and chlorine at the anode so that the strength of the electrolyte decreases gradually and at a uniform rate. The fiber is not connected to the cathode in any way, but is simply placed in the electrolyte so that the removal of the zinc chloride from the fiber is due to direct diffusion of the salt into the surrounding solvent. (1,371,698 and 1,371,699; assigned to Western Electric Co.; March 15, 1921.)

Removing Tar From Pyroligneous Liquids.—The pyroligneous liquors obtained by the distillation of wood are always highly colored due to the presence of tars. Calcium and sodium acetates made from these liquors also contain these tars, which must be destroyed by roasting. The tar can, however, be removed from the liquors before preparing the acetates by using a solvent which is non-miscible with water such as cresol. In making the extraction, EMILE A. BARBET, of Paris, France, suggests the use of a quartz- or coke-filled tower, the pyroligneous liquor being introduced at the top of the tower, and the cresol near the bottom. The tarry cresol which rises to the top is drawn off and distilled to recover the cresol. The decolorized liquor which is drawn off at the bottom of the tower is practically free from tar. The process may also be applied in other industries. (1,371,460 and 1,371,461; March 15, 1921.)

Electrodeposition of Nickel.—Nickel plating with the customary solution of nickel ammonium sulphate is a comparatively slow process, due to the fact that only a 7 per cent solution can be obtained. It has been proposed to use a concentrated solution of nickel sulphate as the electrolyte or plating bath of a nickel-plating electrolytic cell, as it is possible to obtain a 37 per cent solution of this salt, and consequently with such a bath it is possible to impress a current on the cell sufficiently high to plate the nickel out of the bath onto the cathode about five times as fast as is the case when a concentrated solution of nickel ammonium sulphate is used for the electrolyte. However, in cells heretofore used in which a concentrated solution of nickel sulphate is employed as the plating bath, the latter quickly becomes acid. This is due to the fact that in the operation of such cells the nickel dissociated or separated from the nickel sulphate is plated on or taken up by the cathode more rapidly than it is replaced by nickel from the anode, or in other words, more rapidly than the nickel from the anode combines with the SO_4 dissociated from the nickel sulphate by the electric current. Consequently, the excess of SO_4 combines with hydrogen dissociated from the water in the solution by the electric current, to form sulphuric acid. The amount of sulphuric acid so formed continually increases and as this acid acts to dissolve the nickel deposited or plated on the cathode, the efficiency of such cells is soon lost. Moreover, the plating baths of such cells soon become dirty and scum rapidly accumulates on the surface. THOMAS A. EDISON, of Llewellyn Park, West Orange, N. J., maintains the neutrality and composition of a concentrated nickel sulphate bath by circulating it rapidly and continuously through a filter press containing porous cakes of nickel hydroxide. (1,371,414; March 15, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Plans for Chicago Meeting, A.S.M.E.

The 1921 spring meeting of the American Society of Mechanical Engineers is to be held in Chicago, May 23 to 26, at the Congress Hotel.

Well-developed programs will be presented by the professional divisions of the society devoted to Forest Products, Fuels, Machine Shop, Management, Material Handling, Power, and Railroad, and a specially important session will be devoted to Training for Industries. The Chicago committee, jointly with the Western Society of Engineers, is preparing a session on "Chicago as the Rail-Water Gateway."

Visits to a number of points of engineering interest in Chicago will be arranged. Special attention is being given to the correlation of plant visits with the technical sessions.

En route to the meeting, the society, jointly with the Society of Automotive Engineers, will stop at McCook Field on Saturday, May 21, for an inspection of the facilities of the field. On May 27 and 28, the Friday and Saturday following the meeting, a joint excursion with the Army Ordnance Association will proceed to Rock Island Arsenal, where the Ordnance Division will present papers and enjoy an inspection of the plant. Saturday will be devoted to a handicap golf tournament on the Rock Island links.

Government Kelp Products Plant to Be Sold

The kelp products plant of the Bureau of Soils at Sumnerland, Cal., must be sold, under the provisions of the agricultural appropriation bill passed by the last session of Congress. This plant, which is now operating for the production of bleaching carbon, potash salts and iodine, has a capacity of about 100 tons of wet kelp per day. From this it is estimated there can be produced 1,500 lb. of bleached carbon and 2 tons of potash salts daily.

The officials of the Bureau of Soils had hoped to continue the experimental operation of the plant for another year, as by that time they felt certain that it would be generally admitted that the operation was a demonstrated commercial success. However, Congress deemed otherwise and it is now necessary to dispose of the plant as soon after the first of July as a purchaser can be secured. The bureau states that it will make very favorable terms for disposal of the property if it could be assured that the plant will be operated for a sufficient time to demonstrate its possibilities thoroughly. In fact there appears to be more interest in securing a guarantee of operation to complete the experimentation now under way than in realizing any large sum from the sale of the property.

Muscle Shoals Work Stops

Practically all of the work at Muscle Shoals has been stopped. Enough of the money already appropriated for the Wilson dam has been retained to provide for the maintenance of the unfinished project until August, 1922, which is regarded as the earliest time at which new funds are likely to be made available. Enough money also has been withheld to provide for an investigation of the rock beneath the south abutment of the dam as there have been some evidences of instability at that point.

To Examine Georgia Mineral Deposits

The Bureau of Mines is co-operating with the Central of Georgia R.R. in an examination of the clay, feldspar, graphite and bauxite deposits tributary to that railroad. The Bureau of Mines is represented by R. T. Stull, superintendent of its ceramic station at Columbus, Ohio, and by W. M. Weigel, its mineral technologist attached to its Southern experiment station.

Entertainment for Mme. Curie

As Mme. Curie is expected to be but a very short time in New York City, and as it would be impossible for her to attend functions given by any of the individual societies, a luncheon will be given in her honor by the associated chemical societies at the Waldorf-Astoria, on Tuesday, May 17, at 12:30 p.m. Price per cover is \$5. Brief addresses will be made by representatives of each of the chemical societies.

The following gentlemen comprise the committee on arrangements: Chairman, Dr. Edgar F. Smith, American Chemical Society; vice-chairman, Dr. W. S. Landis, American Electrochemical Society; Dr. S. R. Church, Society of Chemical Industry; Dr. George F. Kunz, Société de Chimie Industrielle; secretary-treasurer, Dr. J. E. Zanetti, Chemists' Club of New York City.

Other committees appointed in connection with the luncheon are:

In charge of arrangements with the Waldorf-Astoria Hotel—Dr. George F. Kunz.

Seating—S. A. Tucker, chairman; H. B. Coho, C. A. Doremus, R. H. McKee, J. M. Matthews.

Speakers—Charles Baskerville, chairman; Colin G. Fink.

Program, invitations, music and flowers—Ellwood Hendrick, H. R. Moody, Reston Stevenson.

The following have been appointed to represent their respective societies on the entertainment committee for the entire duration of Mme. Curie's visit:

American Chemical Society—Leo H. Baekeland, Yonkers, N. Y.; Marston T. Bogert, Columbia University, New York City; Prof. J. Enrique Zanetti, Columbia University, New York City; R. B. Moore, U. S. Bureau of Mines, Washington, D. C.; Wilder D. Bancroft, 7 East Ave., Ithaca, N. Y.; Charles F. Chandler, Columbia University, New York City; Charles L. Parsons, 1709 G St., Washington, D. C.; Charles H. Herty, 1 Madison Ave., New York City; W. H. Nichols, 61 Broadway, New York City; Ira Remsen, Johns Hopkins University, Baltimore, Md.; T. W. Richards, Gibbs Memorial Laboratory, Frisbie Place, Cambridge, Mass.; W. A. Noyes, University of Illinois, Urbana, Ill.; S. C. Lind, U. S. Bureau of Mines, Golden, Col.

New York Academy of Sciences—George F. Kunz, chairman; Edward L. Thorndike, Ralph W. Tower, F. A. Lucas, William J. Gies.

American Electrochemical Society—W. S. Landis, president; Colin G. Fink, J. W. Richards, H. B. Coho, E. P. Matthewson.

Society of Chemical Industry—H. G. Carroll, Prof. Ralph H. McKee, Charles H. Herty; S. R. Church, chairman; Allen Rogers, secretary, ex-officio.

Société de Chimie Industrielle—Leo H. Baekeland, Marston Taylor Bogert, Charles A. Doremus, George F. Kunz, chairman; J. Enrique Zanetti.

New York Electrical Society—W. N. Dickinson, president; T. Commerford Martin, C. O. Mailloux, A. L. Doremus, George H. Guy, secretary.

Cooper Union Chemical Society—Prof. Henry C. Enders, George Felder, president.

Following is the text of the appeal by the Marie Curie Radium Fund, which has the task of raising money with which to purchase a gram of radium to present to Mme. Curie in the name of the women of America:

"Women of America are raising a fund of \$100,000 with which to buy a gram of radium for Mme. Curie, who has none with which to continue her research work. It is the one thing most desired by this great scientist. You may aid this fund by subscribing in the name of a woman. Make your check payable to the Marie Curie Radium Fund and send it to the Equitable Trust Co., 37 Wall St."

Chemical Warfare Service Dinner

That the Chemical Warfare Service can rely in the future on general support both within and without the Army became very evident at its third annual dinner held in Washington, April 16. Much significance is attached to the remarks at the dinner of E. J. Wainwright, Assistant Secretary of War, whose warm support of the service hardly would have been forthcoming were it not the attitude of the Administration. The speeches made at the dinner have aroused much comment, particularly in military circles. The Rip Van Winkles in the Army who have been anti-C.W.S. show signs of revising their views with respect to chemical warfare.

The toastmaster at the dinner was Charles H. Herty, editor of the *Journal of Industrial and Engineering Chemistry*. In introducing General Fries he told of the great interest which the 15,000 chemists of the United States have taken in chemical warfare since its introduction into the World War and the very general desire among these chemists to have the public generally awake to the possibilities of this new weapon and to be reliably informed as to all phases of its use.

ADDRESS OF GENERAL FRIES

General Fries in the course of his address declared that he believes in publicity. Were a screen of secrecy drawn across the work of the service, he thinks it would have an adverse affect upon the support given a new activity concerning which there is a great deal of misinformation afloat. General Fries told those assembled at the dinner how the toxic smoke-candle has revolutionized cloud-gas practice and how liquid gas has been improved until it truly is the "dew of death." The battlefield of the future, he declared, never will be free of gas. He analyzed the great advantage which the United States enjoys in having the raw materials needed to make these gases and a great industrial machine which can be diverted to the making of gases in time of war, as well as having the trained personnel which would be required for that service. In concluding his remarks he said:

"The Chemical Warfare Service will guarantee to keep the United States in the very forefront of chemical warfare investigation, development, production and training for just 2 per cent of the Army appropriation, and if the Navy desires it, we can do the same for it for about 1 per cent of the Navy appropriation. With 2 per cent of the Army appropriation we will manufacture all masks needed in peace, including a suitable reserve. We will keep in con-

dition a plant that in time of war will produce masks as fast as men can be mobilized and in addition keep them equipped in the field. We will keep in readiness plants for the manufacture of gases and for the filling of gas shells, bombs and other containers on a scale to meet the needs of any war. We will be able to lead the world in research and development, and we believe that with that 2 per cent we could do as much to guarantee success in war as 25 per cent spent for any other purpose."

PRESIDENT'S PHYSICIAN INTERESTED IN C.W.S.

Brigadier-General Charles E. Sawyer, recently designated by the President to be his personal physician, who was the second speaker on the program, revealed to official Washington that he is an orator and that he has done some sound thinking on public questions. He told of his own interest in chemistry and declared that physicians should use more chemistry in their efforts to diagnose diseases. He stated that he had been impressed particularly with the good which would come in peace time from the research and other activities of the Chemical Warfare Service.

AIR SERVICE RELIES ON GAS

That the Air Service of the Army is relying chiefly upon gas for its war-time effectiveness was indicated by the talk of Brigadier-General William Mitchell, assistant to the chief of the Air Service. He pointed to the vulnerability of New York, where millions of people live within an area of a few square miles. If an enemy were able to get one airplane over the city once in eight days so as to drop two tons of tear gas, it would be necessary for every person in an area of 100 square miles to wear gas masks continuously. If one bombardment squadron, he said, were able to force its way over the New York area once in eight days, it would be possible to drop 70 tons of mustard gas, which then would make it necessary for the entire populace to take further steps to protect itself against that gas. Only two bombing squadrons would have to pass over the New York area once every eight days to drop 200 tons of phosgene, which would make the entire city untenable.

H. C. Parmelee, Editor of *CHEMICAL & METALLURGICAL ENGINEERING*, advocated adequate financial support for C.W.S. by Congress.

GAS WARFARE BY THE NAVY

Following Mr. Parmelee's remarks Rear Admiral W. S. Smith, of the Naval Consulting Board, was introduced. He declared that the Navy is entertaining no delusions as to



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the possibilities of gas and that it may be taken for granted that the Navy will be found prepared in that particular. He stated that he favors allotments from the naval appropriations to the Chemical Warfare Service so that it may manufacture the gas needed by the Navy. He said that those doubting the effective use of gas bombs dropped by airplanes against battleships are influenced by the fact that hits seldom are recorded. He admitted that may be the case when a few bombs are dropped at a target, but it would not be the case when a large fleet of airplanes dropped hundreds of bombs simultaneously. Ships must be made gas-proof, he declared.

WILL BE READY FOR NEXT WAR, SAYS WAINWRIGHT

In addition to his remarks supporting the Chemical Warfare Service, Assistant Secretary of War Wainwright declared with emphasis that the United States will be ready for the next war, whether that war be a conflict with a single nation or any combination of nations. He is anxious to have the Army maintain sufficient supplies to enable it to make war without having to draft into service nearly all the productive power of the country's manufacturing plants. He also referred to the necessity of equipping plants so as to make them readily convertible to war needs.

DR. BANCROFT WOULD INTEREST ALL CHEMISTS IN CHEMICAL MEANS OF WAGING WAR

Dr. W. D. Bancroft pointed out the necessity of keeping the chemists of the country interested to the point that they will have in mind at all times the improvement of chemical means of making war. He stressed the point that every man in the military service in the future must be equipped with a certain amount of knowledge as to gas. He made the point that research alone is not enough. Military tactics must be developed and essential training of military personnel must not be overlooked. The mask particularly is subject to great development. No real fighting mask has been developed as yet, he declared.

CONGRESSMEN SPEAK ON PREPAREDNESS

Following the set speeches, Representative Frank W. Mondell of Wyoming, the Republican floor leader, and Representative Julius Kahn, the chairman of the Committee on Military Affairs, were invited to talk. Mr. Mondell emphasized the need for economy in public expenditures, but referred to a proper degree of military preparedness as insurance on which the nation must pay the premium. The development of a new weapon in warfare must not be disregarded, he declared. If other nations should pretend to abandon the use of gas in war, he ventured the assertion that it would be because they are afraid of our prowess in that direction.

Representative Kahn takes no stock in the assumption that wars are things of the past. He stated that it has been his constant effort throughout his public career to strive for a high degree of military preparedness in the United States. Had there been more preparedness before this war, the nation would be much better off today, he asserted. Had it been possible in recent years to secure an annual investment of \$50,000,000 for preparedness measures, the nation would be the gainer by an untold amount today and the very war itself might have been averted. As it is, \$25,000,000,000 was expended in the World War. Thus in a few short months enough was expended to make annual payments of \$50,000,000 for more than four hundred years. He was particular to call attention to the fact that the cost in money represents only the replaceable part of our loss. The lives that were sacrificed and the suffering that was endured, he declared, are losses which head the list in our calculation. He said the Chemical Warfare Service should be given the \$7,000,000 appropriation for which it had asked.

The dinner and the program of speeches were voted by all in attendance to have combined to make an evening long to be remembered. The committee which had charge of the arrangements consisted of Lieutenant-Colonel H. L. Gilchrist, Major R. F. Maddux, R. S. McBride, W. F. Keohan and Dr. A. W. Shaw.

Corrosion and Its Prevention

The program of the Connecticut Valley Section of the A.C.S. calls for one joint meeting yearly with the Hartford Branch of the American Society of Mechanical Engineers. This meeting was held Monday, April 11, following a dinner at the City Club of Hartford.

A paper on "Corrosion and Its Prevention" was read by W. T. Becker of E. F. Houghton & Co., and Dr. A. S. Cushman of the Institute of Industrial Research gave a talk on the fundamental causes of corrosion, with particular reference to the iron and steel industries.

Mr. Becker said that the mechanical engineer was concerned with the temporary protection of iron or steel surfaces against corrosion. After the article in question had reached its destination and been installed the problem of rust prevention ceased to be of interest to him. After dwelling briefly on the electrolytic theory of corrosion he went on to speak of the importance of proper selection of steel for the particular purpose in view. By selecting a steel having the highest possible drawing temperature which will possess the desired properties there results a product in which the steel is less likely to be strained and consequently less likely to develop electropositive spots resulting in rapid corrosion. He listed the practical methods of rust prevention as (1) the use of inhibiting agents (generally, however, in conjunction with painting), (2) painting, (3) covering with a film of oxide, (4) covering with some other metal, zinc, copper or tin in practice, and (5) covering with a non-drying coating as greases or slushes.

Small machine parts, he said, must nearly always be protected by means of the last class of protective agents, for the coating must be readily removed. A great deal of research has been carried out with regard to the development of proper slushing compounds and many good ones have been developed. The two sources of trouble in this class of materials are found to be checking or cracking if the object is cooled too much, and liquefaction of the grease if the object is warmed. Shipments to the tropics demand a different sort of slushing compound than do shipments in colder regions. A very good test for the efficiency of such a grease consists in coating a test-piece in the ordinary way and then hanging it in fumes of hydrochloric acid. If the film of grease is not perfect, it will be quickly apparent. Another good test consists in coating a test-piece with the grease, hanging it in 5 per cent salt solution for twenty-four hours and again coating and immersing until the grease fails. The paper used for wrapping small parts is frequently a source of corrosion. It should contain neither acid nor sulphates.

Dr. Cushman spoke very interestingly of his early work in the field of corrosion. He described the origin of the investigation as due to complaints of farmers in the Middle West about the deterioration of fence wire and told of his earlier experiments leading up to his electrolytic theory now universally accepted. Some slides which he showed made up of wire nails in gelatine containing phenolphthalein and potassium ferricyanide brought out the positive and negative portions very vividly, and one in particular showed the presence of a field of force about a spot in the surface of a bit of steel wire. The lines of force showed up very clearly in the gelatine and should be sufficient to convince any skeptics of the validity of the electrolytic theory of corrosion.

He went on to point out the importance of many recent discoveries in the "higher physics and higher chemistry," as he called them, to practical industrial problems, but he felt that much more knowledge of the fundamental properties of atom and molecule was necessary before the problem of preventing corrosion could be solved.

The Underwood Typewriter Co. allowed the visitors to inspect its factory. A large number of members availed themselves of the opportunity.

Navy to Use C.W.S. Masks

The gas mask developed by the Chemical Warfare Service has been adopted tentatively for use by the Navy.

Last of Government Surplus Brass Sold

All the remaining surplus of brass cartridge cases has been sold by the War Department. The bulk of this surplus brass recently was sold to the Chase Companies, Inc., the Scovill Manufacturing Co. and the Bridgeport Brass Co. The remainder has been allocated as follows: Western Cartridge Co., East Alton, Ill., 2,074,554 lb.; American Copper Products Corporation, Bay Way, N. J., 2,000,000 lb.; Baltimore Tube Co., Baltimore, Md., 500,000 lb.; Wheeler Condenser & Engineering Co., Carteret, N. J., 1,746,812 lb.; Seymour Manufacturing Co., Seymour, Conn., 2,009,306 lb.; Keeler Brass Co., Grand Rapids, Mich., 761,800 lb.; British American Metals Co., Inc., Plainfield, N. J., 2,000,000 lb.; Ansonia Foundry Co., Ansonia, Conn., 1,500,000 lb.; Standard Underground Cable Co., Pittsburgh, Pa., 1,553,045 lb.

Chicago Chemists Club Party

The Chicago Chemists Club gave a party in headquarters, 315 Plymouth Court, on Friday evening, April 15. It was a social occasion or ladies' night in honor of the inauguration of the new president, Otto Eisenschiml. The evening's program was devoted entirely to entertainment. After dinner an informal reception was held in the club lounge for Mr. and Mrs. Hoskins and Mr. and Mrs. Eisenschiml, followed by dancing and a musical program. Later in the evening a smelling contest was held where eighteen unknown substances were offered to the ladies for identification and twenty-four difficult odors were tested out by the men. The attendance of members and guests broke all previous records.

Navy Interest in Chemical Warfare Is Intense

The Navy is making no effort to conceal its very active interest in the experimental and research work being done by the Chemical Warfare Service. The General Board of the Navy, headed by Rear Admiral W. L. Rodgers, recently has spent considerable time familiarizing itself with the work being done at Edgewood.

The contrast between the interest displayed by high naval officers, as compared with that shown by the General Staff of the Army, is a cause of comment. A change in the policy of the General Staff, however, may take place when the appointee of the new administration takes over the direction of its work.

Plans for Recovery of Wastes at the Holland-St. Louis Sugar Plant, Decatur, Ind.

Following months of scientific research by engineers in which officials of the State Department of Conservation cooperated with officials of the Holland-St. Louis Sugar Co., of Decatur, Ind., and the State Board of Health, Richard Lieber, Director of Conservation, has announced that a plan has been adopted by which it is expected to free St. Mary's River from pollution caused from vegetable matter and refuse from the sugar refinery.

The plan, which has the approval of the Conservation Department, heads of the engineering department of Purdue University, the State Board of Health and the Holland-St. Louis Co., will involve an expenditure by the latter of approximately \$104,000 for the erection of a plant to handle and dispose of the refuse in such a way as to reclaim the byproducts. This plan, engineers claim, will recover potash for use as fertilizer, will increase the sugar yield, and such wastes as eventually reach the river will have been so purified that all contaminating influences are lost.

The wastes from the plant may be divided as follows: (1) Beet-carrying and wash water, 2,000,000 gal. per day. (2) Diffusion battery and pulp press water, 200,000 gal. per day. (3) Lime press cake, 37 tons as a solid cake containing 50 per cent moisture, or 150,000 gal. when diluted with water to make a liquid that will readily flow. (4) Steffens house wastes, 200,000 gal.

No. 1 waste contains beet tails, beet tops, earth and beet roots, but very little soluble organic matter. Its biolog-

ical oxygen demand is zero. It is therefore planned to keep this liquid separate from the other wastes, which can readily be accomplished, pass it through fine screens and discharge it continuously into the river.

DIFFUSION BATTERY WATER RE-USED

No. 2 waste contains much organic matter in solution and also considerable in suspension. Very careful consideration was given to treatment of these wastes and methods were actually devised for coagulating and settling them so that the supernatant liquid could be discharged into a storage lagoon and from there permitted to flow in the river at a rate more or less proportional to the stream flow, so that the stream at no time would be excessively polluted. However, there was finally worked out with the assistance of the company superintendent a method for re-using these wastes. This method is not altogether new, but it is novel in that the wastes will all be recirculated into the process. Treatment comprises liming and carbonating in a manner similar to the treatment applied to the main volume of juice in the plant and then re-using the liquid in the diffusion batteries. The purpose of the liming and carbonating process is to precipitate out non-sugars, which are then filtered off, leaving as a waste a lime press cake which, however, will not greatly increase the volume of lime press cake already produced.

LIME PRESS CAKE

The lime press cake may be handled either as a relatively solid cake or as a rather thick liquid. If handled as a cake, it would be removed from the factory on a small narrow-gauge railroad and dumped at some convenient point where dumping grounds are available. This method, while perhaps the cheapest available, is objectionable, inasmuch as it involves considerable labor. Labor is always hard to get at beet sugar plants because the "campaign" lasts for only 100 days. Accordingly the company favored mixing the cake with water (which water incidentally is used for assisting in the cleaning of the presses) and pumping it to lagoons, where it will be stored until the volume of flow in the river is sufficient to afford ample dilution. It is estimated that a storage capacity sufficient to hold 25 days' production of the liquid lime cake will tide over any period of insufficient dilution in the river that is likely to occur.

POTASH RECOVERED FROM STEFFENS WASTE

The fourth waste is exceedingly strong in organic matter, though low in suspended solids. It results from the process used to recover additional quantities of sugar from the molasses after the first direct recoveries have been made. This waste will be evaporated to dryness in multiple effect evaporators and the final sirup will be ignited for the recovery of potash. It is probable, however, that the ignition process will not be conducted at the plant, but the sirup itself will be barreled and sent to fertilizer works. This process of recovering potash is not new and in fact was used at this plant before. The building in which it was housed burned down in 1918 and owing to the unfavorable market for potash that developed subsequently it was never rebuilt. It is not likely now that the process will pay for itself owing to continued unfavorable potash market. However, when looked upon as a method for treating the wastes, it is reasonably economical.

BIOLOGICAL PROCESSES NOT APPLICABLE

It is to be noted that ordinary methods of sewage treatment involving biological processes are difficult to use in connection with beet sugar wastes for the reason that the campaign runs for only 100 days and it would take any biological process at least several weeks to ripen, during which period most of the damage would have been done in the matter of stream pollution, inasmuch as the campaign is started in October when stream flows are ordinarily low. Another objection to biological processes is that the waste carries so much organic matter that very extensive filter areas are necessary to give the desired capacity. This makes biological processes exceedingly expensive.

Imports and Exports of Chemicals

Imports of chemicals decreased in a very unusual manner during February. Total imports for the month were valued at \$7,434,811, as compared with \$16,460,296 in February of 1920. The total imports of January, 1921, were \$12,221,850. Thus there was a decrease over the corresponding month of last year of more than \$9,000,000, while the decrease from January was nearly \$5,000,000. The figures are those of the Bureau of Foreign and Domestic Commerce.

The decline came largely among the gums—camphor, copal, gambier and shellac. There were slight increases in imports of colors and dyes and in coal-tar products. Outside of the major group some of the imports were as follows:

	Feb., 1920 Pounds	Feb., 1921 Pounds
Iodine	6,975	55,846
Lime, chloride of.....	110,633	257,824
Potash, carbonate of.....	23,263	126,137
Soda, cyanide of.....	996,979	11,023
Arsenic	259,518	564,191

Exports of chemicals also declined sharply. The value of all chemicals exported during February of 1921 was \$5,998,415, as compared with \$13,197,994 in February of 1920 and \$9,420,043 in January of 1921. The decrease applies through each of the major groups as follows:

	Feb., 1920 Value	Feb., 1921 Value
Acids	\$407,564	\$141,455
Dyes and dyestuffs.....	2,461,797	548,420
Extracts for tanning.....	468,711	82,755
Sodas	1,708,544	437,830

Tungsten in 1920

Not since 1902 has the United States produced so small a quantity of tungsten concentrates as in 1920, according to Frank L. Hess, of the United States Geological Survey, Department of the Interior. The Wolf Tongue Mining Co. and the Vasco Mining Co., of Boulder, Col., were the only American tungsten miners. They produced an equivalent of 216 short tons of ferberite ore carrying 60 per cent tungsten trioxide (WO_3).

Tungsten is most used for making high-speed tools for cutting steel, so that the demand for tungsten ore rises and falls with the steel business. In 1920 the steel business was very dull and the demand for tungsten was correspondingly small. At the same time, in spite of the small demand, the imports were rather large for peace times, and consisted in part of very cheap ore from the shallow placers of China. A good deal of the ore was apparently shipped to this country with the expectation that a heavy duty would be imposed on it and that ores in stock would accordingly increase in value. The imports for 1920 were 1,740 long tons of ore, probably averaging 65 per cent or more tungsten trioxide (WO_3) and were equivalent to about 2,111 short tons of concentrates carrying 60 per cent WO_3 . Of this quantity 1,386 short tons of 60 per cent concentrates was shipped from China and most of the rest from South America. Besides the ore 1,997,719 lb. of tungsten and ferrotungsten was imported, equivalent to about 2,250 short tons of 60 per cent ore, and probably more than enough to supply the needs of the high-speed tool industry, so that there was added to the already large stocks in this country somewhat more than the quantity of tungsten represented by the imports of ore.

Exact figures are not at hand, but a large quantity of tungsten ore is in stock in this country, probably more than a three years' supply at the average consumption before the world war.

Armour Research on Nitrides

Prof. Harry McCormack, of the Armour Institute of Technology, spoke before the Chicago Chemists Club on April 12 on "Experiences With a Few Nitrides." Dr. McCormack has been doing research work on nitrides for the past five years, a good deal of his time being devoted to studies with zinc nitrides and aluminum nitrides. While his work on this subject has not been brought to a definite conclusion, a considerable amount of interesting data has been compiled. It is not at all impossible that the manufacture of aluminum nitrides may some day be a commercial process for the fixation of atmospheric nitrogen.

Distillation of Missouri Oaks

The problem of the distillation of Missouri oaks was undertaken in the chemical laboratories of the Missouri School of Mines and Metallurgy to note the yields of products from both the white and black oaks, and to determine the advantage or disadvantage of conducting distillations under reduced pressure. The results of this work were outlined by K. K. Kershner, E. W. Rembert and M. S. Badollet at a meeting of the St. Louis Section of the American Chemical Society, April 8.

The distillations were carried on in a coal-fired, horizontal, cylindrical iron retort, large enough to contain a charge of one-third of a cord of wood. All operations were conducted under good chemical control features and the plant was equipped with adequate condensers and washers. The accompanying table gives the amounts of the various products secured from an average distillation of an 800 lb. charge, running 17 per cent moisture.

DISTILLATION PRODUCTS AND YIELDS

	Normal Pressure		Reduced Pressure	
	White Oak	Black Oak	White Oak	Black Oak
Charcoal, lb.....	200.0	205.0	245.0	251.0
Gas, cu.ft.....	2,910.0	2,785.0		
Pyroligneous acid, lb.....	424.0	414.0	463.0	461.0
Tar-coke, lb.....	1.5	2.0	2.5	2.6
Tar, dissolved, lb.....	14.0	14.4	16.0	20.0
Tar, settled, lb.....	5.4	8.7	10.0	9.9
Acid, as acetic, lb.....	26.7	24.0	30.8	27.7
Acetone, lb.....	1.1	1.1	0.8	0.8
Esters, as methyl acetate, lb.....	1.7	1.3	0.7	1.5
Methanol, lb.....	12.6	15.7	11.3	12.8

The omission of the yield of gas from the reduced pressure distillation is intentional, due to the fact that the suction would occasion an intake of air through every small aperture or leak throughout the entire system.

The greater part of the distillation was conducted under a reduced pressure of 55 to 67 mm. of mercury, a drop to 21 mm. occurring for a short time at the firing point of the charge. The gas ranged from 200 to 500 B.t.u. and gained steadily in amount and heating value as the distillation progressed past the firing point. A general sample of the gas would run about 400 B.t.u. Analysis of gas samples taken every half hour showed that as the distillation progressed there was a drop in carbon dioxide and a gain in unsaturated hydrocarbons, carbon monoxide, methane and hydrogen. There was also a corresponding loss in nitrogen percentage.

About one-third less fuel was required for a reduced pressure distillation as compared with a normal run, although there was a greater tendency for the take-off to become clogged with tar and tar-coke. It was also possible to make a cut containing a higher concentration of desired products in the distillate during a reduced pressure distillation, due to the fact that the greater part of the moisture was removed in the earlier stage of the run.

Obituary

LESTER GRAY FRENCH, prominent in technical journalism and for thirteen years editor and manager of *Mechanical Engineering*, official journal of the American Society of Mechanical Engineers, of which he was assistant secretary, died on April 18 at the French Hospital, New York City, after an operation. Mr. French was born in Keene, N. H., and was graduated from the Massachusetts Institute of Technology in 1891. He began his career as a draughtsman with the Cranston Printing Trust Co. and later was identified with engineering education. In 1897 he became editor-in-chief of *Machinery*, resigning in 1906 to publish technical books. He wrote one of the earliest American treatises on the steam turbine. In 1908 he was made editor of the journal of the American Society of Mechanical Engineers, of which society he was elected a junior in 1899 and a member in 1912. Mr. French was also a member of the Engineers Club of New York.

Personal

JOHN A. BAKER, formerly assistant general superintendent for the Mesta Machine Co. of Pittsburgh, Pa., has been appointed works manager for the Los Angeles plant of the Rich Steel Products Co.

Dr. JAMES BRYANT CONANT, assistant professor of chemistry at Harvard, and Miss Grace Thayer Richards, daughter of Prof. Theodore W. Richards, were married at Cambridge, April 17. The couple intend to travel in Europe during the summer.

JOSÉ ELORRIETA, director of the Forest Service of Vizcaya, Bilbao, Spain, has just completed an extended trip through the United States investigating the forestry of this country. Among other points visited were Chicago and the Forest Products Laboratory at Madison, Wis. He is returning home via Boston.

HAROLD G. MANNING, formerly an assistant examiner in the U. S. Patent Office, and a graduate of the Massachusetts Institute of Technology, has recently opened an office in Waterbury, Conn. Mr. Manning was at one time associated with the law firm of Williams & Pritchard in New York City, and later with the patent department of the Columbia Graphophone Co. of Bridgeport, Conn. While in the Patent Office, he specialized in the examination of electrochemical inventions.

W. C. PETERSON, who for the past twelve years has been associated with the Packard Motor Car Co., in charge of its metallurgical laboratories, has been placed in charge of the metallurgical department of the Atlas Crucible Steel Co.'s mills at Dunkirk, N. Y. Mr. Peterson's work at the Atlas will include research and standardization of the new chromium-molybdenum products which have already been introduced to alloy steel purchasers of the country.

GEORGE B. TROXELL, who has been connected with the Bethlehem Steel Co., Bethlehem, Pa., for the past five years, resigned as assistant superintendent of the electric furnace and crucible departments. He is considering a South American project.

U. C. YOUNG, formerly plant engineer with the Provident Chemical Works of St. Louis, has severed his connection and is now manager of the chemical works of the Calumet Baking Powder Co., Joliet, Ill.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, April 25, 1921.

Trading in heavy chemicals has shown little change during the past week and has been limited to comparatively small lots. Consumers still lack confidence and show no interest beyond their immediate necessities, in spite of offers of material at extremely low prices by holders. Prospective tariff changes are awaited with keen interest and in general enough uncertainty surrounds the chemical industry to warrant the conservative policy that is so manifest.

Manufacturers of chemicals are not discontented over business conditions. Sales cannot be compared with last year at this time, but the demand has shown a marked improvement compared with the first few months of this year. Soda ash is in strong demand for consuming wants. Glass, textile and soap plants are taking this chemical in moderate volume. Solid caustic soda is being well maintained in first hands. Export inquiries from South America are reaching the market quite frequently. Bleaching powder is moving in fair dimensions for domestic consumption. Bichromate of soda has shown a decided improvement, with

small lot sales predominating. Foreign muriate of potash and prussiate of soda have remained fairly steady. Imported caustic potash has attracted a little attention on account of the relatively low prices prevailing. Leading producers, on the other hand, have reduced prices on sal ammoniac, glaubers salt, sulphite of soda and hyposulphite of soda. Arsenic, copper sulphate and other chemicals used for agricultural purposes are not finding an open market. Farmers are not disposed to take much interest in their products when agricultural commodities are selling at the lowest level since the war.

In general, it may be stated that the chemical industry is undergoing a slow development. Slow business usually causes irregularity, but the basic conditions are making for a gradual improvement. The reduction in wage scales and in prices of finished products have been accomplished with very little difficulty.

GENERAL CHEMICALS

Spot bichromate of soda closed firm with most sellers asking as high as 7½c. per lb. Sales were reported for small lots at this figure. The market looked tight, and while it was admitted that a moderate amount of stock is being held by dealers, there is no apparent disposition to release offerings at prevailing prices. Light sales of caustic soda were reported at \$3.65@\$3.70 per 100 lb. ex-store N. Y. It is probable that \$3.60 can be done in some directions, although cheap offerings of standard brands have been well cleared from the market. Producers' prices are unchanged at former levels. Demand did not show any unusual activity so far as resale goods are concerned, although manufacturers did a fair business for prompt and future shipments. Resale light soda ash is scarce and prices are higher. Prominent sellers ask up to \$2.10 for single bags in carload lots on spot. Double bags are not plentiful and are held at \$2.20 per 100 lb. f.a.s. steamer. Barrels are moving at \$2.30@\$2.35. The demand is quite steady. Producers' contracts are unchanged at \$1.72½, basis 48 per cent, in carload lots for single bags f.o.b. works. Imported prussiate of soda has not shown any noticeable strength during the week and the market has been kept unsettled through the keen competition of holders. The range extended from 11½@12c. per lb. during most of the period, but at the close it was reported that 11½c. would probably be accepted by some sellers on a firm bid. Moderate quantities of resale solid sodium sulphide, 60-62 per cent, are being offered by second hands at 5½c. per lb. and some business is reported at this level. The broken variety is quite scarce and is held firmly at 6½c. The War Board has placed nitrite of soda on the list of restricted imports and it is possible that this might force prices up around producers' costs. Stocks around town are known to be quite heavy with offerings for spot material as low as 5½c. per lb. Norwegian nitrite could not be had for less than 10c. per lb. for shipment.

Consumers of arsenic are reported to be well supplied with this chemical at present and the market presented a quiet appearance. Resale lots have reached the market during the week at 7½@8½c. per lb. Leading producers are holding shipments at 8½c. The fact that agricultural material has declined is said to be responsible for the lack of inquiry from manufacturers of insecticides. Spot barium chloride is held at \$60 per ton. The market is still considerably above pre-war figures and buyers are operating on a conservative basis. Imports of magnesium sulphate have been very heavy during the past week, but there was very little change noted in quoted prices. Commercial imported sulphate is quoted at \$1.40 per 100 lb. as against \$2.20 named by domestic makers. Prices on caustic potash are very uncertain in the absence of any demand. Domestic makers are quoting prices far above the spot market. Imported caustic is very weak at 8c. per lb. and resale American material is quoted down to 7@7½c. per lb. Resale prices for formaldehyde range from 13@14½c. per lb., dealers naming about 13½c. Producers are asking 15@15½c., but might consider lower prices on a firm offer. Producers of tin oxide report small sales on the basis of 40c. per lb. Occasional trading in resale lots has gone

through at 39c. Demand has not shown much activity, but offerings are not heavy and the tone appears quite firm.

COAL-TAR PRODUCTS

Trading in intermediates has been entirely without new developments. Prices have been soft in all quarters, with the consuming demand at a very low ebb. A great deal of uncertain feeling that has hung over the market for so long a period is disappearing, however, and the views in producing circles are of a much more optimistic nature, since the intentions of Washington authorities are now more clearly in favor of protection. Conditions in many of the textile mills have shown progressive development. Interest in intermediates and dyestuffs for furs has been fairly active, in view of the business now developing through fur auctions in New York, and *para amidophenol* reflected a steady tendency. The silk mills reported a fair amount of orders from retail quarters. There has been no material change in intermediates, except that distressed lots of *aniline oil* were heard on the market at 18c. per lb. The demand for *beta naphthol* was practically unchanged, although resale material has not been plentiful of late. Prices are quoted at 40@45c. per lb. by makers, while resale lots are held at 32@34c. Prices on *para nitraniline* are still very uncertain, with quotations over a range of 85c.@\$1.05 per lb.

The *naphthalene* market continued dull, with resale material still to be had in sufficient quantity to meet all present requirements. Prices in the resale market for flakes are around 8c. per lb. The refiners of *naphthalene* are asking 8½@9½c. for the flake and 9½@10½c. for the balls, depending on quantity. Business with the fur trade has been fair, but is showing signs of slowing up. *Benzene* producers continue to control supplies and are holding prices firm at former levels, in spite of the lack of interest from consumers. Business, however, is showing some signs of improvement with orders coming in more regularly. There has been very little activity in the market for *aniline salt*. Supplies are available in most quarters and while prices are quotably unchanged at 26@29c. per lb., a firm order would probably induce holders to shade.

The Chicago Market

CHICAGO, April 23, 1921.

There were few developments of noteworthy character in the market for industrial chemicals during the past week. Consumers are still averse to purchasing beyond their immediate needs and business was of the same hand-to-mouth character that has been noted for some time past. The prevailing tone was easy and many products were obtainable at lower prices. *Soda ash* is easier at 2½c. per lb. in small quantities. There are no new developments in *caustic soda*, the market being steady with the offerings light for prompt and nearby delivery. The solid is quoted around \$4.10 per 100 lb. and the ground at \$4.75 in ton lots. *Aluminum sulphate*, iron free, is very quiet, there being little or no demand from the consuming trade. This material is offered on spot at from 3½@4c. per lb., depending upon the quantity. *Ammonium chloride*, white gran., is lower, and is offered in some quarters at 9c. for single barrels. Consumers think this price is still too high and are waiting for further breaks.

Methanol showed no further decline, although the inquiry is light. Second hands are asking 80c. per gal. for the 95 per cent in drums and 85c. for the 97 per cent. There is little or no request for *barium chloride* and the price is unchanged at \$75@\$80 per ton. *Barium peroxide* is also very quiet and is offered at 18c. per lb. There is an ample supply of *carbon tetrachloride* available at 11c. for large drums. Holders show no disposition to shade this price, some factors believing that the market will react soon and that they will be able to obtain higher prices. *Iron sulphate* is in fair demand and is quoted at 1½@2½c., according to the package. Calcined *carbonate of potash*, 80-85 per cent, is easy, and is offered freely at 11c. in cask lots. The continued arrival of cheap foreign material is weakening the market and lower prices are expected. *Caustic potash* is stagnant, with second hands in control of the

market. They are offering 88-92 per cent material of foreign origin at 8@8½c. per lb., while large business would probably bring out even better prices. Resale lots of *bichromate of potash* are available at 14½c. per lb. in casks. *Bichromate of soda* is steadier; 9c. per lb. for spot material seems to be the best offer, while some factors have advanced their ideas to 9½c. Dry powdered *sodium bisulphite* is slowly getting back to normal and is available at 6@6½c., according to the holder. *Sodium bicarbonate* of standard brands is offered at 2½c. per lb. for less than carlots. There are reports from some quarters that a fair volume of business is done at these figures.

Pernanganate of potash is lower, U.S.P. material of domestic manufacture being now available at 39c. per lb. This price is still far from the pre-war level and with the low-priced foreign material coming in lower prices can be expected. C.p. *glycerine* has been reduced by refiners to 16½c. per lb. in large or small drums. This marks the lowest level reached in over ten years and can hardly be expected to go much lower.

In general, there is little change in the list of acids. *Acetic, glacial*, is maintained at 11c. per lb. and the 28 per cent commercial at 2½@3c. per lb. *Hydrochloric*, 18 deg., is steady at 2@3c. per lb. in carboys, price depending upon the quantity. *Sulphuric* is unchanged at \$19@\$20 per ton in tank cars and 2@3c. in carboys. *Nitric* is asked for in small quantities and is quoted in carboys at 8½@9c. per lb.

VEGETABLE OILS

Unusually quiet conditions still prevail in the vegetable oils trade. *Linseed oil* is freely offered at 60c. per gal. in barrels for the raw and 62c. for the boiled. There is little demand from the consuming trade and there is some talk of further reductions. *Corn oil* is in small demand and is offered at 10@11c. per lb. The inquiry for *coconut oil* has improved somewhat, and the price remains unchanged at 10@10½c. per lb.

NAVAL STORES

There were several substantial price advances reported in the local market for naval stores. The leading dealers have advanced the price on *spirits of turpentine*, which is now generally quoted at 65c. per gal. in barrels. Business in *rosins* is slightly more active, the WG grade now being quoted at \$7.75@\$8 per 280 lb. *Rosin oil* is firm at 55c. per gal. in barrels.

COAL-TAR PRODUCTS

There were no developments to speak of in coal-tar products, and, in general, prices are unchanged. *Benzene* is quiet, the prevailing quotations being 28@31c. per gal. for the 90 per cent, and 30@33c. for the pure. Refined *toluene* is unchanged and an ample supply is available at 33c. per gal. in drums. There is a slight movement of *naphthalene flakes*, with most holders asking 8½@10c., according to the size package.

The Iron and Steel Market

PITTSBURGH, April 22, 1921.

Price readjustment in the steel market is now practically complete, and practically the whole market is now on a uniform basis as between the Steel Corporation and the independents. Prospects are that the market will remain on this equalized and stabilized basis for some time to come, possibly through the summer. The Steel Corporation has no incentive to reduce its new prices, as it has absorbed a great deal since the Industrial Board settlement of March 21, 1919, including the absorption of the wage advance of Feb. 1, 1920, the freight rate advance of Aug. 26, 1920, and the present price reductions, all without reducing wages.

The market is now quotable steady all along the line as follows: Billets, \$37; slabs, \$38; sheet bars and small billets, \$39; forging billets, \$42; rods, \$48; merchant bars, 2.10c.; shapes, 2.20c.; plates, 2.20c.; hoops, 2.75c.; blue annealed sheets, 3.10c.; black sheets, 4c.; galvanized sheets, 5c.; tin plate, \$6.25; plain wire, 3c.; wire nails, \$3.25; standard steel pipe, 62½ per cent basing discount.

New seamless tube prices have been announced by the

National Tube Co., representing a reduction of about \$20 a ton from the Industrial Board schedule. At the same time there is a reversion to the system of quoting discounts from list, the Government price control having started a new system, that of quoting per net ton. Discounts are: 1-in., 56 per cent; 1½-in., 49 per cent; 1½-in., 48 per cent; 1¾-in., 25 per cent; 2 to 2½-in., 17½ per cent; 2¾ to 4-in., 20 per cent; 4½ and 5-in., 7½ per cent, on cold-finished seamless tubes.

MANUFACTURED PRODUCTS

New prices have been made by steel mills or others on various manufactured steel products, and the following prices may now be quoted: Standard railroad spikes, 3.30c.; ½-, ⅞- and 1-in., 3.65c.; 1½-in., 4.25c.; boat and barge spikes, 3.85c.; track bolts, 4.50c.; chain, 6.35c., base, for 1-in. proof coil; button-head structural rivets, 3.50c.; cone-head boiler rivets, 3.60c.; cold-finished steel bars, 3.10c.; cold-rolled strip, 5.50c.

Prices of manufactured steel products in general show larger percentage spreads above the mill prices of the hot-rolled material from which they are made than obtained before the war. Thus, if the disposition of the ultimate consumer to make purchases is to be gaged by the price, which usually is not precisely the case, comparison should be made of the prices of the manufactured products rather than of the mill prices for the intermediate material. For illustration, comparing present prices with average prices in the five years 1909 to 1913 inclusive, bars at 2.10c. are up 58 per cent, while standard railroad spikes at 3.30c. are up 104 per cent.

BUYING LIGHT

New buying in steel products has been very light since the market got on the stabilized and equalized basis. It is understood that the independents gathered up a very fair volume of business as they were withdrawing their extreme prices, as of course they were willing to accept orders if the buyer would act at once. This will probably give the independents a better operation for the next two or three weeks than they have had. Their average rate early in April was about 35 per cent of capacity, against about 32 per cent in March and 30 per cent in February and January.

The Steel Corporation is receiving slightly more business than formerly in releases against suspended orders and in specifications against old contracts, now that it has reduced its prices, as of course the reduction applies to unexecuted obligations. Last week and this the corporation's operations as a whole have averaged about 40 per cent of capacity or a shade less, there having been a continued decline from the rate of 90 per cent shown for January. Corporation operations have probably rounded the turn, and may mount to 50 per cent within a few weeks.

PIG IRON AND COKE

The pig iron market continues to exhibit an almost complete apathy on the part of buyers. Indeed, the only inquiry of any consequence for any grade is a single inquiry for 10,000 tons of basic, for the United Alloy Steel Co., Canton, Ohio, and doubts are entertained whether any considerable tonnage will really be bought at this time against the inquiry. The market remains quotable at prices formerly developed, \$25 for bessemer, foundry and malleable and \$23 for basic, f.o.b. valley furnaces, freight to Pittsburgh being \$1.96. Consumption of merchant iron is at a very low rate and production is at a still lower rate, but there are stocks of considerable magnitude in the aggregate still to be absorbed before the market is equalized as between the buying power of the consumer and the production cost of the merchant furnaces. The furnaces can now have no complaint as to the cost of coke, in this general matter of deflation of costs and selling prices, since recent sales of Connellsville furnace coke at \$3.50 have been followed by some small sales at \$3.30 per net ton at ovens. The high freight rates remain, putting a great burden on furnaces in assembling about four tons of material per ton of pig iron made.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
	\$0.13 -	\$0.13 ½	\$0.40 -	\$0.45
Acetic anhydride.....lb.			.13 ½	.14
Acetone.....lb.	2.50 -	2.75	3.00 -	3.25
Acid, acetic, 28 per cent.....100 lbs.	4.00 -	4.25	4.50 -	5.50
Acetic, 56 per cent.....100 lbs.				
Acetic, glacial, 99 ½ per cent, carboys, 100 lbs.	9.50 -	9.75	10.00 -	10.50
Boric, crystals.....lb.	.13 ½	.14	.14 ½	.15
Boric, powder.....lb.	.15 -	.15 ½	.16 -	.16 ½
Citric.....lb.			.47 -	.50
Hydrochloric.....100 lb.	1.50 -	1.65	1.75 -	2.00
Hydrofluoric, 52 per cent.....lb.	.13 -	.13 ½	.14 -	.14 ½
Lactic, 44 per cent tech.....lb.	.10 -	.11	.11 ½	.12
Lactic, 22 per cent tech.....lb.	.04 ½	.05 ½	.06 -	.07
Molybdic, C. P.....lb.	4.00 -	4.50	4.50 -	5.00
Muriatic, 20 deg. (see hydrochloric).....				
Nitric, 40 deg.....lb.	.06 ½	.06 ¾	.07 -	.07 ½
Nitric, 42 deg.....lb.	.07 ½	.07 ¾	.07 ¾	.08 ½
Oxalic, crystals.....lb.	.17 -	.18	.18 ½	.20
Phosphoric, Ortho, 50 per cent solution.....lb.	.17 -	.17 ½	.18 -	.19
Picric.....lb.	.30 -	.32	.35 -	.40
Pyrogallol, resublimed.....lb.			1.90 -	2.15
Sulphuric, 60 deg., tank cars.....ton			14.00 -	15.00
Sulphuric, 60 deg., drums.....ton				
Sulphuric, 66 deg., tank cars.....ton	19.00 -	20.00		
Sulphuric, 66 deg., drums.....ton	22.00 -	22.50	23.00 -	23.50
Sulphuric, 66 deg., carboys.....ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 -	24.00		
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 -	26.00	26.50 -	27.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 -	35.00	40.00 -	
Tannic, U. S. P.....lb.			1.00 -	1.10
Tannic (tech.).....lb.	.50 -	.52	.54 -	.57
Tartaric, crystals.....lb.			.35 -	.39
Tungstic, per lb. of WO.....lb.			1.30 -	1.40
Alcohol, Ethyl.....gal.			4.90 -	5.25
Alcohol, Methyl (see methanol).....gal.				
Alcohol, denatured, 188 proof.....gal.			.36 -	.40
Alcohol, denatured, 190 proof.....gal.			.40 -	.45
Alum, ammonia lump.....lb.	.04 -	.04 ½	.04 ½	.04 ¾
Alum, potash lump.....lb.	.05 -	.05 ½	.05 ½	.06 ½
Alum, chrome lump.....lb.	.13 -	.13 ½	.14 -	.14 ½
Aluminum sulphate, commercial.....lb.	.02 ½	.02 ¾	.03 -	.03 ½
Aluminum sulphate, iron free.....lb.	.03 ½	.03 ¾	.03 ¾	.04 ½
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07 -	.07 ½	.07 ½	.08
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 -	.32	.33 -	.35
Ammonium carbonate, powder.....lb.	.07 ½	.08	.08 ½	.10
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	.06 ½	.06 ¾	.07 -	.07 ½
Ammonium chloride, granular (gray salamoniac).....lb.	.08 ½	.08 ¾	.09 -	.09 ½
Ammonium nitrate.....lb.	.08 -	.08 ½	.09 -	.10
Ammonium sulphate.....100 lb.	2.75 -	2.85	2.90 -	3.00
Amylacetate.....gal.			4.00 -	4.25
Amylacetate tech.....gal.			3.00 -	3.25
Arsenic oxide, (white arsenic) powdered lb.	.07 ½	.08	.08 ½	.09
Arsenic, sulphide, powdered (red arsenic) lb.	.12 -	.12 ½	.13 -	.14
Barium chloride.....ton	60.00 -	65.00	70.00 -	75.00
Barium dioxide (peroxide).....ton	.19 -	.20	.21 -	.22
Barium nitrate.....lb.	.11 -	.11 ½	.12 -	.12 ½
Barium sulphate (precip.) (blanc fixe).....lb.	.04 ½	.05	.05 ½	.06
Bleaching powder (see calc. hypochlorite).....				
Blue vitriol (see copper sulphate).....				
Borax (see sodium borate).....				
Brimstone (see sulphur, roll).....				
Bromine.....lb.	.40 -	.41	.42 -	.45
Calcium acetate.....100 lbs.	1.75 -	2.00		
Calcium carbide.....lb.	.04 ½	.04 ¾	.05 -	.05 ½
Calcium chloride, fused, lump.....ton	27.00 -	29.00	30.00 -	32.00
Calcium chloride, granulated.....lb.	.01 ½	.01 ¾	.02 -	.02 ½
Calcium hypochlorite (bleach powder) 100 lb.	2.55 -	2.65	2.75 -	3.00
Calcium peroxide.....lb.			1.25 -	1.50
Calcium phosphate, tribasic.....lb.			.15 -	.16
Camphor.....lb.			.63 -	.65
Carbon bisulphide.....lb.	.07 -	.07 ½	.07 -	.08
Carbon tetrachloride, drums.....lb.	.10 -	.10 ½	.11 -	.12
Carbonyl chloride (phosgene).....lb.			.75 -	1.00
Caustic potash (see potassium hydroxide).....				
Caustic soda (see sodium hydroxide).....				
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08 -	.09	.09 ½	.10
Chloroform.....lb.			.38 -	.40
Cobalt oxide.....lb.			3.00 -	3.10
Copperas (see iron sulphate).....				
Copper carbonate, green precipitate.....lb.	.23 -	.24	.25 -	.27
Copper cyanide.....lb.			.50 -	.62
Copper sulphate, crystals.....lb.	.05 -	.05 ½	.06 -	.06 ½
Cream of tartar (see potassium bitartrate).....				
Epsom salt (see magnesium sulphate).....				
Ethyl Acetate (Conc. 85°).....gal.			.90 -	1.00
Ethyl Acetate pure (acetic ether 98° to 100°).....gal.				
Formaldehyde, 40 per cent.....lb.	.14 -	.14 ½	.14 ½	.15
Fusel oil, ref.....gal.			3.25 -	3.50
Fusel oil, crude.....gal.			1.75 -	2.00
Glauber's salt (see sodium sulphate).....				
Glycerine, C. P. drums extra.....			.16 ½	.17 ½
Iodine, resublimed.....lb.			3.75 -	3.85
Iron oxide, red.....			.10 -	.20
Iron sulphate (copperas).....100 lb.	.75 -	1.00	1.10 -	1.25
Lead acetate.....lb.			.11 -	.13
Lead arsenate, paste.....lb.	.83 -	.09	.09 ½	.10
Lead nitrate.....lb.			.15 -	.20
Litharge.....lb.	.08 -	.09	.09 ½	.10
Lithium carbonate.....lb.			1.25 -	
Magnesium carbonate, technical.....lb.	.10 ½	.11	.11 ½	.12
Magnesium sulphate, U. S. P.....100 lb.	2.75 -	3.00		
Magnesium sulphate, technical.....100 lb.			1.40 -	2.25
Methanol, 95°.....gal.			.75 -	.77
Methanol, 97°.....gal.			.78 -	.82
Nickel salt, double.....lb.			.13 -	.1 ½
Nickel salt, single.....lb.			.14 -	.1 ½
Phosgene (see carbonyl chloride).....				
Phosphorus, red.....lb.	.45 -	.46	.47 -	.50
Phosphorus, yellow.....lb.			.35 -	.37
Potassium bichromate.....lb.	.12 -	.12 ½	.12 ½	.13

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$.35 — .40	\$0.30 — \$0.35
Potassium bromide, granular..... lb.	.35 — .40	.20 — .40
Potassium carbonate, U. S. P..... lb.	.06½ — .07	.08 — .09
Potassium carbonate, crude..... lb.	.08 — .09	.10 — .14
Potassium chlorate, crystals..... lb.	.07 — .07½	.32 — .35
Potassium cyanide..... lb.	52.00 — 55.00	.08 — .10
Potassium hydroxide (caustic potash)..... lb.	.09½ — .09½	2.75 — 3.00
Potassium iodide..... lb.	.35 — .37	.10 — .12½
Potassium nitrate..... lb.	.35 — .37	.39 — .40
Potassium permanganate..... lb.	.35 — .37	.38 — .40
Potassium prussiate, red..... lb.	.26 — .27	.28 — .29
Potassium prussiate, yellow..... lb.	—	1.75 — 1.80
Potassium sulphate (powdered)..... per unit	—	—
Rochelle salts (see sodium potas tartrate)	—	—
Salammoniac (see ammonium chloride)	—	—
Sal soda (see sodium carbonate)	—	—
Salt cake..... ton	—	33.00 — 35.00
Silver cyanide..... oz.	—	1.30 — 1.35
Silver nitrate..... oz.	—	.39 — .40
Soda ash, light..... 100 lb.	2.10 — 2.20	2.25 — 2.50
Soda ash, dense..... 100 lb.	2.35 — 2.40	2.50 — 2.60
Sodium acetate..... lb.	.04½ — .05	.05½ — .06
Sodium bicarbonate..... 100 lb.	2.50 — 2.60	2.70 — 3.00
Sodium bichromate..... lb.	.07½ — .08	.08½ — .08½
Sodium bisulphate (nitre cake)..... ton	5.00 — 5.25	5.50 — 6.50
Sodium bisulphite powdered, U.S.P..... lb.	.05½ — .05½	.05½ — .06½
Sodium borate (borax)..... lb.	.06½ — .06½	.07 — .07½
Sodium carbonate (sal soda)..... 100 lb.	1.90 — 2.00	2.25 — 2.50
Sodium chlorate..... lb.	.08½ — .09	.09½ — .10
Sodium cyanide, 96-98 per cent..... lb.	.19 — .20	.21 — .30
Sodium fluoride..... lb.	.12 — .12½	.13 — .14
Sodium hydroxide (caustic soda)..... 100 lb.	3.65 — 3.75	3.80 — 4.00
Sodium hyposulphite..... lb.	—	.03½ — .04
Sodium nitrate..... 100 lb.	2.60 —	2.75 —
Sodium nitrite..... lb.	.55 — .06	.06½ — .07
Sodium peroxide, powdered..... lb.	.25 — .26	.27 — .30
Sodium phosphate, dibasic..... lb.	.04½ — .04½	.05 — .05½
Sodium potassium tartrate (Rochelle salts)..... lb.	.11½ — .11½	.12 — .12½
Sodium prussiate, yellow..... lb.	1.25 — 1.35	1.40 — 1.50
Sodium silicate, solution (40 deg.)..... lb.	.02½ — .03	.03½ — .03½
Sodium silicate, solution (60 deg.)..... lb.	1.50 — 1.75	2.00 — 2.25
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	.05½ — .05½	.06 — .06½
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.03½ — .04	.04½ — .04½
Sodium sulphite, crystals..... lb.	.16 — .16½	.17 — .18
Strontium nitrate, powdered..... lb.	.07 — .07½	.07½ — .08
Sulphur chloride, red..... ton	20.00 — 22.00	—
Sulphur, crude..... lb.	.08 — .08½	.09 — .10
Sulphur dioxide, liquid, cylinders extra..... lb.	—	2.25 — 3.10
Sulphur (sublimed), flour..... 100 lb.	—	2.00 — 2.75
Sulphur, roll (brimstone)..... 100 lb.	—	—
Tin bichloride, 50 per cent..... lb.	.18 — .19	.40 — .42
Tin oxide..... lb.	.16 — .18	.19 — .20
Zinc carbonate, precipitate..... lb.	.11 — .11½	.11½ — .12
Zinc chloride, gran..... lb.	.45 — .49	.50 — .60
Zinc cyanide..... lb.	.12 — .13	.13½ — .14
Zinc dust..... lb.	.08½ — .09	.09½ — .10
Zinc oxide, XX..... lb.	.03½ — .03½	.04 — .05
Zinc sulphate..... lb.	—	—

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.15 — \$1.25
Alpha-naphthol, refined..... lb.	1.45 — 1.50
Alpha-naphthylamine..... lb.	.38 — .40
Aniline oil, drums extra..... lb.	.19 — .26
Aniline salts..... lb.	.26 — .29
Anthracene, 80% in drums (100 lb.)..... lb.	.75 — 1.00
Benzaldehyde U.S.P..... lb.	1.00 — 1.50
Benzidine, base..... lb.	.90 — 1.00
Benzidine sulphate..... lb.	.75 — .80
Benzoic acid, U.S.P..... lb.	.65 — .70
Benzoate of soda, U.S.P..... lb.	.65 — .70
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 — .28
Benzyl chloride, 95-97%, refined..... lb.	.28 — .30
Benzyl chloride, tech..... lb.	.25 — .27
Beta-naphthol benzoate..... lb.	3.50 — 4.00
Beta-naphthol, sublimed..... lb.	.70 — .75
Beta-naphthol, tech..... lb.	.33 — .45
Beta-naphthylamine, sublimed..... lb.	2.25 — 2.40
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)..... lb.	.25 — .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.90 — .95
Cresylic acid, 95-97%, dark, in drums..... gal.	.85 — .90
Cresylic acid, 50%, first quality, drums..... gal.	.55 — .60
Dichlorobenzene..... lb.	.06 — .09
Diethylaniline..... lb.	1.20 — 1.25
Dimethylaniline..... lb.	.44 — .55
Dinitrobenzene..... lb.	.32 — .35
Dinitrochlorobenzene..... lb.	.20 — .30
Dinitronaphthalene..... lb.	.30 — .40
Dinitrophenol..... lb.	.35 — .40
Dinitrotoluene..... lb.	.25 — .27
Dip oil, 25%, tar acids, car lots, in drums..... gal.	.40 — .45
Diphenylamine..... lb.	.60 — .70
H-acid..... lb.	1.30 — 1.50
Meta-phenylenediamine..... lb.	1.20 — 1.25
Monochlorobenzene..... lb.	.14 — .16
Monoethylaniline..... lb.	1.75 — 1.85
Naphthalene crushed, in bbls. (250 lb.)..... lb.	.08 — .08½
Naphthalene, flake..... lb.	.08½ — .09½
Naphthalene, balls..... lb.	.09½ — .10½
Naphthionic acid, crude..... lb.	.70 — .75
Nitrobenzene..... lb.	.12 — .15
Nitro-naphthalene..... lb.	.30 — .35
Nitro-toluene..... lb.	.16 — .18
Ortho-amidophenol..... lb.	3.20 — 3.75
Ortho-dichlor-benzene..... lb.	.15 — .20
Ortho-nitro-phenol..... lb.	.75 — .80
Ortho-nitro-toluene..... lb.	.17 — .20
Ortho-toluidine..... lb.	.20 — .25
Para-amidophenol, base..... lb.	1.75 — 1.85
Para-amidophenol, HCl..... lb.	2.00 — 2.10

Para-dichlorobenzene..... lb.	.15 — .20
Paranitroaniline..... lb.	.90 — 1.05
Para-nitrotoluene..... lb.	.85 — 1.00
Para-phenylenediamine..... lb.	1.95 — 2.00
Para-toluidine..... lb.	1.25 — 1.60
Phthalic anhydride..... lb.	.50 — .60
Phenol, U. S. P., drums (dest.), (240 lb.)..... lb.	.11 — .13
Pyridine..... gal.	2.00 — 3.50
Resorcinol, technical..... lb.	1.75 — 1.85
Resorcinol, pure..... lb.	2.25 — 2.30
Salicylic acid, tech., in bbls. (110 lb.)..... lb.	.22 — .23
Salicylic acid, U. S. P..... lb.	.21 — .22
Salol..... lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 — .16
Sulphanilic acid, crude..... lb.	.30 — .35
Tolidine..... lb.	1.35 — 1.45
Toluidine, mixed..... lb.	.40 — .45
Toluene, in tank cars..... gal.	.25 — .28
Toluene, in drums..... gal.	.28 — .31
Xylidines, drums, 100 gal..... lb.	.40 — .45
Xylene, pure, in drums..... gal.	.42 — .45
Xylene, pure, in tank cars..... gal.	.45 — .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 — .35
Xylene, commercial, in tank cars..... gal.	.30 — .35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.23 — \$0.25
Beeswax, refined, light..... lb.	.25 — .27
Beeswax, white pure..... lb.	.40 — .45
Carnauba, Florida..... lb.	.66 — .68
Carnauba, No. 2, North Country..... lb.	.30 — .32
Carnauba, No. 3, North Country..... lb.	.18 — .19
Japan..... lb.	.18 — .19½
Montan, crude..... lb.	.07 — .08
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.04 — .04½
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.03½ — .04
Paraffine waxes, refined, 118-120 m.p..... lb.	.04 — .04½
Paraffine waxes, refined, 125 m.p..... lb.	.04½ — .04½
Paraffine waxes, refined, 128-130 m.p..... lb.	.05½ — .06
Paraffine waxes, refined, 133-135 m.p..... lb.	.06 — .06½
Paraffine waxes, refined, 135-137 m.p..... lb.	.06½ — .06½
Stearic acid, single pressed..... lb.	.11 — .11½
Stearic acid, double pressed..... lb.	.11½ — .12
Stearic acid, triple pressed..... lb.	.12 — .12½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.00 —
Rosin E-I..... 280 lb.	5.25 —
Rosin K-N..... 280 lb.	5.75 —
Rosin W. G.-W. W..... 280 lb.	6.25 —
Wood rosin, bbl..... 280 lb.	6.25 —
Spirits of turpentine..... gal.	.63 —
Wood turpentine steam dist..... gal.	.62 —
Wood turpentine, dest. dist..... gal.	.60 —
Pine tar pitch, bbl..... 200 lb.	— 7.00
Tar, kiln burned, bbl. (500 lb.)..... bbl.	— 13.00
Retort tar, bbl..... 500 lb.	13.00 — 13.00
Rosin oil, first run..... gal.	.40 —
Rosin oil, second run..... gal.	.43 —
Rosin oil, third run..... gal.	.45 —
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.70 —
Pine oil, pure, dest. dist..... gal.	1.60 —
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.48 —
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 —
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 —
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.36 —
Turpentine, crude, sp. gr. 0.900-0.970..... gal.	1.20 —
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.37 —
Pinewood creosote, ref..... gal.	.55 —

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41 —
70-72 deg., steel bbls. (85 lb.)..... gal.	.39 —
68-70 deg., steel bbls. (85 lb.)..... gal.	.38 —
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30 —

Crude Rubber

Para-Upriver fine..... lb.	\$0.17 — \$0.18
Upriver coarse..... lb.	.11½ — .12½
Upriver cauchol ball..... lb.	.14 — .14½
Plantation—First latex crepe..... lb.	.18½ —
Ribbed smoked sheets..... lb.	.16½ —
Brown crepe, thin, clean..... lb.	.18 —
Amber crepe No. 1..... lb.	.20 —

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.08½ — \$0.09½
Castor oil, AA, in bbls..... lb.	.09 — .10
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.09½ — .09½
Cocoonut oil, Ceylon grade, in bbls..... lb.	.10 — .10½
Cocoonut oil, Cochinchina grade, in bbls..... lb.	.10½ — .11
Corn oil, crude, in bbls..... lb.	.07½ — .08
Cottonseed oil, crude (f. o. b. mill)..... lb.	.04 — .04½
Cottonseed oil, summer yellow..... lb.	.06½ — .06½
Cottonseed oil, winter yellow..... lb.	.07 —
Linseed oil, raw, car lots (domestic)..... gal.	.60 — .61
Linseed oil, raw, tank cars (domestic)..... gal.	.53 —
Linseed oil, in 5-bbl lots (domestic)..... gal.	.63 — .65

Olive oil, Denatured.....	gal	\$1 40	—	\$1 70
Palm, Lagos.....	lb.	.07	—	.07½
Palm, Niger.....	lb.	.05½	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.05½	—	.05½
Peanut oil, refined, in bbls.....	lb.	.10	—	.10½
Rapeseed oil, refined in bbls.....	gal.	.88	—	.90
Rapeseed oil, blown, in bbls.....	gal.	1.00	—	1.05
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07½	—	.07½
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.04½	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.42	—	\$0.43
Yellow bleached menhaden.....	gal.	.45	—	.....
White bleached menhaden.....	gal.	.48	—	.....
Blown menhaden.....	gal.	.80	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	.....
Blanc fixe, dry.....	lb.	.05	—	.05½
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.16
Chalk, domestic, extra light.....	lb.	.05	—	.05½
Chalk, domestic, light.....	lb.	.04½	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04½	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	25.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07½	—	.08
Graphite, Ceylon chip.....	lb.	.06	—	.06½
Graphite, high grade amorphous crude.....	lb.	.02½	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.57	—	.....
Shellac, orange superfine.....	lb.	.60	—	.....
Shellac, A. C. garnet.....	lb.	.45	—	.....
Shellac, T. N.....	lb.	.45	—	.....
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	14.00	—	15.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	35.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	
Carborundum refractory brick, 9-in.	1,000	1250.00	less than carlot
Chrome brick, f.o.b. Eastern shipping points.....	1,000	1100.00	carload lots
Chrome cement, 40-45% Cr ₂ O ₃	net ton	80-100	
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	45-50	
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	
Magnesite brick, 9-in. straight.....	net ton	90	
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105	
Magnesite brick, soaps and splits.....	net ton	120	
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	45-55	
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	45-55	
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	45-55	

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.15	—	.16
Ferrochrome per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.16	—	.17
Ferromanganese, 76-80% Mn, domestic.....	gross ton	85.00	—	90.00
Ferromanganese, 76-80% Mn, English.....	gross ton	85.00	—	90.00
Spiegeleisen, 18-22% Mn.....	gross ton	32.00	—	35.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50	—	.....
Ferrosilicon, 10-15%.....	gross ton	50.00	—	55.00
Ferrosilicon, 50%.....	gross ton	80.00	—	85.00
Ferrosilicon, 75%.....	gross ton	145.00	—	150.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45	—	.50
Ferrouranium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	.....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00	—	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.45	—	.50
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.45	—	.50
Coke, foundry, f.o.b. ovens.....	net ton	4.50	—	5.50
Coke, furnace, f.o.b. ovens.....	net ton	3.50	—	4.25
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00	—	16.00
Fluorspar, lump, f.o.b. Heathden, New Mexico.....	net ton	17.50	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.50
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.30	—	.35
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.14	—	.15
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.14	—	.15
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.13
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	—	3.25
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	.....
Zircon, washed, iron free.....	lb.	.03	—	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.75
Aluminum, 98 to 99 per cent.....	28.00 @ 28.5
Antimony, wholesale lots, Chinese and Japanese.....	5½ @ 5½
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	.35
Monel metal ingots.....	.38
Monel metal, sheet bars.....	.40
Tin, 5-ton lots, Straits.....	30.75
Lead, New York, spot.....	4.25 @ 4.35
Lead, E. St. Louis, spot.....	4.20
Zinc, spot, New York.....	5.10
Zinc, spot, E. St. Louis.....	4.60

OTHER METALS

Silver (commercial).....	oz.	\$0.60½
Cadmium.....	lb.	1.00-1.10
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.65
Cobalt.....	lb.	4.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00-75.00
Iridium.....	oz.	250.00 @ 300.00
Palladium.....	oz.	65.00 @ 70.00
Mercury.....	75 lb.	44.00-45.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	20.50-20.75
Copper bottoms.....	28.00-28.25
Copper rods.....	19.25-20.00
High brass wire.....	18.25
High brass rods.....	15.25
Low brass wire.....	20.25
Low brass rods.....	20.25
Brazed brass tubing.....	29.00
Brazed bronze tubing.....	34.25
Seamless copper tubing.....	22.00
Seamless high brass tubing.....	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	8.50 @ 9.00	18.50	10.00	10.50
Copper, heavy and wire.....	8.00 @ 8.25	16.50	9.50	9.50
Copper, light and bottoms.....	7.00 @ 7.50	14.50	9.00	8.50
Lead, heavy.....	3.25 @ 3.50	7.25	4.00	4.00
Lead, tea.....	2.15 @ 2.30	5.25	3.00	3.00
Brass, heavy.....	4.25 @ 4.50	9.50	7.00	10.00
Brass, light.....	3.00 @ 3.25	8.00	5.00	5.50
No. 1 yellow brass turnings.....	4.00 @ 4.25	9.50	5.50	6.00
Zinc.....	2.00 @ 2.50	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.50	\$3.23	\$3.23
Soft steel bars.....	2.50	3.00	3.13
Soft steel bar shapes.....	2.50	3.13	3.13
Soft steel bands.....	2.85	3.83	3.83
Plates ½ to 1 in. thick.....	2.50	3.30	3.30

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

LITTLE ROCK—The Arkansas Producing & Refining Co., Gazette Bldg., has plans under way for the erection of a new oil refinery in the vicinity of El Dorado, Ark., to have an initial capacity of about 3,000 bbl. The plant will comprise a large tankage system, both for run-down and storage service, with pipe lines extending to the company's wells, about 5 miles distant. The new plant is estimated to cost in excess of \$125,000. The company is capitalized at \$350,000. George A. Sonricker, El Dorado, is engineer for the project.

Connecticut

SOUTH MANCHESTER—The Rogers Paper Mfg. Co. is planning for the rebuilding of the portion of its plant destroyed by fire, April 14, caused by an explosion.

Delaware

WILMINGTON—The Electric Hose & Rubber Co., 12th St., manufacturer of rubber hose, has awarded a contract to John E. Healy & Sons, 707 Tatnall St., for the erection of a 1-story addition, 57 x 90 ft., to be equipped as a pressing department. C. D. Garretson is general manager.

Florida

MIAMI—The Moore Haven Sugar Corp. has awarded a contract to the L. R. Steel Corp., Atlanta, Ga., for extensions and improvements in its mills at Moore Haven. A large part of the plant will be remodeled and considerable machinery installed. The present work is estimated to cost about \$350,000, and will be supplemented by other improvements and additions at a later date to cost a like sum. John C. Grambling is secretary and treasurer.

BUNNELL—The Pidcock-Roberts Co., recently organized, is planning for the development of ocher and sienna properties in this section. It is proposed to install a complete washing plant and other operating machinery. J. N. Pidcock is president, and D. B. Roberts secretary-treasurer and general manager.

Illinois

CHICAGO—The Scientific Oil Co. plans the erection of a \$10,000 building at 1645 South Kilbourne Ave. as addition to existing plant.

Indiana

INDIANAPOLIS—The Henry Furnace & Foundry Co., 915 North Davidson St., has preliminary plans under way for the erection of a new 1- and 2-story plant on Massachusetts Ave., to cost about \$100,000. It is expected to call for bids some time in June.

RUSHVILLE—The Dill Foundry Co. is arranging plans for a 3-story plant addition, 40 x 100 ft., estimated to cost about \$40,000. William Dill is secretary and treasurer.

Louisiana

ST. ROSE—The Petroleum Export & Import Co. has awarded a contract to H. P. Farnsworth, St. Charles St., New Orleans, La., for the erection of a number of new buildings for its oil works. Five buildings will be erected, including a barrel-filling plant, 60 x 250 ft.; canning plant, 60 x 175 ft.; power plant, 40 x 70 ft.; pumping plant, 60 x 90 ft., and boiler plant. The company is a subsidiary of the Carson Oil Co., 29 South La Salle St., Chicago, Ill., of which Edward B. Carson is president.

MARRERO—The J. S. Long Co., manufacturer of soap products, is planning for the rebuilding of the portion of its plant, recently destroyed by fire with loss estimated at about \$100,000 including machinery.

Maryland

HAGERSTOWN—The Maryland Fiber Products Co., recently incorporated with a

capital of \$150,000, is planning the establishment of a local plant for the manufacture of fiber specialties, including boxes containers, etc. Mark H. Landis, manager of the Landis Engineering & Mfg. Co., Ringgold St., Waynesboro, Pa., is head of the new company. Richard G. Stevenson and Thomas M. Cunningham, Hagerstown, are directors.

CUMBERLAND—The Potomac Glass Mfg. Co., is planning for the rebuilding of the portion of its plant, recently damaged by fire.

BALTIMORE—The American Sugar Refining Co., 117 Wall St., New York, is completing plans for two new buildings to be erected at its local refining plant at Woodall and Clement Sts. The structures will comprise a 9-story manufacturing plant, 140 x 320 ft., and 7-story pan house, 80 x 154 ft., both of steel and reinforced concrete. The entire plant is estimated to cost in excess of \$5,000,000.

BALTIMORE—The new paper mill to be erected by the Gwynn's Falls Paper Co., 517 Equitable Bldg., at Gwynn's Falls, will comprise a main 1-story building and a number of smaller structures, estimated to cost about \$250,000 with machinery. The company has recently filed articles of incorporation with a capital of \$600,000. George W. Davis is head. Joseph H. Wallace, 5 Beekman St., New York, is engineer for the project.

Massachusetts

WALTHAM—The O'Hara Waltham Dial Co., Rumford Ave., has broken ground for the erection of the proposed 1-story addition to its watch dial manufacturing plant, 50 x 65 ft., to cost about \$15,000. L. J. Geoffrion, 12 Howard St., has the building contract. Eliot O'Hara is head.

New Jersey

NEWARK—The Paragon Tannery Co., a new organization, has leased a portion of the plant of the Universal Caster & Foundry Co., 106-26 Adams St., near Ferry St., totaling about 35,000 sq. ft. of space, for the establishment of a new tanning plant for shoe and glove leather. Possession will be taken at once and it is proposed to have the plant ready for service at an early date.

JERSEY CITY—The Richard Chemical Co., Warren St., has taken bids for the construction of a 4-story brick addition, 50 x 54 ft., estimated to cost close to \$40,000.

New York

NORTH TONAWANDA—The Earl R. Maltby Co., Ellicott Sq., Buffalo, has awarded a contract to Morris & Allen, Prudential Bldg., Buffalo, for the erection of the first unit of its proposed new plant at North Tonawanda for the manufacture of paper roofing products. The factory will be 1-story, 100 x 130 ft.; construction will be inaugurated at once.

BUFFALO—The Climax Compression Tube Co. of New York, Inc., 200 Cherry St., manufacturer of rubber tubes, etc., is planning the establishment of a new branch plant in this section. Negotiations are under way for the purchase of an existing works, to be equipped immediately for production. To finance the proposed expansion, the company has arranged for a stock issue of \$1,000,000, and a large portion of the proceeds will be used for machinery and equipment. A. L. Case is chairman of the board.

Michigan

DETROIT—The Jeffrey-DeWitt Co., Butler Ave., manufacturer of spark plug porcelain, laboratory porcelain products, etc., is completing plans for the erection of its proposed new 5-story and basement plant at Hamtramck, to be reinforced concrete and estimated to cost about \$200,000 with machinery.

DETROIT—The General Spring & Wire Co., 1930 Marston Ave., will take bids about the middle of May for the erection of a new 1-story plant, 200 x 250 ft., to cost about \$175,000 with equipment. A power house will also be constructed. C. L. Clerk is secretary, Edward D. Shank,

38 South Dearborn St., Chicago, Ill., is architect.

Ohio

NORWALK—The Pioneer Rubber Co. has completed plans for the erection of its proposed new 2-story and basement plant, 40 x 80 ft., estimated to cost about \$30,000. B. G. Smith is head.

TOLEDO—The Standard Oil Co. has completed the erection of its new Bay Shore refinery and production has been inaugurated. The plant consists of a total of 100 stills and the different units will be placed in service as fast as possible. The plant represents an investment of close to \$15,000,000.

COLUMBUS—The Board of Trustees, Ohio State University, is taking bids up to May 3 for the erection of a 1-story addition to the chemistry building, to 205 x 298 ft., and estimated to cost about \$275,000. Joseph N. Bradford, Brown Hall, State University Campus, is supervising architect.

Pennsylvania

CHARLEROI—The Electric Alloy Steel Co., manufacturer of high-speed tool steel, is completing the installation of a new electric furnace, giving the plant two 6-ton electric furnaces and one crucible furnace with an aggregate capacity of 55 tons every 24 hours. Plans are under way for the installation of another 3-ton electric furnace at a later date.

MARCUS HOOK—The Union Petroleum Co., 17 Battery Pl., New York, is reported to have plans under way for the erection of the initial units of its proposed new oil refinery on property at Marcus Hook, recently acquired. The site totals about 200 acres of land. The entire plant is estimated to cost in excess of \$5,000,000. The company is a subsidiary of the Sinclair Consolidated Oil Co., 120 B'way.

MACUNGIE, PA.—J. G. Wiedner, manufacturer of paper boxes and containers, is said to be planning for the erection of an addition to his plant, with the installation of new machinery.

Texas

SAN ANTONIO—The International Petroleum Co. has commenced work on the completion of its new local oil refinery, and plans for occupancy and operation at an early date. A. A. Ash is secretary.

HOUSTON—The Madison Coal & Oil Co., recently organized with a capital of \$3,000,000, has plans under way for the erection of a new plant in the vicinity of Navasota, Tex., for the manufacture of coal briquets. The plant will include an extensive byproducts department for the production of carbonized briquets, and the recovery of fuel oil, ammonium sulphate, pitch, tar and other chemical products. The initial plant will have a capacity of about 30 tons of briquets per hour. David M. Duller, Houston, is engineer for the company.

FORT WORTH—The Fort Worth Envelope Co., 610 West Daggett St., recently organized, has plans under way for the installation of new machinery in a local plant building for the manufacture of envelopes and other paper specialties. It is proposed to develop an output of about 250,000 envelopes per day. John A. Stafford is president, and W. C. Lowden secretary.

SOUTH BEND—The Graham Oil & Refining Co., Graham, Tex., has commenced the erection of its proposed new gasoline refinery at South Bend, and plans to have the plant ready for service at an early date. It will have an initial capacity of 1,000 bbl.

DALLAS—The Trinity Paper Mill has preliminary plans under way for the erection of a new paper pulp mill in the vicinity of McKinney, Tex. The company recently acquired the plant of the Collins County Mill & Elevator Co., near McKinney.

Virginia

RICHMOND—The Jerry Bros. Belting Co., 1823 East Main St., manufacturer of leather belting, has plans completed for the erection of an addition to its plant to cost about \$25,000. Considerable machinery will be installed, including trimming and finishing machines, presses, etc. George Gassman is manager.

West Virginia

MORGANTOWN—The United States Sheet & Window Glass Co. is reported to be planning for extensions in its local plant, to include the installation of new machinery. The company recently filed articles of incorporation with a capital of \$4,000,000. Walter A. Jones is head.

Capital Increases, Etc.

THE ROCKWOOD SILICA Co., Rockwood, Mich., has filed notice of increase in capital from \$250,000 to \$375,000.

THE SARGENT PAINT Co., Indianapolis, Ind., has filed notice of change of name to the Sargent-Gerke Co.

THE EMPIRE PAINT Co., Indianapolis, Ind., has filed notice of change of name to the Sargent-Gerke Co.

THE EMPIRE ORNAMENTAL GLASS Co., 437 Washington St., New York, N. Y., has filed notice of increase in capital from \$15,000 to \$50,000.

THE BELLEVILLE COMMERCIAL FOUNDRY Co., Belleville, Ill., has filed notice of increase in capital from \$25,000 to \$60,000.

THE D. & C. OIL Co., Bridgeport, Conn., has filed notice of increase in capital to \$50,000.

THE NEW ERA PROCESS CORK Co., New York, N. Y., has filed notice of increase in capital from \$500,000 to \$750,000.

THE COSMUS CHEMICAL Co., Muncie, Ind., has filed notice of dissolution under state laws.

THE WOLVERINE GLASS Co., Saginaw, Mich., has filed notice of increase in capital from \$125,000 to \$150,000.

THE PACIFIC BONE & FERTILIZER Co., American National Bank Bldg., San Francisco, Cal., has filed notice of increase in capital to \$300,000.

New Companies

THE FEDERAL LIGHT & REFINING Co., Newark, N. J., has been incorporated with a capital of \$200,000 to manufacture gas mantles and kindred products. The incorporators are Clarence B. White, Ambrose J. Walsh and James H. Kriek, 122 Commerce St.

THE CONCORD SMELTING & REFINING Co., Boston, Mass., has been incorporated with a capital of \$50,000 to manufacture refined metal products. The incorporators are Samuel Friedman, Boston; Bernard M. Edinberg, Roxbury, Mass. and Nathan Kositsky, Concord, Mass.

THE ELECTRO CHEMICAL REFINERIES, INC., 29 South La Salle St., Chicago, Ill., has been incorporated with a nominal capital to manufacture chemical products. The incorporators are A. M. Johnson, Burton P. Sears and Kenneth Mullins.

THE LAFAYETTE PAPER Co., New York, N. Y., has been incorporated with a capital of \$20,000 to manufacture paper goods. The incorporators are R. Robins, M. Walach and A. A. Cohen. L. M. Feinberg, 44 Court St., Brooklyn, represents the company.

THE HOLMES CHEMICAL Co., Elizabeth, N. J., has been incorporated with a capital of \$25,000 to manufacture chemicals and chemical byproducts. The incorporators are Herbert E. Manvel, Judson H. Sencindiver, New York; and Irving J. Denton, South Orange, N. J.

THE CHARLES L. RICHARDSON Co., Boston, Mass., has been incorporated with a capital of \$10,000 to manufacture chemical products, drugs, etc. The incorporators are Charles A. Vail, M. T. Allen and C. M. Hollander, 37 Leverett St.

THE LANCASTER MIDWAY OIL Co., Whittier, Cal., has been incorporated with a capital of \$250,000 to manufacture petroleum products. The incorporators are P. H. Porter, Ray Steele and W. E. Dilts, all of Whittier.

THE PAUL RUBBER Co., Salisbury, N. C., has been incorporated with a capital of \$250,000 to manufacture rubber products. The incorporators are M. L. Miller, W. J. Daniel and E. C. Brainard, Salisbury.

THE ANDREW RAGONE Co., New York, N. Y., has been incorporated with a capital of \$100,000 to manufacture paper products. The incorporators are G. J. Russell, D. R. Cavalla and W. A. Wight, 41 Park Row.

THE ELLICOTT PAINT Co., Buffalo, N. Y., has been incorporated with a capital of \$50,000 to manufacture paints, oils, etc. The incorporators are C. H. Nagel, G. G. Allen and E. G. Guenther. Kellogg, Babcock & Sullivan, Buffalo, represent the company.

THE MURPHY-MILES OIL Co., Room 1843, 122 South Michigan Ave., Chicago, Ill., has been incorporated with a capital of \$20,000 to manufacture oil products. The incorporators are Robert P. Longman, Everett Miles and Clement J. Murphy.

THE STORER RUBBER Co., Boston, Mass., has been incorporated with a capital of \$200,000 to manufacture rubber products. Fred E. Storer, 26 Fellsway, West, Somerville, Mass., is president and treasurer; Walter R. Storer and F. E. Barnes are directors.

THE STANDARD PAPER BOX Co., Detroit, Mich., has been organized to manufacture paper boxes and containers. George E. Watson and Edward C. Parker, 888 Delaware St., heads the company.

THE SCHERMULY POLARIZATOR CORP., New York, N. Y., has been incorporated with an active capital of \$20,000 to manufacture coal oil products. The incorporators are J. H. Klein, A. B. Brenner and S. Bachrach. Vanvorst, Marshall & Smith, 25 Broad St., represent the company.

C. S. LITTELL & Co., INC., New York, N. Y., has been incorporated with a capital of \$200,000 to manufacture chemicals and chemical byproducts. The incorporators are C. S. Littell, T. W. Day and C. C. Bruen, Greene & Hurd, 43 Exchange Pl., represent the company.

THE PYRO-REM CHEMICAL Co., 801 West Ninth St., Los Angeles, Cal., has filed notice of organization to manufacture chemical products. John J. Nesom, 125 West Elk St., Glendale, Cal., heads the company.

THE NITRO CHEMICAL Co., Nitro, W. Va., has been incorporated with a capital of \$50,000 to manufacture chemicals and chemical byproducts. The incorporators are W. D. Payne, Berkeley Minor, Jr., and C. P. Miller, Charleston, W. Va.

THE W. J. READY BRICK Co., Richmond, Va., has been incorporated with a capital of \$50,000 to manufacture bricks and other burned clay products. The incorporators are W. J. Ready and W. J. Crump, Richmond.

GEORGE F. BASSETT & Co., East Orange, N. J., has been incorporated with a capital of \$150,000 to manufacture china products. The incorporators are E. Holbrook, William B. and W. Irving Harris, East Orange.

THE SMITH-BEYER PAPER Co., Los Angeles, Cal., has been incorporated with a capital of \$100,000 to manufacture and deal in paper products. The incorporators are W. B. Smith, William Chanin and J. E. Mahon, all of Los Angeles.

RADIATED BEARINGS, INC., 127. North Dearborn St., Chicago, Ill., has been incorporated with a capital of \$100,000 to manufacture steel bearings, etc. The incorporators are A. A. and A. M. McClanahan, and Walter J. Dukes.

THE MACK PAINT PRODUCTS Co., Pittsburgh, Pa., has been incorporated with a capital of \$10,000 to manufacture paints, oils, etc. The incorporators are E. G. and R. L. McNamara, and L. Van Buren, Pittsburgh.

THE HOPEKO SUPPLY CORP., Rochester, N. Y., has been incorporated with a capital of \$100,000 to manufacture refined oil products. The incorporators are A. A. Hopeman, M. W. Hogle and F. S. Gould, Rochester.

THE MINIT PRODUCTS Co., Buffalo, N. Y., has been incorporated with a capital of \$150,000 to manufacture soap and kindred products. The incorporators are C. Whitney, J. Kaufman and A. Fybush.

THE MID-WEST DRUG & CHEMICAL Co., 1539 West Polk St., Chicago, Ill., has been organized to manufacture chemicals, drugs, etc. The company is headed by Louis Schiavone and Peter J. Spingola.

THE VITAMINE Co. OF AMERICA, INC., Jersey City, N. J., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture chemicals and chemical byproducts. The incorporators are Harry C. Hand, Robert M. Gavett and James S. Lindsay, 15 Exchange Pl.

THE WINSTON-SALEM PAINT Co., Greenville, S. C., has been incorporated with a capital of \$10,000 to manufacture and deal in paints, oils, etc. J. L. Carson is president, and J. B. Jenkins secretary and treasurer.

THE RADIUM LABORATORIES, INC., New York, N. Y., has been incorporated with a capital of \$350,000 to manufacture chemicals and chemical byproducts. The incorporators are C. J. Dolan, J. H. Kaesen and A. C. B. McNevin, 31 Nassau St.

THE FERTILIZER CHEMICAL CORP., Fredericksburg, Va., has been incorporated with a capital of \$1,250,000 to manufacture chemicals and affiliated products. The incorporators are Paul H. Brattain and E. W. Black, both of Washington, D. C.

THE ANTHONY OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$250,000 to manufacture petroleum prod-

ucts. The incorporators are C. G. Anthony, H. D. Laughlin and D. M. Sutherland, all of Los Angeles. The company is represented by B. J. Bradner, 911 Wright & Callender Bldg.,

THE NEW MILFORD CHEMICAL Co., New York, N. Y., has been incorporated with a capital of \$50,000 to manufacture chemicals and chemical byproducts. The incorporators are P. Cifini, J. Mazza and F. Balzerini. The company is represented by Ryan, Hefferman & Dawn, 25 West 45th St.

THE STANDARD POURED BRICK Co., Miami, Fla., has been incorporated with a capital of \$100,000 to manufacture cement brick and kindred specialties. The incorporators are L. R. Nordquist and J. L. Holmberg, Miami.

Coming Meetings and Events

AMERICAN ASSOCIATION OF ENGINEERS will hold its seventh annual convention at the Hotel Lafayette, Buffalo, N. Y., on May 9, 10 and 11.

AMERICAN CHEMICAL SOCIETY is holding its sixty-first meeting at Rochester, N. Y., April 26 to 29. Headquarters are at the Hotel Rochester.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17. Headquarters will be at the Congress Hotel.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

AMERICAN WELDING SOCIETY will hold its annual meeting April 27 to 30 in the Engineering Societies Building, New York City.

AMERICAN ZINC INSTITUTE will hold its annual meeting in St. Louis May 9 and 10.

BRITISH IRON AND STEEL INSTITUTE will hold its spring meeting May 5 and 6, at the Institution of Civil Engineers, Great George St., S. W. 1, London, England.

CHAMBER OF COMMERCE OF THE UNITED STATES will hold its ninth annual meeting in Atlantic City April 27, 28 and 29.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-eighth annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., the week beginning June 20.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF INDUSTRIAL ENGINEERS will hold a meeting in Milwaukee April 27 to 29.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month; except June, July, August and September.

TANNERS' COUNCIL OF THE UNITED STATES will hold its annual spring convention at the Hotel Traymore, Atlantic City, May 5 and 6.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

CHEMICAL & METALLURGICAL ENGINEERING

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ALAN G. WIKOFF
R. S. McBRIDE
CHARLES N. HULBURT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

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Number 18

Sunday Clothes

For Chemists' Ideas

THE following is a true story of the proceeds to various parties engaged in the development of a chemical enterprise:

To the chemist for the "idea" together with process and plans	\$ 5,000
To the lawyer for legal services in organization....	50,000
To the broker for services in floating the new company	100,000
To the owner, net returns in three years.....	300,000

The chemist, the lawyer and the broker, all three, contributed information. It probably took the chemist longer to see the process through than it did the lawyer to draw up the papers, or the broker to get the subscriptions. But time spent is no gage of the value of professional services. The question is one of intrinsic value. Relatively speaking, the chemist was the parent of the establishment, and the lawyer was its nurse; and outside a divorce court we seldom hear of a nurse who gets all but one and two-thirds per cent of a parent's possessions. There is something wrong in the apportionment of that \$55,000. Either the lawyer got too much or the chemist did not get enough. Both contributed professional services. We shall not attempt to bring into consideration as this time the broker's wage. His work is social rather than professional. He knows men, knows how to get their confidence and to induce them to give up their savings. If the owner knew men better he would not need the broker and if the chemist knew men and their ways better he would get a better fee for his own work.

We need more business in chemistry. If a chemist enters the employment of another man or of a corporation, then whatever he discovers in connection with his employment belongs to his employer. We maintain this, no matter how differently some others may feel. But when he becomes consultant the traditions are against him. He is supposed to work by the hour, like a hod-carrier, at cost plus a bare living. Chemistry has the tradition of being cheap and easy to hire.

There is a strategic reason for this. The chemist comes along first. He is the man with the idea. One can take it or leave it, and it is very easy to pass it by. So few persons want the idea that he soon bids against himself to get it taken up. The lawyer comes in when the money has been spent and trouble looms in the offing. He doesn't worry. Whatever happens he gets his reward. And he has learned how to charge for his services. The chemist has not.

Of course there are a great many poor chemists; men of whom negative results may be predicted almost with certainty. But there are also a great many poor lawyers. As such they are trouble-makers, and the wise man does not retain them. He knows lawyers. But he does not know chemists save once in a thousand

times; and he is not wholly to blame for it either. He doesn't know how to go about it to find out the best men available.

What chemists need is Sunday clothes for their ideas; silks and satins and scarlet and velvet for the public to admire and desire. Now the art of presenting ideas so that they are desired and regarded as valuable is called business, whether it has to do with selling goods or negotiating loans or securing subscriptions to an underwriting. Chemists need more business in chemistry to make it pay and to give the profession its proper standing among men.

Nutrition and the

Road to Pleasant Living

THE Chandler lecture at Columbia University was given this year on April 18 by Dr. F. GOWLAND HOPKINS, professor of biological chemistry, Cambridge, England, on the subject, "Newer Aspects of the Nutrition Problem." Prof. HOPKINS is one of the leading men in the chemistry of nutrition, and it was he who first recognized the necessity of some theretofore unknown accessories to the diet of fats, carbohydrates and proteins now known under the general term of vitamins. A large part of the great gift of the Rockefeller Foundation for research in medical science in England has been set aside for work under Dr. HOPKINS and his associates.

He made an earnest appeal for more work and more workers in this field of supreme importance. The tendency in the last few years, he said, has been for physical chemists to enter the field, and the value of their contributions has been exceedingly great. It enables us to arrive at knowledge which generations have been waiting for, and their methods of reaching results are rapid. In metabolism, however, there are problems which involve chemical reactions that are still unknown, and the distinctions between living and diseased tissues can be learned only by the study of molecular structure; therefore the need extends also for those whose work and experience and habit of thought have to do with organic chemistry.

We noted certain signals of warning to the effect that vitamins have lately come in for more attention and discussion than their functions would seem to warrant, bearing in mind the many other features of similar importance in metabolism. The lecturer also urged us not to forget the differences in metabolism between a large organism such as the body of a man and a small one such as the body of a rat or a guinea pig, in reaching conclusions from experiment.

The social effect of advance in understanding the chemistry of nutrition may be greater than most of us appreciate. Apart from what Prof. HOPKINS told us it would seem to point the way not only toward better

health but toward better living conditions. Suppose it were possible to cut down the cost of wholesome and agreeable foods to a much lower figure than that which now obtains. There are signs of it already. Many men in posts of authority whose rewards for service are so high that the cost of meals is not considered are going over to a much simpler diet than that of the day laborer. The cost of preparation at expensive restaurants is high, but that is due to the accessories such as furnishings, tableware, table linen, service, including high rents, more than to the food, or even to its preparation.

This brings us around to a favorite thesis, to the sermon we have been preaching for several years past, and that is that the road to pleasant living is not through wealth, but rather through interest and curiosity. The interest to which we refer is not the earning power of bonds, but the same word in another sense—to wit, the quality of interest in various topics which is akin to curiosity. Therefore whoever has an intellectual ambition, or whose interest in any subject within the arts and sciences is aroused, he may work by the day and yet be a remarkably free man. When the day is over, his task is done and the best of art and literature is open to him. This is not the case of the employer or those with creative intellects whose work is never done, and who cannot address themselves with the same seriousness to the graces of life. Their spare time is not really free. True, art and literature have a hard time these days among those who belong to what is technically known as the ranks of labor, but these same ranks of labor have the golden opportunity to advance themselves in scholarship, in learning and in the newer humanities. Therefore a possible concomitant of research in nutrition may be a very widespread and distinguished culture among those who work with their hands.

The Overtones of Efficiency

IN THE May number of the *North American Review* a member of our staff presents a popular essay on "Relativity and Life." The thesis is that relativity has been known as a philosophic concept for many years, but that EINSTEIN was the first to present it as a scientific principle in which dimensions are determined and eventually measured and compared. It is proposed that this may be done in fields more generally familiar than that of cosmic physics, and dimensions are sought for liberty and other ideas which are under daily discussion. It is held that the dimensions of liberty are freedom and service; that freedom is a more restricted concept than we generally admit, and that without service, rendered either by ourselves or by others, we cannot enjoy liberty. Rights are declared to emanate from liberty, to rest on liberty, and it is maintained that there is no such thing as a single or independent right. In resting on liberty, rights also rest on service, which is a dimension of liberty.

It is possible that this postulate may aid us in planning work. In the consideration of service we have not been disposed to measure it; our disposition has been to get as much of it as we can at the lowest cost. Or, if we render service, it has been our disposition to get as much as we can for it, irrespective of its measurement. What we have neglected is the *obligation* of service. We think so little of the obligation of service that it does not enter into the romance of our generation; we do not find it save on rare occasions, in fiction

or in the drama or in moving pictures. The most frequent idea seems to be that if some hero or heroine is pleasing and affable and does the day's work acceptably, then the reward is a great inheritance of wealth which in turn is a reward of service that has been rendered by somebody else.

The jingle of dollars, however, is not enough to hold the public attention. The public demands more of human interest than a bank account or a big storage vault for securities. So there is introduced what is technically called heart interest, which is usually sex interest, and everybody is satisfied when the hero and heroine, one of whom is rich and the other poor, agree to get married.

Now we do not want the drama's conventional heart interest in industry, and yet we do need some kind of a real heart interest in it. We need something in every organization that will induce every one connected with it to desire to give service for a cause.

If we compare a present-day stone mason with one of the thirteenth century we find the modern mason getting better pay, working shorter hours, but wholly indifferent to the building he is working on. He doesn't know and doesn't care what the building is to be. The foreman has blueprints to guide him in directing the work, and the easier it is the better everybody likes it. It is less "bother" if it is easy. The mediæval mason, on the other hand, knew all about the building, knew its purpose, knew he was building for time, had opportunity to exercise his own ingenuity in carving as well as laying the stone, and he was doubtless proud that he had a hand in the work.

In industry it behooves us to seek its purpose, the purpose that makes it so desired that the product is wanted. If a man cannot be proud in having a hand in his work, there is something lacking. Industrial life needs larger thinking than it has enjoyed: more thinking and less belligerence.

As a rule labor is still unwilling to take chances on production. Labor and employers can agree on a minimum wage and an interest in profits, but when the profits go down labor usually strikes at the reduction. It isn't always so, but it happens too often to make profit-sharing a workable practice, even when employees would welcome it. But beyond the wages there is something needed to encourage service. It is a perplexing question, but that is what makes it interesting. This is the overtone to the jingle of dollars, to the commodity price paid for work. It could even be mathematically expressed if we knew it better.

If we bear in mind that our liberties and our rights emanate from services, our own or those of somebody else, it will make us all less bumptious in our claims and more willing in our work. We cannot as American citizens live upon the liberty achieved by the founders of the republic. We shall use it up in no time unless we ourselves do constantly contribute; contribute more than we require for ourselves. We cannot run away from our obligations.

The trouble is that we do not learn what our obligations are by having them preached at us. We must discover them for ourselves. We are more inclined to do this when we see somebody else seeking and finding his responsibilities and fulfilling them. To sense obligations and to fulfill them is an achievement in character rather than an art or an inheritance. Right conditions induce it, and to find and provide the right conditions is the greatest problem in industry today.

Federal Trade Commission

Accepts Judge Gary's Invitation

FORMAL complaint has been issued by the Federal Trade Commission against the Steel Corporation and its subsidiaries, alleging unfair methods of competition in violation of section 5 of the commission's organic act and section 2 of the Clayton act. The complaint is made upon application of the Western Association of Rolled Steel Consumers and other users of steel products, and is the outgrowth of conditions complained of by more than 2,700 fabricators of steel in the Chicago, Duluth and Birmingham districts, by legislatures of three states, by several municipalities and by chambers of commerce and by many business organizations.

In brief, the applicants complain against the device known as the Pittsburgh plus price. Under this device all steel except rails, wherever made and whether made by the Steel Corporation plants or by independents, is sold at the Pittsburgh price plus an amount equivalent to freight to point of destination, irrespective of whether the cost of production at the plants outside of Pittsburgh is less, as it generally is, than the cost of production in Pittsburgh. The "Birmingham" price is also complained of, which is described as the Pittsburgh price plus an additional charge of \$5 a ton.

The complaint charges that the Steel Corporation has complete control, supervision and direction over the subsidiaries, transportation materials used in the manufacture of iron and steel and products made therefrom in interstate commerce; that the corporation through certain of its subsidiaries owns and controls over 75 per cent of the total iron ore deposits in the Lake Superior district, where is located the greater part of the iron ore deposits of the United States; that it owns and controls the greater part of the iron ore deposits of Alabama, where production is second only to that of the Lake Superior district; that it owns and controls the ultimate iron ore supply of the United States; that it owns and controls the major number of railroads and lake transportation systems which carry iron ore from mines to manufacturing plants of its subsidiaries and their competitors, and that it likewise owns and controls coal mines and limestone quarries necessary in the manufacture of steel.

The complaint charges that of the total production in the United States of the following items respondents manufacture and sell approximately 47 per cent of the crude steel in the form of ingots; 45 per cent of semi-finished rolled steel in the form of billets, blooms and slabs and sheet and tin plate bars; 45 per cent of finished rolled iron and steel products in the form of rails, plates and sheets, structural fabrics, bars, iron rods, skelp, hoops, bands, cotton ties, etc., and 60 per cent of other steel products.

Paragraph 5 of the complaint charges that the corporation for at least seven years has issued from time to time price quotations and schedules covering rolled steel manufactured by its subsidiaries and that these quotations are adopted by all the subsidiaries and their competitors substantially as their prices.

Paragraph 5 also recites that because of the power and influence of the corporation through the large percentage of the steel-manufacturing business done by it and supported by it the consequent potential power to embarrass or destroy its competitors by unduly lowering its price schedules is tantamount to the naming by the Steel Corporation of prices that are to be charged by all steel manufacturers in the United States.

This proceeding by the Federal Trade Commission was urged by Judge GARY, chairman of the board of the Steel Corporation, at a preliminary hearing in Washington on July 9, 1919. When questioned by the commission at that time as to whether he thought it had jurisdiction, he replied affirmatively and that it was a question that ought to be taken up and settled by the commission. He added: "It is one of the most important questions you ever had before you, or ever will have before you." He also said that the principle of the Pittsburgh plus price plan was duplicated in whole or in part in a great majority of the other basic industries of the country.

Of course, the substance of the complaint is: Pittsburgh, the high-cost-producer, gets the bulk of the business at a profit arbitrarily decreed; plants elsewhere get additional profits because of their lower costs of production; every increase in transportation rates means additional profits to the plants outside of Pittsburgh, because the amount of the increased rate is added to the selling price.

The investigation has been invited by the head of the Steel Corporation. The invitation has been accepted by the Federal Trade Commission. It is well that it should proceed. If, as Judge GARY says, the practice is followed in the other basic industries of the country, such should be brought out. If it is a good thing, its wisdom should be established. If it is not, but makes merely an added burden which the consumer has to pay, its abolition should be decreed, not only in the steel industry but in all others where it prevails.

Artistic Influence

In Scientific Development

The Past as clear as Polished Glass appears
While Dark as Lacquer seem the Coming Years;
Yet, mirrored in the Past, the Eye may see
The Faces of the Centuries-to-Be.

FAR back in the dim ages as the time may have been when the potter first employed his hands to coil character and clay into expressions of beauty he developed a spirit of accomplishment which has been handed down to our present day ceramists. With this tradition of idealism in their hearts a few of today's old-timers assembled some twenty years ago and founded the American Ceramic Society.

Now a large national organization, its principal activities are centered on the application of chemistry and physics to technical problems, and human understanding to problems of organization and trade development in the clay-working industries. That this same influence carries the work along and that the ceramists are anxious to preserve it to future generations was crystallized in the formation of a new art division of the society at the annual convention in February.

Other events at this meeting plainly indicated the field of the future in the bringing of the heavy clay industries together for research into methods of scientific control, in the pleas that manufacturers forego degeneration consequent upon secrecy of process, and in the plans for broadening of business activities to an international scope.

The trend of the growth of American ceramics clearly appears in many details and it may be definitely predicted that the ideals of the artist will be a continued constructive influence in the scientific development of the calling.

Readers' Views and Comments

Activities of Fixed Nitrogen Research Laboratory

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with much interest the article by Dr. R. C. Tolman on "Government Fixed Nitrogen Research" in your journal of April 6, 1921, page 595, and feel myself obliged to comment upon some of the propositions inferentially laid down by Dr. Tolman.

In order to clear the ground I may say that I believe as firmly as Dr. Tolman does that research in the problem of fixing nitrogen is the most important thing at present before the world. It is an old saying, and probably a true one, that what enabled us to pay off the debt of the civil war and cure inflation by "resumption of specie payments" was the invention of the twine binder, which, together with the unoccupied lands of the West, enabled us rather suddenly to make an immense addition to our productive power. All the world is at present staggering under war debts; and the man who makes "two blades of grass grow where one grew before" is more than ever a public benefactor. He is wanted by all the world. To clear off these debts quickly, not only in this country but all over the world, we need again an immense increase in production; and one way to get it is to grow more food to support more workers in industry. This can be done by cheaper fertilizer enabling the farmer to make a decent profit from cheap food.

Without going into the question of how far this necessary research work should be done by the Government and how far it should be done by private enterprise, I may say that any information that expert skill in the service of the Government can contribute toward this matter is welcome—welcome to all of us. It should, however, be noted that in this country experience teaches us not to be very sanguine as to Government activity in business.

Where I differ from Dr. Tolman, in the first place, is in his assumption all through his article that the results which his laboratory obtains may properly be kept secret from the public. As he states it, if the Government is to run certain plants, then and in that event all results of his work are to be kept "confidential"; which means that they are not to be disclosed to the public at large. Now I personally have a very vivid interest in the problem of fixing nitrogen, and I am a taxpayer. I feel that the results of Government work in this line, if any, should be made public and not held in secret archives of the Government. I must therefore register a protest against any such policy of bureaucratic secretiveness.

Secondly, I must question the choice of lines of investigation. Mainly this research work is to be done upon the cyanamide and the Haber processes. Now as it happens both these matters are more or less covered by patents. Is it the proposition that the Government is to do work in this line which is to be kept secret from the public and which either will inure largely to private benefit—namely, to those gentlemen who happen to have a financial interest in the Haber process and in the cyanamide process—or else will form the basis of Government competition with such interests?

I also dissent on general principles from the idea that this work shall be mainly limited to these two lines. The cyanamide process, Dr. Tolman states, is at present "the only means by which nitrogen can be fixed in America in case of emergency"; but he also virtually admits that after a while it must be dropped. With the latter admission I am in accord. For generations the price of inorganic nitrogen for fertilizer purposes has fluctuated around 15c. per lb., that being the datum plane set by Chilean saltpeter. About 3c. a lb. being the Chilean export duty, we are now, on a consumption of 200,000 tons of nitrogen, annually paying tribute of about \$12,000,000, partly to Chile, but mostly to help make it interesting to capital to invest in byproduct coke ovens (illustrating, by the way, the workings of protection). Very little of this tribute goes to the cyanamide interests. Even with such stimulation, the only cyanamide plant operating in America after about fifteen years of development is in Canada. If we may set 5c. nitrogen as a goal of fixation activity, it is pretty certain that we must find a faster vehicle than the cyanamide process.

Taking the second main proposition, the Haber process has already been worked out very well in Germany and I do not know that there is any great secret as to the results which the Germans get. They appear to be still some distance from the 5c. mark. Various private interests in this country now know as much on paper as the Germans do. I therefore very much question the advisability of spending Government money for duplicating this information, and particularly if the information is to be kept "confidential." If not kept confidential and used in competition with private enterprise it will inure to the benefit of my friend the General Chemical Co., which knows most of it anyhow.

Dr. Tolman is perfectly sound in his reluctance to go very far into the arc process; but feeling as he does, I am surprised that he is putting even \$14,000 into equipment for it. I would suggest that \$14,000 spent in Norway would probably bring more information than \$14,000 spent here. It is a truism in research work that it is better to start things where the other fellow left off; and in Norway they have spent many dollars and much time in learning about the process.

Finally, I must take exception to the casual way in which fixation in the form of cyanide is dismissed. While it is perfectly true that the Bucher process got into trouble because of the inherent difficulty in transmitting large amounts of heat through a retort wall to an open and pervious charge undergoing endothermic action, yet the fact remains that cyanide formation is, so to speak, the only way of fixation to which nitrogen seems to take naturally and easily. In other ways nitrogen must be bludgeoned into combination by electricity or pressed with the very purest of hydrogen, but into cyanide the nitrogen goes because it seems to feel like it. The energy involved is about 8,000 units, suggesting a material and fuel cost under ½c. a lb.

Acyanide process makes rather intriguing promises. I might recommend that Dr. Tolman, if he is going to continue these investigations, pay more attention to

cyanide and less to other things; but again there is the inherent difficulty that if he does so the results either will injure or will benefit private interests. Yet, even so, on the principle of equal opportunity and non-discrimination, I am constrained to suggest that a fair share of any appropriation for nitrogen fixation be devoted to the development of the cyanide method.

Ferro Chemicals, Inc.,
Washington, D. C.

R. FRANCHOT.

SIR:—The Fixed Nitrogen Research Laboratory always welcomes constructive suggestions, such as Mr. Franchot's, as to the policy which it should adopt.

With regard to Mr. Franchot's first suggestion, I may say that the War Department has kept the results of the work of the laboratory confidential in order that they might be available solely to the U. S. Fixed Nitrogen Corporation, which was contemplated in the Wadsworth bill, which failed to pass during the last session. Assuming that the failure of this bill means that the Government is not itself going to undertake the fixation of nitrogen, it is obvious that there is no longer any necessity for keeping the researches of the laboratory secret. In fact, the laboratory has no justification for existence unless the information which it obtains is put to some useful purpose, either by the Government or by private industry, and the laboratory is now definitely recommending to the War Department that the results of its researches be published.

With regard to the relative amount of attention which the laboratory has paid to the different methods of nitrogen fixation, the greatest emphasis has in the past been put on the cyanamide and the Haber processes, in order that information should be available for the governmental operation of the Muscle Shoals plant, which at the time the laboratory was founded seemed probable, and in order that the Haber plant at Sheffield might be reconstructed.

In the future more emphasis will be put on other methods of nitrogen fixation, and as a matter of fact for some time the laboratory has been planning work on the cyanide process.

RICHARD C. TOLMAN.

Fixed Nitrogen Research Laboratory,
Washington, D. C.

Commercializing Priestley's Theory

To the Editor of Chemical & Metallurgical Engineering

SIR:—Your recent article and correspondence anent the subject of "Easy Money From Peat"* recalled to me a similar experience which I had a few years ago, which may be of interest in this connection.

I was called upon to investigate the composition of a liquid being widely promoted as a carbon remover for gasoline engines. The action of this liquid was claimed to be due to its property of liberating *gaseous oxygen* when submitted to a *pressure* of 50 lb. or more. When mixed with the gasoline in the proportion of about 1 oz. to 5 gal. sufficient liquid was supposed to be carried into the cylinder with the vaporized gasoline to compensate for the large volume of nitrogen in the air of a combustion mixture by means of this oxygen!

Upon casual investigation this truly remarkable substance seemed to be composed chiefly of kerosene with small quantities of naphthalene alcohol and amyl acetate common to similar preparations.

The quantity of oxygen claimed to be liberated was, if I remember correctly, not less than 10 liters per

cubic centimeter! Aside from the improbability of any substance decomposing in this way under the influence of pressure, which would naturally tend to have the reverse effect, I attempted to point out that such a volume of oxygen would weigh considerably more than the total weight of the liquid from which it was obtained, but found that this apparent difficulty had been disposed of by the ingenious inventor. I was gravely informed that "according to the Priestley theory" pure oxygen possessed no weight whatsoever, the mass ordinarily found associated with this substance being due entirely to impurities therein.

Upon the failure of the technical experts of this project to put in an appearance at several conferences and demonstrations which we attempted to arrange the subject was dropped, but it seems unfortunate to allow modern chemical science to struggle along without the marvelous benefits which would doubtless accrue from the judicious application of the "Priestley theory."

New York City.

GUSTAVE REINBERG, JR.

Important British Fertilizer Supplies

Up to ten years ago the names of the Island of Nauru and Ocean Island were practically unknown to any save the geographer and the specialist. They are tiny specks of land lying in one of the loneliest spaces of the Pacific Ocean fifty miles south of the Equator and 3,000 miles west of the South American coast.

In 1885 these islands, which were considered of no commercial value, were formally annexed by Germany. Some time afterward phosphate deposits were discovered on Ocean Island and some years later on Nauru. One of the effects of the world upheaval of August, 1914, was the formal transfer of these German islands to Great Britain under the terms of a mandate. An agreement was made on July 2, 1919, between the governments of the United Kingdom, the Commonwealth of Australia and the Dominion of New Zealand for the allotment of British-controlled phosphates in the Pacific Ocean on the basis of 42 per cent to the United Kingdom, 42 per cent to Australia and 16 per cent to New Zealand.

It now appears that the British Empire has acquired one of the richest supplies of phosphates in the world, reports Commercial Attaché Dennis, of London. It is stated that the formation of these phosphate deposits has been accomplished largely through the agency of fish-fed sea birds which have left vast deposits of guano on the islands. These deposits, mingling with the lime of the coral rocks, have practically converted the whole of the islands into great repositories of phosphate of lime. These phosphate deposits run to a depth of 40 ft. on Nauru and 57 ft. on Ocean Island. A representative sample of this island phosphate yields:

	Per Cent
Moisture sample:	
Water	3.87
Tribasic phosphate of lime.....	82.56
Ground sample (dried):	
Carbonic acid	2.06
Equal to carbonate of lime	4.69
Phosphoric acid	39.34
Equal to tribasic phosphate of lime.....	85.89
Oxide of iron and alumina.....	0.76
Organic matter and combined water	2.86

Neither island possesses harbor facilities. It has been necessary, therefore, to construct jetties, of the cantilever type, running far out over the reefs. From these the phosphate is lightered to steamers. The present annual production of the islands is in the neighborhood of 250,000 tons.

*See CHEM. & MET. ENG., vol. 24, Nos. 5 and 12, pp. 213 and 506, Feb. 2 and March 23, 1921.

Italian Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

GENOA, ITALY, April 15, 1921.

THROUGH the large quantities of German war reparation chemicals and dyestuffs delivered to Italy this country was not only overstocked with some products but the national producers suffered severely through the great reduction in the prices that followed. Therefore a movement was begun to stop or at least reduce the supply of some of these products from Germany, and replace them with others of which Italy is still in great need.

FOREIGN EXCHANGE SINKS STRONGLY

After several months of very high foreign exchange, that had demonstrated only a very slight tendency toward reduction, a sudden fall took place toward the middle of March, bringing down with it all prices. Business, already very dull, came in many cases to a complete standstill, old stocks being used up by many, while others suspended manufacturing operations awaiting events. Italian metals, minerals and chemicals received a further fall, and so did Sicilian products such as sulphur, essences, sumac leaves, manna, mannite, tartaric acid, citric acid, cream of tartar, etc., creating a panic among holders of such products, many of whom tried to sell their stocks, often not finding buyers.

NEW DECREE ON BENZENE FOR CHEMICAL WORKS

To assist and encourage manufacturing operations where benzene is employed largely, the Italian Government has arranged a specially reduced importation tariff of two lire per 100 kilos on benzene and other light coal-tar oils destined to serve as raw materials for the production of artificial organic coloring matters or varnishes and similar products. Such benzene must, however, be submitted to a certain degree of adulteration at the expense of the buyers. The adulterant will be established for the different industries by the Minister of Finances.

NEW WATER-POWER AND HYDRO-ELECTRIC DEVELOPMENTS IN ITALY

Different projects are being studied for utilizing the water power available in the Trentino. One proposal is to form an independent corporation controlling the property of different Italian and Tyrolese industrials and of several municipalities, and another is to utilize the Noce Torrent, collecting a portion of its waters in a large reservoir in the Palu Valley and a portion in a second reservoir constructed between Pelizzano and Mezzana. The extensions of fields and woods would thus be occupied by two large artificial lakes, and the valley of Palu would be dammed by a stone dike 75 m. high and 65 m. thick, inclosing a volume of water of a possible volume of 38,000,000 cu.m. (about 50,000,000 cu.yd.), covering a surface of about 900,000 sq.m. (about 1,100,000 sq.yd.). The water power derived from these lakes would permit the production of 150,000 to 180,000 electric horse power.

Development of the Italian hydro-electric companies has increased considerably. Although these once possessed a total capital of only 600,000,000 lire, today their capital is 1,500,000,000 lire, an increase of 180 per cent. The Italian Government gave no support in this instance; on the contrary it receives 70,000,000 lire per year in taxes and other fixed rights. During

the five years 1915-1920, 265,000 electric horse power obtained from new hydraulic plants was put in operation, and at present plants are under construction for harnessing more than 400,000 horse power. The capital needed to bring to completion similar plants is calculated at 1,200,000,000 lire. Other plants are also in contemplation to bring into being another million horse power.

TECHNICAL DIRECTORS MEET

At a meeting in Milan recently of the new association of technical directors, to which members came from Piedmont, Liguria, Lombardy, Veneto and Emilia, the industrial and financial situation of Italy was closely examined, and it was generally conceded that the labor-control experiments conducted in some works only tended toward general disorganization and to a loss of authority and initiative on the part of technical directors and industrials. It was decided to call the attention of all absent technical directors to this state of affairs in the hope of getting their co-operation in solving the problem.

A CONVENTIONAL EXCHANGE

The use of a conventional, or reduced, foreign exchange with England and France seems to have taken a certain development during March. A similar arrangement appears, however, to have been made by many Italian and foreign firms for the last six months and during the war whenever the exchange made a great increase that would have stopped or reduced business. Many foreign exporters could thus conduct their business as in normal times and without great danger of loss. By this arrangement the buyer deposits to the credit of the foreign sellers in an Italian bank the value of the goods purchased at a reduced exchange arranged by both sides. This deposit then remains in Italy until it is most profitable for the seller to draw it out. The foreign seller does not, however, lose the use of the whole sum, for he can obtain from any bank in his country a loan of 75 per cent on it, and at the worst loses only the difference of interest on the foreign loan and Italian credit.

ITALIAN FERTILIZERS

The serious difficulties encountered in the supplies of fertilizers, and especially of perphosphates, decreased considerably during March, owing to greater activity on the part of Italian fertilizer works, which began the construction of new works and extended older works. Italian production of sulphate of copper and of nitrogenized fertilizers such as cyanamide, nitrate of ammonia, etc., was also increased and much improved.

ITALIAN LITHOPONE INDUSTRY

The manufacture of lithopone is conducted in only one works, at Brescia, belonging to the Milan firm Attilio Gelpi, which produces only a few hundred kilos per day, although the zinc and barium minerals necessary are particularly abundant. For this reason the greater part of the product used here has to be imported. During March a campaign was begun to increase the production of this important substitute for carbonate of lead, and it is hoped means will be found for large future developments. This would seem to be an excellent opportunity for the investment of American capital. Germany is already trying to do something in this direction, but her initiative is not looked upon with favor. Before the war the zinc and barium minerals were largely exported. This is, however, no longer profitable, owing to the high transportation expenses.

The Crystalline Structure of Metals

A Brief Definition of Crystallinity; a Discussion of the Methods Used in X-Ray Analysis of Atomic Spacing; and a Statement of the Results of Such Studies Made to the Present Time

By ZAY JEFFRIES AND R. S. ARCHER
Research Bureau, Aluminum Company of America

IT IS PERHAPS because we are accustomed to associate regularity of external form, brittleness and transparency with the crystalline state that it seems somewhat strange to regard ordinary pieces of metal as crystalline. The essence of crystallinity, however, lies in regularity of internal structure, and it has been abundantly proved that all metals are crystalline. Study of their crystalline structure has led to very clear conceptions of the mechanism of deformation and failure, and recently to a general theory of the strength of alloys.¹ The application of X-ray analysis has made our knowledge of crystal structure more complete and exact, and is clearly destined to play an important part in the future development of metallographic science.

Crystallinity depends upon an orderly arrangement of the molecules of a substance. In the molten condition or in solution in a solvent the molecules are arranged in an entirely haphazard manner. On the other hand, when the substance crystallizes, the molecules group themselves according to definite and repeating patterns. Metals are monatomic—that is, their molecules contain only one atom. The case under consideration in this paper is thus simplified in that the atom is the unit in the pattern.

SPACE LATTICES

The pattern which forms the foundation upon which a crystal is built is known as a *space lattice*. It consists of a series of points in space such that every point is situated similarly to every other point. Space may be imagined as divided into cells by three sets of parallel planes. The planes of each set are at equal distances from each other and parallel; the distance between planes may be different in the various systems, and the three sets of planes may make any angles with each other. The points of intersection of these planes constitute a space lattice, as is illustrated in Fig. 1.

The arrangement of atoms in planes is responsible for the characteristic and commonly observed properties of crystals. For instance, when a crystal is allowed free development, it assumes a form bounded by plane faces. The direction, or orientation, of these faces is determined by the lattice underlying the crystal. Similarly, it is found that crystalline bodies often possess the property of breaking easily along certain planes, called cleavage planes. Deformation of metals takes place by sliding on planes known as slip planes, as will be described later. In any given crystal the orientation of the cleavage planes and slip planes is fixed. When a crystalline substance is subjected to attack by a chemical solvent, it is found that the resistance to solution is

greatest on certain planes. The planes determining external form, cleavage, slip and resistance to chemical attack are planes which pass through atom centers in the space lattice. It will readily be seen that a very large number of sets of parallel planes could be drawn which would pass through all of the atoms, but the significant planes are limited to those on which the concentration of atoms is large.

SYMMETRY

Any plane passing through a crystal in such a way that the atoms on one side occupy the positions of mirror images of those on the opposite side is a *plane of symmetry*.

Two kinds of planes of symmetry are distinguished. If the structure on one side of the plane can be rotated on the plane through some angle (other than 180 deg.) without destroying the symmetry, the plane is said to be a *principal plane of symmetry*. If such rotation destroys the symmetry for all positions other than the

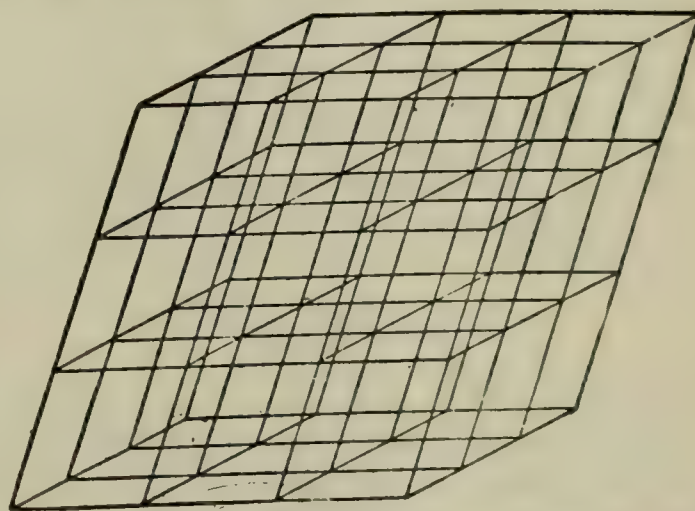


FIG. 1. THREE SETS OF PARALLEL PLANES WHOSE INTERSECTIONS FORM A PARTICULAR SPACE LATTICE (BRAGG)

original or one reached after a rotation of 180 deg. then the plane is called a *secondary plane of symmetry*. To express this more mathematically, principal planes contain two or more equivalent and interchangeable directions, while secondary planes possess no interchangeable directions.

An axis of symmetry is a line through a crystal such that a revolution about it through some angle less than 360 deg. will result in a duplication of the original position of the crystal. The degree of symmetry with respect to the axis depends on the number of times during a complete revolution that such duplication occurs. When such a condition is brought about by a revolution of 180 deg., or twice during a complete revolution, the crystal is said to possess a twofold or binary symmetry. Similarly the classification is extended to threefold or

¹This theory, which the authors have called the "slip interference" theory, will form the subject of another article to appear soon.

ternary, fourfold or quadratic, and sixfold or hexagonal symmetry. Axes of more than twofold symmetry are called principal axes of symmetry. Twofold or binary axes are called secondary axes.

In considering their structural characteristics, crystalline bodies are looked upon as extending indefinitely, in all directions. The planes and axes referred to represent directions rather than specific planes or lines. Other planes through atom centers parallel to a plane of symmetry are likewise planes of symmetry of exactly the same kind. When we say that the isometric system possesses three principal planes of symmetry, we mean that there are three sets of parallel planes any one of which is a principal plane of symmetry for a crystal extending indefinitely in all directions.

ISOMETRIC OR CUBIC SYSTEM

The direction of a crystallographic plane is defined by referring it to a system of axes chosen with respect to the particular crystal system under consideration. The cubic or isometric system, which is the simplest and also the most common among metals, will serve to illustrate the method of designation. Axes OX , OY and OZ (Fig. 2) are in this case the intersections of the three principal planes of symmetry. They are perpendicular

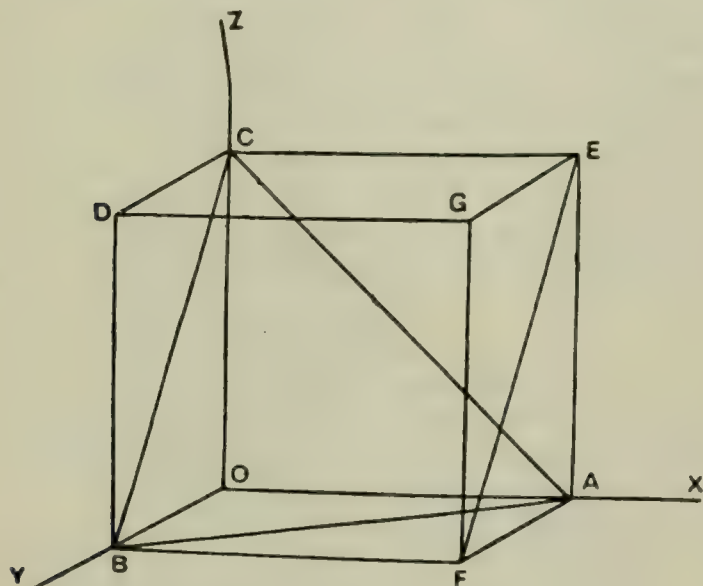


FIG. 2. SKETCH OF CUBIC CRYSTAL ILLUSTRATING SYMMETRY (BRAGG)

to each other and are said to be of equal length, meaning that the same scale is used to represent distances on all the axes, and there is nothing inherent which distinguishes one from the other.

Plane ABC is called the ground plane. In all systems one of the parameters² of the ground plane is taken as unity for simplicity of reference, and the other parameters are then fixed in accordance with the nature of the system. In the isometric system all of the parameters of the ground plane are equal, and hence unity and plane ABC intersects all axes at equal distances from the origin.

The *indices* of a plane are the reciprocals of the parameters, and planes are more usually designated by indices. The planes noted in Fig. 2 have indices as follows:

ABC	(111)	$CDEF$	(011)
$CDGE$	(001)	$DGBF$	(010)

The directions of OA , OB and OC in Fig. 2 are considered positive, and the opposite directions negative.

If the parameter of a plane is negative, then the corresponding index is negative and it is written with the negative sign above the index. If the parameters of a certain plane are $OA = -2$, $OB = 1$, $OC = 1$, the indices are $\bar{2}, 1, 1$. Since, however, indices and parameters express only ratios, not the actual position of a particular plane but the direction of a series of parallel planes, the indices $(\bar{2}, 1, 1)$ are the same, crystallographically, as $(\bar{1}, 2, 2)$, $(\bar{2}, 4, 4)$, etc. Writing without commas, $\bar{1}22$ is used because it has no fractions and has at least one index unity. The above system of notation is the Miller system.

CRYSTAL SYSTEMS

All possible crystal structures can be divided into six groups, each characterized by a particular grade of symmetry³:

1. *Isometric or Cubic System*.—Three principal and six secondary planes of symmetry. Crystals referable to three equal rectangular axes. Most metals belong to this system.

2. *Tetragonal System*.—One principal and four secondary planes of symmetry. Crystals referable to three rectangular axes, only two of which are equal. No metals are definitely known to belong to this system, with the possible exception of tin.

3. *Hexagonal System*.—One principal and six secondary planes of symmetry. Crystals referable to four axes, three of which lie in the same plane intersecting at 120 deg., and are equal in length. The fourth axis is perpendicular to the plane of the three others at their intersection and may have either greater or less length. The metals magnesium, zinc and cadmium belong to this system.

There are three other systems—namely, orthorhombic, monoclinic and triclinic, in which no metals are known to crystallize.

VISIBLE METALLIC CRYSTALS

Under some circumstances the crystalline nature of metals becomes apparent to the unaided eye. The crystalline appearance of the zinc on iron galvanized by the hot dip process is familiar to everyone. Similar regularity of external form is frequently produced when metals solidify with one surface free from restraint. Fig. 3 shows the surface of a piece of cast tellurium which solidified in an open mold.

During solidification of a metal crystallization begins at centers called nuclei, and proceeds in a directional manner. Growth is most rapid along some line which bears a simple relation to the symmetry of the crystal. A trunk shoots out in this direction and branches grow out from the sides of the trunk parallel to one another and in directions determined by the structure of the crystal. The result is a formation which from its resemblance to a tree is called a *dendrite*. The dendritic appearance of many of the crystals can easily be seen in the photograph of tellurium, Fig. 3. Because of the fact that most metals contract on solidifying, the dendrites which form on the surface of a metal are left in relief by the contraction of the mother liquor.

Since several nuclei form simultaneously and growth proceeds in all directions (especially when the nuclei are completely surrounded by the molten metal), it is obvious that adjacent crystals growing toward one an-

²The parameters of any plane are the intercepts on the axes of reference. The parameters of plane $CDGE$, for example, are $\infty, \infty, 1$ and $(OC) = 1$.

³"Elementary Crystallography," by W. S. Bayley; McGraw-Hill Book Co.



FIG. 3. FIR-TREE CRYSTALS ON SURFACE OF CAST TELLURIUM. $\times 2$

other must meet. If a single crystal is allowed to develop from a molten bath, its external shape will be a fairly perfect geometrical figure. With a large number of growing crystals, however, as the molten metal becomes exhausted the crystals must meet in such a manner as to fill the space completely. These crystals will be oriented in different ways, and hence in order to fill space cannot form their habitual external shapes. Such a crystal with orderly arrangement of the atoms in the interior but an external shape determined by the influence of other crystals is called an *allotriomorphic crystal*, or *crystallite*, or more commonly a *grain*. In any given grain, therefore, the atoms are arranged in the same manner as they would be in a perfect crystal of the metal, but the grain may have any external shape.

No two adjacent grains in a cast metal have the same orientation. By orientation is meant the direction of the crystallographic axes. If two adjacent grains had the same orientation, the boundary between them would disappear and the two grains would become one. A metal, therefore, which has solidified from the molten state consists of an aggregate of differently oriented grains. These grains vary widely in size and shape, according to the specific crystallizing properties of the metal itself, the rate of cooling through the solidifica-

tion range, the temperature gradients, purity and other factors. Sometimes the grains are so large that they can readily be seen with the unaided eye and at other times they are so small that a microscope is required to see them.

ETCHING POLISHED SECTIONS

For examination under the microscope a piece of metal must be ground or filed flat and then carefully polished. Examination then reveals no structure whatever, except for particles of included foreign matter such as slag and oxides. The boundaries of the grains themselves are not distinguishable. It has been suggested by Beilby⁴ that the process of polishing has produced a surface layer of amorphous metal which is opaque and covers the crystalline metal underneath. This amorphous layer can be dissolved in a chemical reagent in which the metal is soluble. The process of chemical attack on the polished surface is called *etching*. The boundaries between the grains are regions of low resistance to chemical attack and their location is shown after light etching.

Deeper etching develops marked differences in color between different grains, some appearing dark and others light. The process of solution produces minute facets, which vary in orientation from one grain to another. Light falling on an etched surface will be reflected into the microscope only by such facets as have the appropriate orientation. These grains will appear light, while other grains will appear darker. The different tints of the grains are therefore evidence of their crystallinity and of their different orientations.

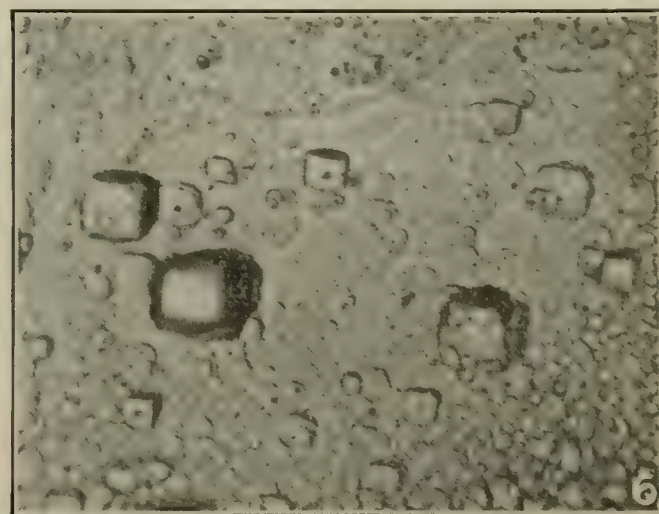
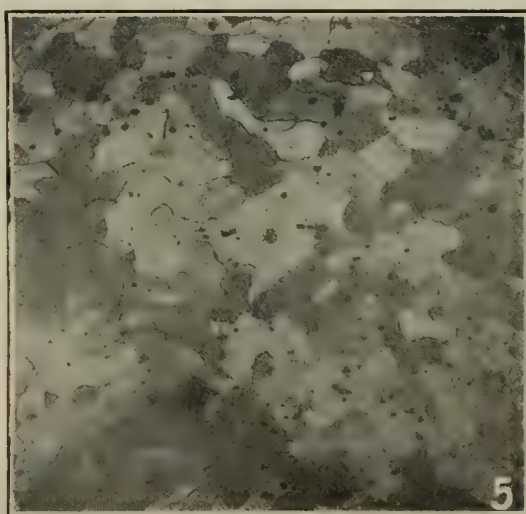
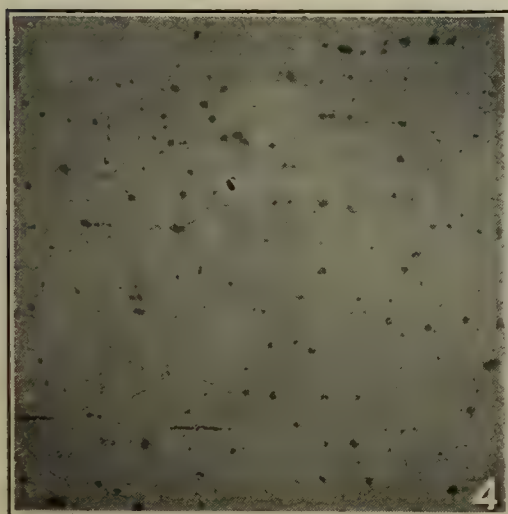
Still deeper etching often produces within certain grains geometrical figures which are called etching pits. These pits approximate a definite geometrical form, such as a triangle or rectangle, and within any particular grain have the same form and orientation. They furnish additional evidence of the crystallinity of metals.

The various effects of etching just described are shown in Figs. 4, 5 and 6, taken from a specimen of nearly pure iron (Armco iron).

INTRACRYSTALLINE SLIP

If a piece of ductile metal is polished and etched to bring out the grain boundaries, and is then subjected to a load which causes a slight permanent deformation, examination under the microscope reveals systems of parallel lines running across the grains. In any one

⁴"The Hard and Soft States in Metals," by Sir George Beilby; May lecture, Institute of Metals, 1911.



FIGS. 4, 5 AND 6. ARMCO IRON, AFTER VARIOUS ETCHINGS

Fig. 4. Light etching, developing grain boundaries. $\times 40$

Fig. 5. Moderate etching; various grains having different tones. $\times 40$.

Fig. 6. Deep etching, developing so-called etching pits. $\times 800$.

grain the lines are approximately straight and parallel to one another, but their direction is different in different grains. In the first stages of deformation only a few of these lines appear, and not in every grain. As the deformation increases more lines appear, becoming closer together and appearing in grains previously free from them. Finally other sets of lines are developed, parallel to one another in any one grain and crossing the first set of lines. Close examination shows that the first sets of lines have been displaced along the second sets by a minute amount, so that they no longer register exactly.

The nature of these lines has been very carefully investigated,⁵ and they are known to represent block movement or slip along crystallographic planes. The lines observed are steps on the polished surface produced by the elevation or depression of blocks or fragments of the grains. They are called *slip bands* and the crystallographic planes along which slip occurs are called *slip planes*. A slip band becomes visible under the microscope only when the displacement along the slip plane is on the order of 0.00001 in., which corresponds roughly to 1,000 atom diameters. Displacements have been measured as high as 0.00005 in., or about 5,000 atom diameters. Even greater movements probably occur in severe deformation.

COLD-WORK OR PLASTIC DEFORMATION

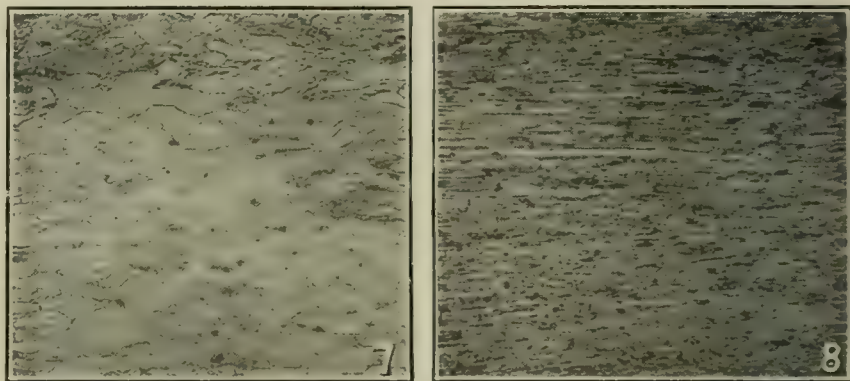
The great permanent deformations imposed on metals in the various processes of mechanical working, such as rolling, forging and drawing, are substantially integrations of very many block movements along slip planes. This type of deformation is called plastic deformation, as opposed to fluid deformation, which is characteristic of liquids and of amorphous solids like pitch and glass. In plastic deformation relative motion is confined to the slip planes, the crystalline fragments between such planes moving as units in which the atoms retain substantially their initial relative positions with respect to their neighbors.

When the external shape of a piece of metal is changed by a deforming load, the shapes of the grains undergo similar changes. Normally, the grains are so shaped that on the average their diameters are equal in all directions. Such grains are called equiaxed grains. Now if the metal is deformed as by drawing out into a wire, the grains are similarly drawn out. The change in the external shape of a grain is made up of a multitude of minute slips each so small that the grain retains an apparently smooth outline. In Fig. 7 is shown a section through the piece of iron shown in Figs. 4 and 5, after compressing it cold until its height was reduced about 60 per cent. A much greater degree of deformation is represented in Fig. 8, a section through a piece of drawn tungsten wire. The specimen shown in Fig. 7 was repolished and etched after being compressed, a procedure which effaces slip bands. However, lines are visible within the grains which are undoubtedly due to the cold deformation. Rosenhain considers these to be the traces of slip planes on the plane of the micro-section. Howe is less certain of their nature, and calls them "X-bands."

Grain deformations are permanent when effected be-

low a temperature known as the annealing temperature or recrystallization temperature. If the metal is subsequently heated above that temperature, the grains recrystallize into new grains which have a tendency toward equiaxial shape and bear little relation to the old grains. If the deformation is carried out above the annealing temperature, the mechanism is substantially the same, except that the metal anneals during the working. Mechanical work carried out on a metal above the annealing temperature is called hot-working, while if the temperature is below the annealing temperature it is called cold-working. Cold-work results in a distorted structure and increased hardness. Hot-working produces a normal structure without any hardening. Cold-working followed by annealing has similar effects to hot-working.

When a ductile or malleable crystal (or grain) is loaded sufficiently to cause failure along some crystallographic plane, the fragments formed cohere, and deformation takes place without rupture. The atoms of one fragment are not sufficiently removed from those of the others to lose cohesion permanently. When a brittle crystal is broken, fracture takes place usually along the crystallographic cleavage planes, and the fragments formed do not stick together. A crystal that is brittle



FIGS. 7 AND 8

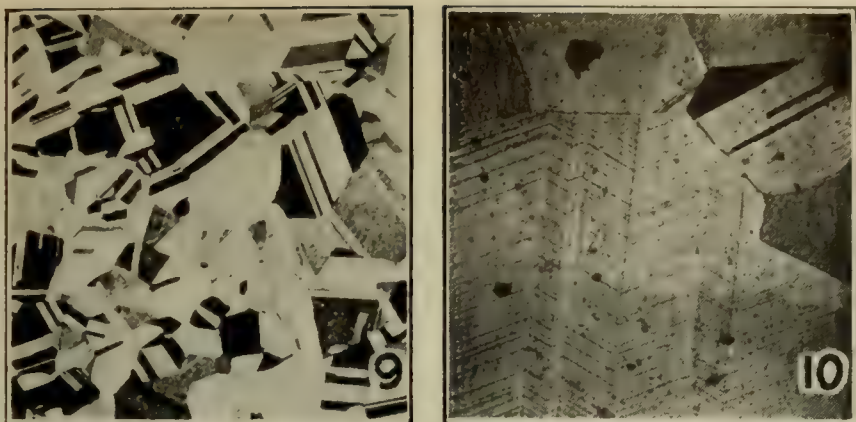
Fig. 7. Armco iron, cold-rolled; 60 per cent reduction. Compare Fig. 4. $\times 40$.

Fig. 8. Extreme deformation of crystalline grain in tungsten wire reduced 98.8 per cent by swaging. $\times 160$.

at one temperature may be ductile at a higher temperature. Crystals that are brittle under ordinary conditions of loading may be capable of undergoing plastic deformation under increased hydrostatic pressure. Bismuth and antimony, for example, which are ordinarily quite brittle, can be extruded into wires when sufficient pressure is applied in such a way that the metal is confined on all sides. Increase of pressure brings the atoms into closer contact, facilitating the re-establishment of cohesion bonds along the planes of failure. Increase of temperature serves the same purpose by increasing the amplitude of atomic vibrations.

Brittle metals, such as chromium and manganese, break without permanent deformation, and their cleavage planes are clearly revealed. The fracture then looks crystalline. Ductile metals break only after the grains are greatly drawn out and slip has taken place on very many planes. The fracture then has a more or less fibrous appearance which does not suggest the inherent crystalline nature of the metal. The same piece of metal, however, when subjected to repeated applications of stress, breaks along the crystallographic planes with practically no permanent deformation, and the fracture may appear crystalline. It is often said that the fatigue has caused the metal to "crystallize," whereas in reality the peculiar manner of failure has merely revealed the crystalline structure already present.

⁵"The Metallography of Steel and Cast Iron," by Henry Marion Howe; McGraw-Hill Book Co. Ewing and Rosenhain, "The Crystalline Structure of Metals," *Phil. Trans.*, vol. 195, p. 279. Stead, "The Crystalline Structure of Iron and Steel," *J. Iron and Steel Inst.*, 1898, p. 145. "Introduction to the Study of Physical Metallurgy," by Walter Rosenhain; D. Van Nostrand Co.



FIGS. 9 AND 10

Fig. 9. Twins in alpha brass (Bassett). $\times 50$.

Fig. 10. Slip bands in alpha brass twins (C. H. Mathewson). $\times 200$.

TWINNED CRYSTALS

Sometimes grains grow together in such a manner that they are symmetrical structurally with respect to a plane between them. These are called twin crystals. Usually the twinning is of such a nature that if either part of the twin were revolved a certain amount about an axis perpendicular to the twinning plane the two parts would possess the same orientation and would merge. Sometimes several parallel twinning planes occur so that each alternate crystalline strip has the same orientation. This is called polysynthetic twinning. Fig. 9 shows this type of twinning in alpha brass, a solid solution possessing the essential structural characteristics of pure metal. Fig. 10 shows slip bands in alpha brass twins. It will be noted that these slip bands are continuous through each grain, but change direction at each twinning plane.

These twins in brass were produced on annealing after cold-working. Twins produced in this way are generally called *annealing twins*, to distinguish them from mechanical twins, which are formed in some metals, notably alpha iron and zinc, by cold deformation alone. Mechanical twins, in fact, are removed by annealing. Mechanical twins appearing in iron as narrow dark bands are known as Neumann bands or Neumann lines. They are parallel to certain crystallographic planes.

X-RAY ANALYSIS OF OPAQUE CRYSTALS

Our study of the structure of metals is limited by the wave length of the light we use. With the highest powered microscopes available it is possible to distinguish separate particles whose diameters are not less than about one one-hundred thousandth of an inch. It is theoretically possible approximately to double this resolving power by using ultra-violet light of short wave length, but this has not so far been accomplished in a practical manner. At the best, visibility or photography is limited to distances on the order of 1,000 atom diameters.

Within the past decade methods of crystal analysis by means of X-rays have been developed by Laue, Bragg and Bragg,⁶ Hull⁷ and others, which extend the field of investigation down to the atom itself. X-rays are entirely similar to visible light but have wave lengths of the same order of magnitude as the distances between atoms in crystals. It has been possible by their use to determine not only the arrangements of the atoms in metals but the exact distances between them.

The fundamental principle of these methods is similar to that of the ordinary diffraction grating, which consists of a piece of glass or metal on which are ruled a great many parallel and equidistant lines. A beam of monochromatic light falling upon such a grating is diffracted through an angle depending on the wave length of the light and the spacing of the lines on the grating. When white light falls upon the grating, the rays of different wave lengths (or color) are diffracted through different angles, thus forming a spectrum. The grating can be used for the analysis of light and for the exact measurement of the wave length of any particular portion of the spectrum. Or, conversely, monochromatic light of known wave length may be used to determine the spacing of the lines on an unknown grating.

The wave lengths of X-rays are about one ten-thousandth as large as those of visible light, and it would be entirely impossible to construct a grating of appropriate spacings by the usual method of ruling lines. It occurred to Laue that the ordered arrangements of the atoms or molecules in crystals might be used for the investigation of X-rays, since the spacings of the planes of atoms (or molecules) are of the right order of magnitude. This idea has been successfully developed experimentally. The first problem was to verify the supposition that X-rays were indeed of undulatory character like ordinary light, and to measure their wave lengths. The process could then be reversed, using monochromatic X-rays of known wave length to measure the spacing of the planes of atoms in a crystal.

The problem differs from that of the ordinary grating in that the crystal grating extends over three

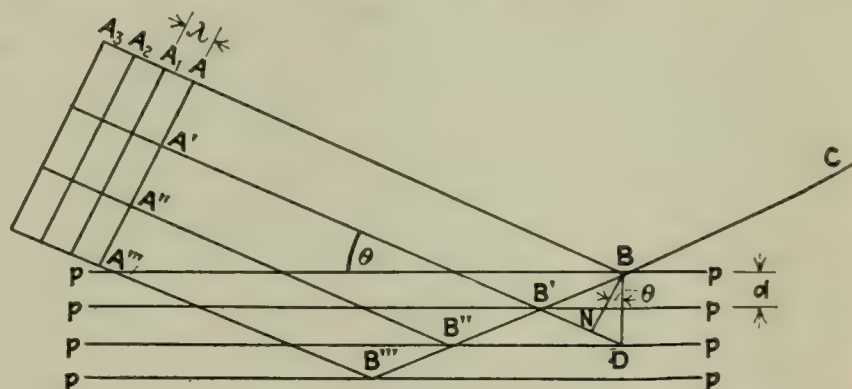


FIG. 11. REFLECTION OF X-RAYS BY ATOMS (BRAGG)

dimensions. The principle⁸ can be explained by reference to Fig. 11. The lines p, p, p , etc., represent planes of atoms in a crystal, separated by a common distance d . A, A', A'', A''' , etc., are a train of advancing waves of X-rays of wave length λ . Consider that these rays are partly reflected from each plane according to the usual law that the angle of incidence is equal to the angle of reflection. Only a small part is reflected at each plane, the remainder penetrating deeper into the crystal.

Consider any path of reflection as BC , which is parallel to all other paths of reflection and typical of them. The waves $AB, A'B', A''B''$, etc., join in reflection along BC . These waves are in phase with one another at $AA'A''A'''$, a line perpendicular to the direction of propagation. If they remain in phase with one another after reflection along BC , reinforcement will take place and a strong beam will result. If they are not in phase, the rays will be lost by interference. The necessary condition for reinforcement is that the

⁶"X-Rays and Crystal Structure," by W. H. Bragg and W. L. Bragg; G. Bell and Sons.

⁷"A New Method of X-Ray Crystal Analysis," *Phys. Rev.*, vol. 10, No. 6, December, 1917.

⁸"Roentgen Rays and Crystal Structure," *METALLURGICAL & CHEMICAL ENGINEERING*, vol. 15, p. 35 (July 1, 1916).

difference in the paths of these waves must be an integral multiple of the wave length.⁶ Let us express this condition mathematically:

Draw BN perpendicular to AB . Draw BD perpendicular to pp . Prolong $A'B'$ to D . Then:

$$A'B'C' - ABC = (A'D + BC) - (A'N + BC) \\ = A'D - A'N = DN$$

$$DN = 2d \sin \theta$$

Therefore

$$n\lambda = 2d \sin \theta \quad (1)$$

where n is any whole number.

This is the fundamental equation. It expresses the fact that in order for strong reflection to occur, the glancing angle θ must have one of certain definite values. These values are given by:

$$\lambda = 2d \sin \theta_1 \\ 2\lambda = 2d \sin \theta_2 \\ 3\lambda = 2d \sin \theta_3, \text{ etc.}$$

The reflection at the angle θ_1 is called the reflection of the first order, that at the angle θ_2 reflection of the second order, and so on. The possible number of reflections is limited for given values of d and λ , since $\sin \theta$ cannot have a value greater than 1.

Then in the limit:

$$n\lambda = 2d \\ n = \frac{2d}{\lambda} \quad (2)$$

For example, if the spacing, atom to atom, equals 5×10^{-8} cm., and the wave length in use is 3.5×10^{-8}

cm., $n = \frac{2 \times 5 \times 10^{-8}}{3.5 \times 10^{-8}} = 2.85$. Reflections of the first and second order only are possible.

Now let us represent an experimental set-up by the line drawing of Fig. 12.

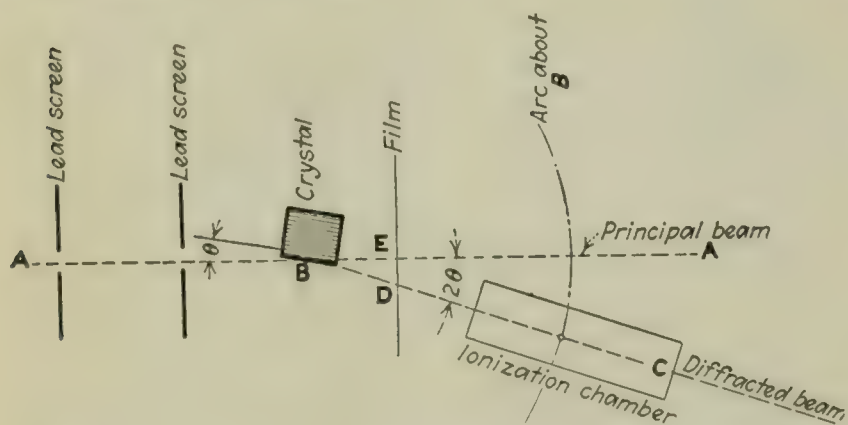


FIG. 12. DIAGRAM OF APPARATUS FOR CRYSTAL ANALYSIS

$A-A$ is a pencil of monochromatic X-rays. B is a crystal having crystallographic planes (planes of atoms) as indicated by the fine parallel lines. B is mounted on a pedestal capable of rotation about an axis perpendicular to the plane of the paper.

C is a device for detecting X-rays, such as an ionization chamber. (X-rays have the property of ionizing gases, thereby causing them to conduct electricity. The conductivity of the gas in the chamber C can be measured by means of an electroscope, which gives a measure of the intensity of X-radiation entering C .) C is mounted to swing on the arc indicated about the same axis as B . By rotating B on its axis and C along its arc, several conjugate positions can be found for which strong reflections will enter C , corresponding to the various orders of reflection. The angles θ_1 , θ_2 , etc., can readily be measured and, given

the wave length of the radiation, the spacing of the planes of atoms can be calculated in accordance with the equation (1).

By choosing different faces of the crystal, this process can be repeated so as to give the spacings of the various sets of parallel planes, from which data the arrangement of the points in the space lattice can be deduced.

HULL'S METHOD OF CRYSTAL ANALYSIS

Suppose that the crystal B in Fig. 12 is properly oriented for a reflection of the first order. If a photographic film DE is interposed perpendicular to the beam AB , the diffracted beam will strike it at the point D , on the path of BC . The principal beam AB will for the most part not be diffracted, and will strike the film at E . Now suppose the crystal to be so mounted that it can be rotated about $A-A$ as an axis; during the rotation, the correct glancing angle θ_1 will be preserved, and the diffracted beam BDC will draw on the film a circle about E as a center. One complete rotation of the crystal will cause it to assume successively all of the positions from which it is capable of sending out a reflection of the first order from the particular set of planes in question. The diffracted beam generates a cone of light about $A-A$ as an axis. A film interposed cuts out a circle, which is thus the locus of all the possible first-order reflections from this set of planes.

For reflections of higher orders, other circles will be drawn on the film, having diameters increasing with the order of the reflection. It will of course be necessary to reset the crystal to the proper glancing angle in each case before carrying out the rotation about $A-A$.

Now suppose the crystal to have its orientation so altered that another set of crystallographic planes diffracts beams on to the film. If we repeat the above process of setting the crystal to the proper glancing angles and rotating it about $A-A$, we will obtain another set of circles representing the various orders of reflection. If the spacing of the planes differs from that of the first set, the circles will have different diameters, corresponding to the different glancing angles involved.

This process might be repeated for every set of crystallographic planes. The result would be a series of concentric circles. Each circle would be proof of the presence of a set of planes having that particular spacing capable of diffracting a beam through the angle represented by the circle.

Instead of carrying out this process by the systematic method of setting the crystal and rotating it about $A-A$, we might simply cause the crystal to assume successively all possible orientations. We would then get exactly the same pattern of concentric circles. Or, if instead of a single crystal, we choose as our specimen a very large number of small crystals, of thoroughly mixed orientation, we obtain again the same result, without rotating the specimen.

This is the foundation of Hull's generalized method of crystal analysis, or the method of powders.⁷ A fine grained metal possesses the same properties as a powder for this purpose, since it is an aggregate of crystalline grains of mixed orientation. Smaller specimens can be used if they are rotated, as this gives the effect of a greater number of crystal orientations. A single photograph of such a specimen gives all of the possible circles and hence the spacings of all pos-

sible crystallographic planes. A diffraction pattern of aluminum obtained by this method is shown in Fig. 13. In actual practice it is customary to photograph only one quadrant of the pattern, and to bend the film into the arc of a circle so that the distances between the lines cut from the large circles are proportional to the angles involved. Patterns of this type are shown in Figs. 14 and 15. Fig. 14, in fact, may be considered a magnified section of a portion of Fig. 13. It was photographed on a film bent around an arc about B , whereas Fig. 13 was a flat plate; consequently the ratios of the distances between successive lines do not have a simple arithmetical relation. However, two bright lines are followed by a broad space, a bright line, a narrow space, two close lines, one brighter than the other, etc.

ATOMIC ARRANGEMENT

In this discussion we have necessarily been obliged to omit consideration of many important details, in order to simplify the presentation of the essential principles. It is also beyond the scope of this article to go into the actual synthesis of crystal structures from the data obtained by these methods, subjects which are completely discussed in the appended references. For the present we shall confine ourselves to the presentation and discussion of some of the results thus far obtained on metals. The arrangement of atoms in metals has been found to be extremely simple.

The most simple arrangement possible is one in which

the atoms occupy positions at the corners of a system of equal closely packed cubes. This is known as the simple cubic arrangement. No metals or other elementary substances have been found to have this arrangement, but it is typical of salts composed of equal numbers of positive and negative ions, such as the alkali halides. The most common arrangement in metals is the face-centered cubic arrangement, shown in Fig. 16, where the atoms are at the corners of a system of equal closely packed cubes and also at the centers of each cube face. This arrangement may be considered as formed by two simple cubic lattices intersecting each other in such a manner that the corner atoms of one lattice fall at the centers of the faces of the other lattice. All of the atoms in the face-centered arrangement are in reality similarly situated. Any particular set of atoms may be equally well regarded as corner atoms or as face atoms. Each atom is surrounded by twelve equidistant and symmetrically situated atoms. This arrangement is one of two which furnish the closest possible packing for a number of equal balls. It is accordingly sometimes referred to as the cubic close-packed arrangement.

The next most common arrangement is built upon a unit cube having an atom at each corner and one at the center. This is illustrated in Fig. 17. The corner atoms and center atoms are interchangeable, so that if the system of lines in Fig. 17 had started with one of the center atoms all the corner atoms would become center atoms, and *vice versa*. Each atom is surrounded

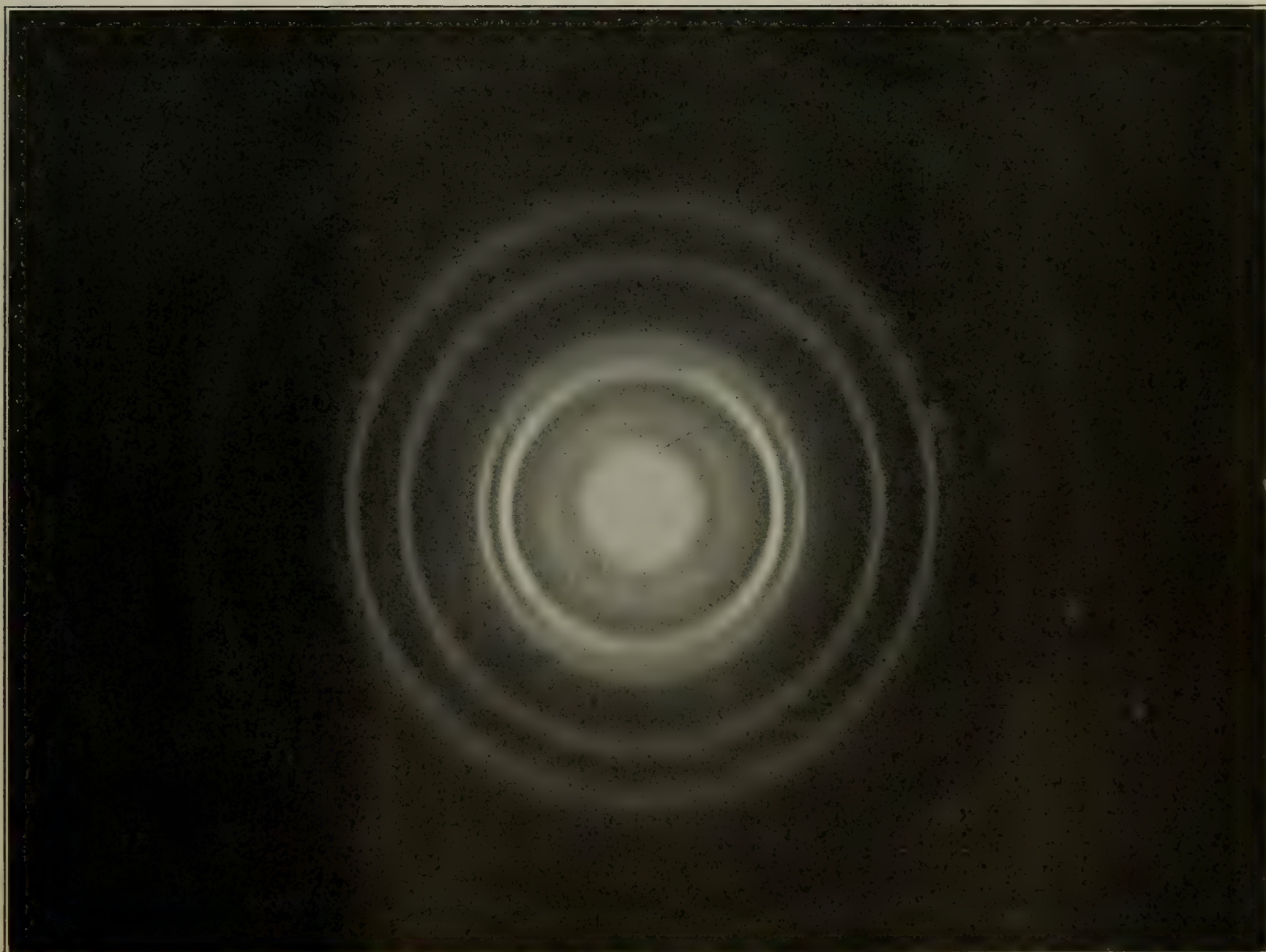


FIG. 13. DIFFRACTION PATTERN OF ALUMINUM (HULL)

by eight equally distant and symmetrically situated atoms. This arrangement is not so closely packed as the face-centered arrangement.

There is one other arrangement found in metals, known as the hexagonal close-packed arrangement (Fig. 18). It is equally close packed with the face-centered cubic. The space occupied by a crystal of this sort may be regarded as built up of a series of equal closely packed right triangular prisms whose bases are equilateral triangles. The altitudes of the prisms are equal to 1.633 times the length of the sides of the triangles. An atom is located at each prism corner and at alternate

The study of the positions of atoms in metals is so recent that only a few generalities can be drawn at present. Some features which may be mentioned are:

1. No metal crystallizing with the face-centered cubic arrangement has been found so far which is not ductile throughout a considerable range of temperature. The face-centered metals are usually ductile even at liquid air temperatures.

2. All of the noble metals so far studied crystallize with the face-centered cubic arrangement.

3. All of the best electrical and heat conductors have face-centered cubic arrangements.

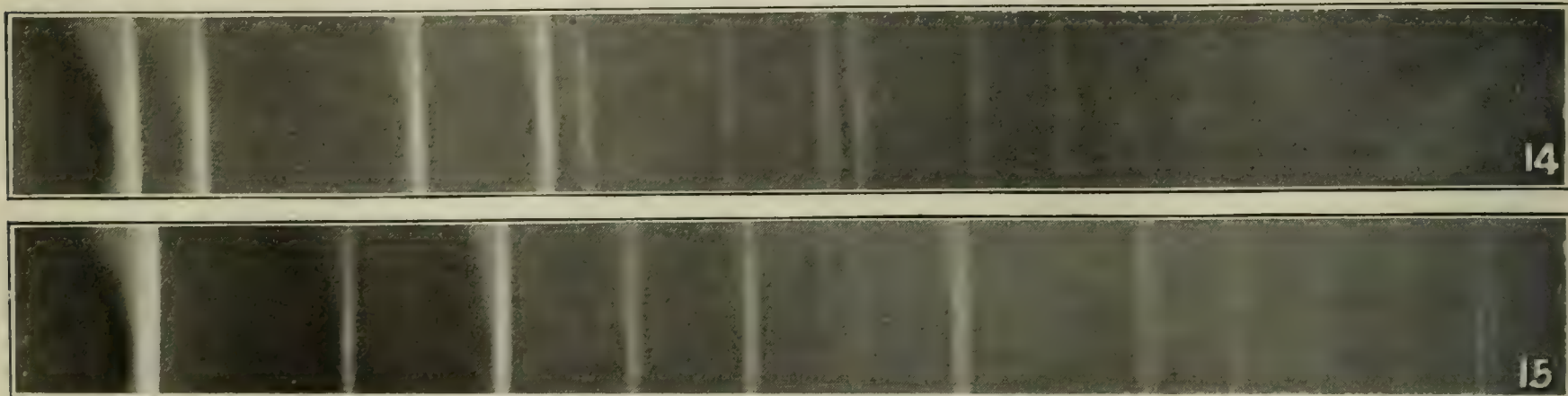


FIG. 14. DIFFRACTION PATTERN OF ALUMINUM, PHOTOGRAPHED ON CURVED FILM (HULL)
FIG. 15. DIFFRACTION PATTERN OF MOLYBDENUM (HULL)

prism centers. Each atom is therefore surrounded by twelve other equidistant atoms, as in the face-centered cubic arrangement, but not quite so symmetrically.

The following table by Hull⁹ gives information on the positions of atoms in several metals. (1 Angstrom is 0.00000001 cm. = 10^{-8} cm.):

Metal	Arrangement of Atoms	Length of Side of Elementary Cube in Angstroms	Distance Between Centers of Nearest Atoms in Angstroms
Aluminum.....	Face-centered cubic.....	4.05	2.86
Cobalt ¹⁰	Face-centered cubic.....	3.57	2.52
Nickel.....	Face-centered cubic.....	3.54	2.50
Copper.....	Face-centered cubic.....	3.60	2.54
Rhodium.....	Face-centered cubic.....	3.82	2.70
Silver.....	Face-centered cubic.....	4.06	2.87
Platinum.....	Face-centered cubic.....	4.02	2.85
Gold.....	Face-centered cubic.....	4.08	2.88
Lead.....	Face-centered cubic.....	4.92	3.48
Lithium.....	Centered cubic.....	3.50	3.03
Sodium.....	Centered cubic.....	4.30	3.72
Chromium.....	Centered cubic.....	2.91	2.52
Iron.....	Centered cubic.....	2.86	2.48
Molybdenum.....	Centered cubic.....	3.15	2.73
Tungsten.....	Centered cubic.....	3.15	2.73
Magnesium.....	Hexagonal (close packed).....	.....	3.22
Zinc.....	Hexagonal (close packed).....	.....	2.84
Cadmium.....	Hexagonal (close packed).....	.....	3.15
Cobalt ¹⁰	Hexagonal (close packed).....	.....	2.53

⁹"The Position of Atoms in Metals," American Institute of Electrical Engineers, 1919.

¹⁰The case of cobalt is exceptional in that both the hexagonal and cubic close-packed arrangements are found.

4. Both ductile and brittle metals are found in the body-centered cubic arrangement. This system seems to be less favorable to ductility than the face-centered, according to Hull.

5. In the hexagonal arrangement both brittle and ductile metals are found. In ductile hexagonal metals the temperature range in which ductility obtains is relatively small. Hull points out that in the hexagonal arrangement there is only one set of planes parallel to which easy gliding can take place, whereas in the face-centered cubic there are four.

6. Metals having the hexagonal close-packed arrangement harden rapidly under cold deformation.

7. Mechanical twinning (Neumann lines) occurs in metals having the centered cubic and the hexagonal close-packed arrangements. Alpha iron is an example of the former and zinc of the latter. Mechanical twins have also been observed in tin, which is thought to crystallize in the tetragonal system.

8. Annealing twins are certainly most prevalent in metals crystallizing in the face-centered cubic arrangement.

9. Annealing twins have not been observed in metals

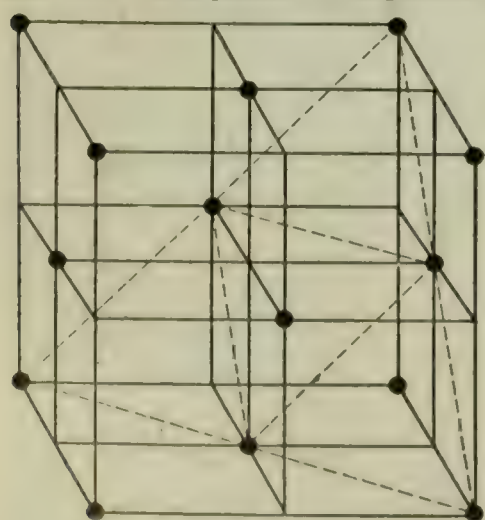


FIG. 16

Fig. 16. Face centered cubic arrangement of atoms; or cubic close packing (Hull).

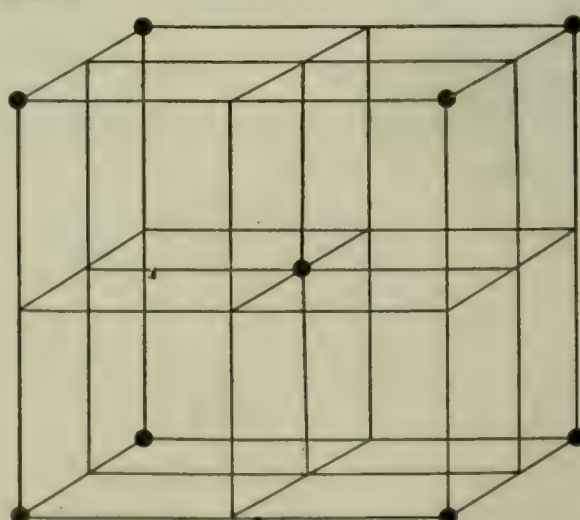


FIG. 17

Fig. 17. Centered cubic arrangement (Hull).

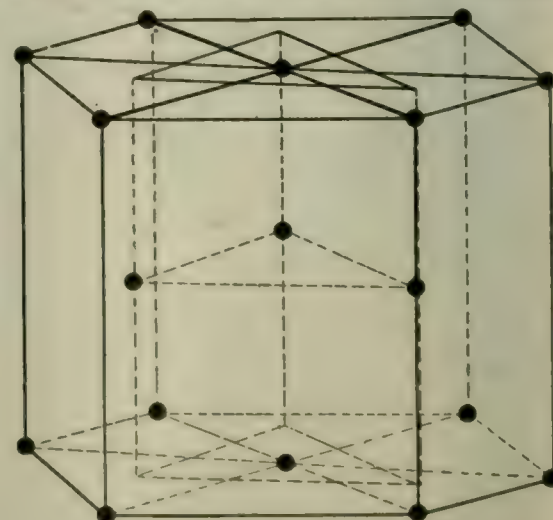


FIG. 18

Fig. 18. Hexagonal close-packed arrangement (Hull).

FIGS. 16, 17 AND 18

having the centered-cubic arrangement, such as alpha iron, tungsten and molybdenum.

10. Not all face-centered metals show twinning. Twin crystals have not been observed in aluminum, for example.

ALLOTROPY

Several of the metals are known to exist in two or more allotropic modifications. The most important case is that of iron. Steel owes its remarkable capacity for hardening to the fact that at high temperatures iron exists in the form of gamma iron having a very considerable solvent power for carbon, while alpha iron, the form stable at ordinary temperatures, has in comparison no such solvent power.

It has been difficult to define allotropy in a certain manner. The new information on crystal structure suggests that an allotropic change may be defined as a change in atomic arrangement. This definition should furnish a positive criterion of allotropy, hindered only by the experimental difficulties involved in determining atomic arrangements at high temperatures.

The gamma form of pure iron is stable only above 900 deg. C., and its atomic arrangement has never been determined. It is possible, however, by means of certain alloying elements to preserve at room temperatures solid solutions, denoted by the generic term austenite, which are isomorphous with gamma iron. Such an austenitic steel is obtained, for example, by the use of about 13 per cent manganese. This material has been examined by Jeffries and Bain and found to possess the face-centered cubic arrangement, which may therefore be assumed to be the arrangement in gamma iron. In common with other metals having this arrangement of atoms, austenitic steels are very ductile, and also show twinning. The fact that the face-centered cubic arrangement is more closely packed than the centered cubic arrangement accords nicely with the expansion noted when gamma iron transforms into non-gamma.

The arrangement of atoms in several solid solution alloys has been investigated by Hull, Davies and Andrews of the General Electric Co. It seems that the atoms of the solute generally replace those of the solvent without substantial change in the arrangement or spacing. If two metals have different crystalline arrangements there may be a certain range of composition within which both arrangements are found simultaneously.

Although intermetallic compounds have not been studied with the X-ray, it seems obvious that in the crystal lattice the atoms of the different elements are not interchangeable, as they appear to be in solid solutions.

The information to be yielded by the X-ray analysis of metals has only begun to accumulate. We may confidently expect further important results in the future, concerning in particular the constitution of metallic solid solutions and of intermetallic compounds. The methods should also enable us to detect the presence of a second physical phase in a metal, such as a highly dispersed intermetallic compound, when the particles of this phase are too fine for resolution by the microscope. Altogether, the advent of the X-ray spectrometer at the present time promises to be about as important an event in the history of metallurgy as was the introduction of the microscope in the latter part of the last century.

Supply of Potash in Illinois Shale

The discovery of shale in Illinois which may prove a cheap American source of potassium for agricultural purposes, and which is rich enough in potassium to increase the yield of certain crops grown on peaty soil as much as 180 per cent, is announced by the University of Illinois. Tests have been in progress since 1915 to find a source of potassium.

The experiments carried on under greenhouse control indicate marked benefit to crops resulting from applications of the shale. The shale produced an increase in the yield of sweet clover of 168 per cent; of rape, 96 per cent; of corn fodder, 146 per cent, and of buckwheat, 180 per cent. These results were obtained on peaty soil in pot-culture work.

There is also some indication, according to the university, that the shale may serve as a source of potassium for gray silt loam, another type of Illinois soil. In the production of buckwheat, there was an increase from use of shale of 32 per cent in the grain and 19 per cent in the straw. Corn fodder also showed increases.

Shales which contain 5 per cent or more of potash occur in at least two localities in Illinois. Outcropping in several places near Jonesboro, in Union County, which contains 5 per cent of potash would be suitable, so far as can be determined from its chemical composition and physical character, for use in the manufacture of portland cement. By using this material in the manufacture of cement and by applying the known methods of potash recovery, a yield of 5.3 lb. of potash, representing a value of 70c. to 80c. per barrel of cement, could be obtained. Shale from Dixon, Lee County, contains 5.8 per cent of potash, which is held for the most part in a more stable condition than that in the southern Illinois shale.

While further experimentation will be necessary to determine whether these potassium compounds can be made available under field conditions, enough has been done to show not only the presence of vast amounts of this valuable material in Illinois shales, but also to demonstrate that the compounds are capable of reduction by agricultural plants grown under laboratory conditions.

Agricultural Experiment Station Bulletin 232 just off the press at the University of Illinois, Urbana, Ill., describes in detail the research carried on by S. W. Parr and M. M. Austin in the chemical laboratory. Part II of the same bulletin covers the geology of the subject investigated by Frank Krey. Part III covers the work of Robert Stewart, chief in soil fertility at the university, who determined the action of these shales in soil improvement for growing plants.

Chemical Tonnage on Class 1 Railroads

In analyzing the freight tonnage handled by the Class 1 railroads during the last quarter of 1920, the Interstate Commerce Commission finds that chemicals and explosives furnished 1,987,141 tons of freight. Fertilizers are shown separately and account for 981,935 tons more.

By far the greater part of the chemical and explosives tonnage of the country is handled by the railroads in the Eastern district, where the amount is shown to have been 1,286,457 tons. The Western district was in second place with 352,186 tons, while the railroads of the Southern district handled 257,309 tons.

A Device for Measuring the Flow of Gases

BY CARLE R. HAYWARD*

DURING some tests in the metallurgical laboratory of the Massachusetts Institute of Technology it became necessary to measure the flow of gas from a cylinder of liquid SO_2 . The nature of the gas prevented the use of an ordinary meter and the amount was so small that the change in weight of the cylinder was not

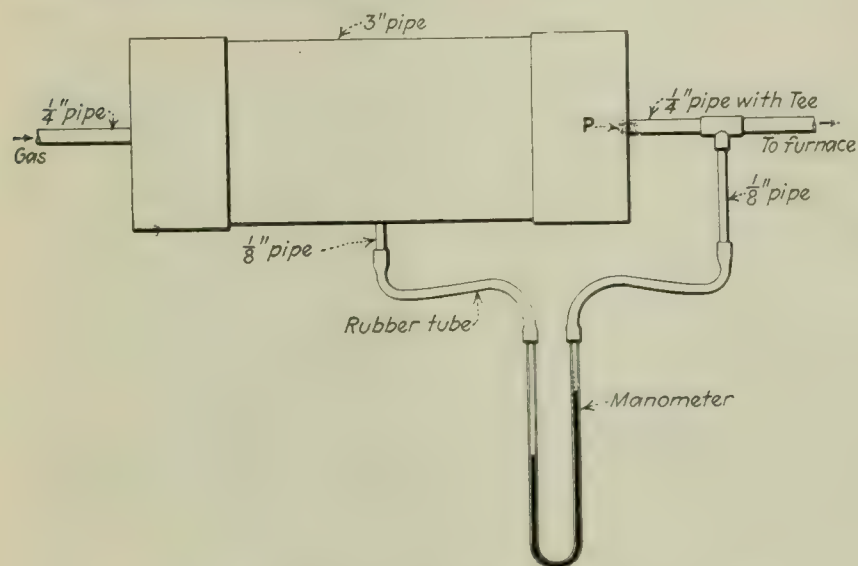


FIG. 1. PRESSURE DIFFERENTIAL GAS METER

easily measured. It was also desirable to change the rate of flow at will.

The apparatus devised for the above purpose is shown in the sketch (Fig. 1). The fundamental principle is well known, but some features of construction are believed to be new. The device is easily made and is so useful that a brief description may be of interest.

The body consists of a piece of ordinary 3-in. steel pipe, 8 in. long capped at both ends. A hole is bored in each cap and threaded to receive short lengths of $\frac{1}{4}$ -in. pipe as shown. The pipe from one cap is fitted with a T into which is put a short piece of $\frac{1}{8}$ -in. pipe. The side of the 3-in. pipe is also bored to receive a piece of $\frac{1}{8}$ -in. pipe. Each of the $\frac{1}{8}$ -in. pipes is connected to one arm of a U manometer which may contain either mercury or water according to pressure used. The gas flows in the direction indicated by the arrows.

The pipe leading out of the pressure chamber is threaded to receive a brass plug *P*, through which a small hole is bored. A series of these plugs is kept on

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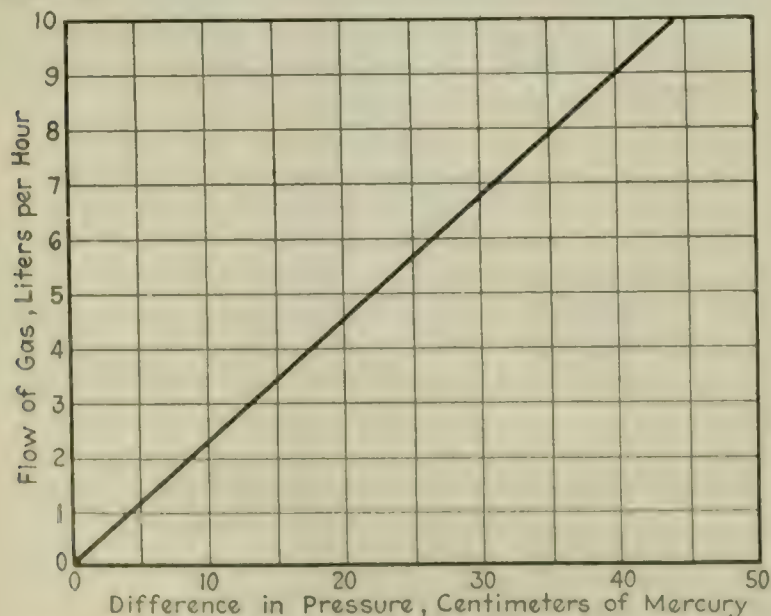


FIG. 2. CURVE WHEN CAPILLARY TUBE IS USED

hand with holes varying in size from $\frac{1}{16}$ in. to $\frac{1}{8}$ in. The plugs can be easily changed by removing the cap from the large pipe. For very small flows a piece of broken thermometer tube has been cemented in the pipe in place of the plug.

The operation of the meter is self-evident from a study of the sketch. The flow of gas through the orifice in the plug *P* depends on the size of the orifice and the difference in pressure on the two sides of the plug. The latter is measured by the manometer. Precautions must be taken to have all joints tight.

The flow through each plug was determined for different manometer readings by connecting the meter to a compressed air line and measuring the flow with a gas meter, or in the case of very small volumes by displacing water in a graduated tube. Having determined the flow for each inch difference in pressure, the results are plotted in a curve. The general shape of these calibration curves is shown in Figs. 2 and 3.

After determining the curve for each plug the meter is available for use on any gas. The writer has used it for SO_2 , hydrogen and air in volumes varying from 3 liters per hour to 100 liters per minute. Pressures have varied from 1 in. of water to 30 in. of mercury.

It is possible to use the meter with the gas flowing

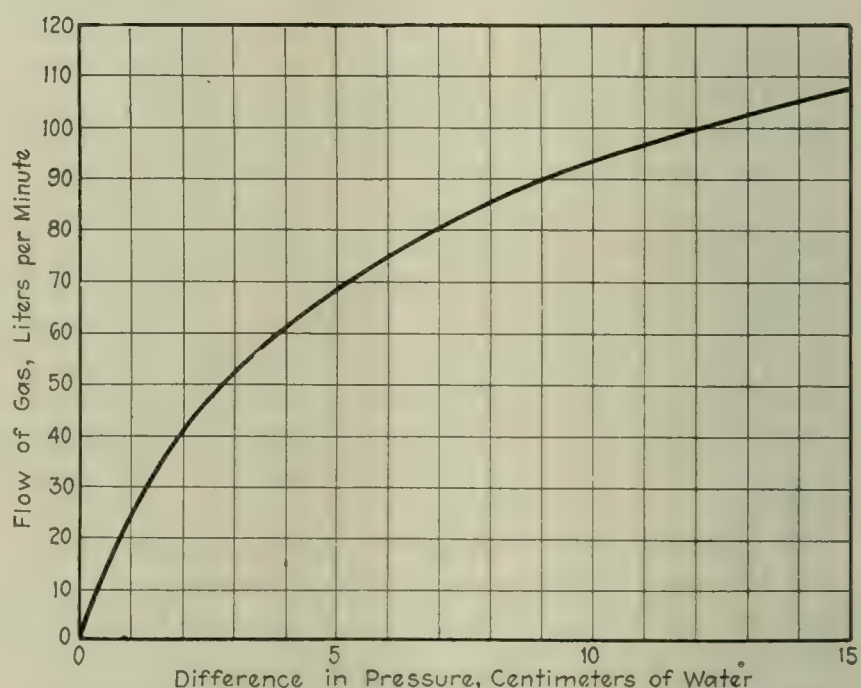


FIG. 3. CURVE WHEN NO CAPILLARY TUBE IS USED

in the direction opposite to that shown in the sketch, but the adjustment when used in that way does not seem so sensitive under the high gas pressures thus far used. It is possible that with low initial gas pressures it would be more satisfactory.

The original suggestion for using pipe fittings for this device was made by Henry M. Schleicher, to whom credit is gladly given.

Municipal Sulphuric Acid Plant Proposed

It is reported that there is under consideration the building of a sulphuric acid plant by Bradford in connection with the city's sewage works, reports Consul Young, of Bradford, England. This plant uses large quantities of sulphuric acid for precipitation purposes.

Before the war the sewage department paid 25s. (\$6.08) a ton for the acid. At the present time the cost is about £6 (\$29.20). At this latter figure it is estimated that £100,000 (\$486,650) for sulphuric acid will be needed annually, and it is believed that if the sewage committee built its own works the acid could be produced at less than half the present cost.

Present Status of Fruit and Vegetable Dehydration

Results of Investigation and Fundamental Principles of Operation and Construction of Fruit and Vegetable Dehydrating Plants—Advantages of Dehydration—Data on Air Volume, Thermal Units and Humidities Required

BY WILLIAM V. CRUESS

Assistant Professor of Fruit Products, University of California

AS A result of the stimulus of government orders for dehydrated vegetables for army use during the World War many firms in different parts of the United States and Canada undertook the large-scale production of Julienne (vegetable soup mixture), dehydrated potatoes, onions, carrots, spinach and other vegetables. A few of these manufacturers had previous experience in dehydration, but to most of them the industry was new. With assistance from officers of the quartermasters corps, investigators of the U. S. Department of Agriculture and state experiment stations most of these new plants were soon placed upon a satisfactory producing basis. Considering the many difficulties to be met in vegetable dehydration, the rapid rate of progress made by those who undertook to supply the army with dehydrated products is truly remarkable.

The success obtained in producing dehydrated vegetables for the army led a number of firms immediately after the close of the war to attempt the dehydration and sale of dehydrated fruits and vegetables for civilian use. To create a demand they relied upon the high quality of their product, its cheapness and convenience. Some of the pamphlets issued by newly organized dehydration companies painted a most rosy future for the dehydration industry and promised large and quick returns to those who should invest in the new enterprise.

Evidently these overoptimistic promoters were "ahead of the times," because most of them have fallen by the wayside and nothing remains of their ill-fated projects except unpaid bills and idle evaporators.

There are, however, several very well-financed corporations managed by men who not only know the many advantages of dehydrated foods but who also realize the need of popularizing such foods and of educating the housewife, through advertising, to change her age-old custom of using fresh vegetables only when she can get

them and doing without when fresh vegetables are not in season.

There has also been another condition to blame for the present slump in dehydration. A considerable amount of inferior dehydrated vegetables has been produced and has created an unfavorable impression upon those who have purchased it. Through carelessness or lack of technical knowledge on the part of some manufacturers, dehydrated products have developed lusty infestations of the Indian meal moth (*Plodia interpunctella*) after leaving the factory. Both of these conditions have now to a very great degree been removed; the first by virtue of the fact that most of the inexperienced operators of dehydrators are bankrupt and the second because the manufacturers now know how to prevent insect infestation.

COMMERCIAL OPERATIONS

At the present time one corporation in Oregon, the Kings Food Products Co., is operating two large plants representing an investment of over half a million dollars. Dehydrated fruits are the principal products. These find a ready market at prices considerably above those paid for the average "run" of evaporated fruits and the profits from these fruits in a large measure "pay the way" for the development and advertising of the dehydrated vegetables produced by this same company. Over \$500,000 has been spent by this one firm in national and local advertising. Its owners state that they would welcome competition from other concerns which would produce dehydrated vegetables and fruits of the highest quality in order that the popularization of dehydrated foods might be hastened. This firm has recently been capitalized for \$10,000,000 and will establish new plants in addition to expanding the two now in operation.

In California a large plant has been built and is operated by the Caladero Products Co., a subsidiary of the Atascadero Colony. It represents an investment of over \$200,000 and has been one of the most successful of the large dehydrators on the Pacific Coast. The products are advertised through the columns of the colony's monthly illustrated *Review*, a journal with a wide circulation. The company is now specializing upon pumpkin flour, which is ground dehydrated pumpkin put up in canisters for the preparation of pumpkin pies. The product is excellent in flavor and color and very convenient to use. It has met with great favor and gives promise of becoming a staple article of trade.

The Japanese farmers of southern California have erected in Los Angeles a modern dehydrating plant equipped with modern machinery. They have made a special effort to popularize a dehydrated soup mixture. The plant is used as a means of converting surplus

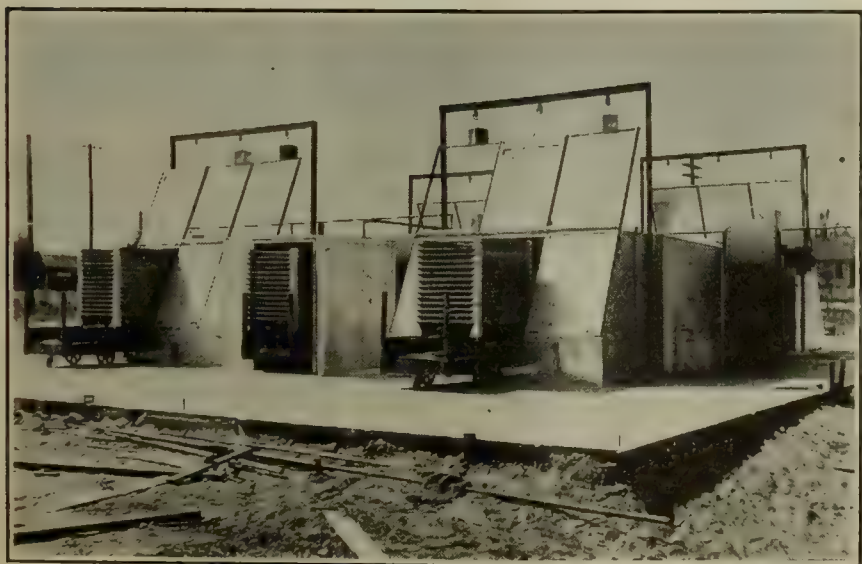


FIG. 1. INTERNATIONAL DEHYDRATORS

vegetables in times of overproduction into marketable products. The company is known as the California Evaporated Products Co. and markets its dehydrated products under the name "Cepco."

In Chicago the Anhydrous Food Products Co. has recently launched upon a campaign of expansion, and its development is watched with great interest by those interested in dehydration on the Pacific Coast. Dehydration of sweet corn is, in the writer's estimation, by far the best of the dehydrated vegetables so far produced. Sweet corn is reported to have been dehydrated by the carload in several Eastern states during the past season.

Other companies might be mentioned, but the situation is perhaps best summarized by stating that the dehydration industry is now on a well-established basis in several states, but will require a great deal of money for advertising purposes before it becomes a major food preservation industry. Development also depends upon standardization of equipment and processes. Time and sustained effort on the part of American dehydration companies will be needed to place this industry upon the basis that the advantages of the dehydration process warrant.

In European countries the advantages of dehydration have been recognized more universally than in America. Germany possessed, it is stated by Prescott and Sweet, in 1906, 36 dehydration plants; in 1909, 199; in 1914, 488 and in 1917, about 1,900 plants. Some of these were "built-over" breweries. The amount of potatoes dried in Germany in 1917 was more than three times the total crop of the United States for that year. These facts afford one reason why Germany was able to maintain her food supply during the war.

The writer has recently seen dehydrated vegetables in compressed brick form which had been exported to the United States from Holland in commercial quantities. These were of very excellent quality.

ADVANTAGES OF DEHYDRATION

It is stated that 20 to 40 per cent of all fresh fruits and vegetables spoil between the producer and the consumer. Dehydration offers an economical and thoroughly satisfactory means of converting such surplus into non-perishable products. As the population of the world increases and the struggle for existence becomes more keen, dehydration may well serve to increase the available food supply by reducing waste through spoiling of fresh products. It can serve to stabilize production and markets by making it possible to store one year's overproduction for use in a year of underproduction.

One of the most evident advantages of dehydrated foods is their small bulk and weight. Many vegetables lose 80 to 95 per cent of their weight in drying and decrease to from one-quarter to one-half their original volume. By compression into bricks the volume can be decreased in some cases to one-tenth or less the original volume of the fresh material. The small bulk and weight of dehydrated foods effect a saving in transportation and storage costs.

If properly disinfected or sterilized to destroy insects and packed in insect-proof containers, dehydrated foods will keep for very long periods of time. The writer has recently used dried soup vegetables said to have been dehydrated fifteen years ago. Vegetables dehydrated for use of the British Army in South Africa were in one instance stored in paraffine-sealed barrels at the end of the Boer War. At the outbreak of the European

war, fifteen years later, these barrels were opened, the contents found good and the vegetables used by the British forces. This instance has been reported by Prescott and Sweet.

Canned foods are much more bulky than dehydrated products and more costly to the consumer. For example, it has been stated that a case of canned tomatoes costing \$2.60 in California costs \$7 when delivered to Havre, France. The same quantity of tomatoes dried and selling at 26c. per lb. in California would cost, delivered in Havre, 40.5c. per lb., equivalent to \$1.22 a case, since a case of tomatoes contains about 45 lb. of vegetables and tomatoes dry in the ratio of about 15 lb. of fresh to 1 lb. dry.

Table I, compiled from data published by Prescott and Sweet,¹ summarizes the relation between the weight of dried and canned products from one ton of fresh fruits and vegetables.

TABLE I. WEIGHT OF ONE TON OF VARIOUS FRUITS AND VEGETABLES CANNED AND DRIED

Material	Weight Canned and Boxed, Lb.	Weight Dried, Lb.
Corn.....	1,426	465
Peas.....	4,291	350
String beans.....	3,832	200
Tomatoes.....	1,763	125
Pumpkins.....	2,146	200
Sweet potatoes.....	2,250	513
Cabbages.....	2,400	215
Apples.....	2,640	200-300
Peaches.....	2,850	300-400
Apricots.....	2,850	300-400
Pears.....	2,850	400-570

Dehydrated foods are of "net food value." That is there is no waste in paring or trimming or waste in discarding sirup or brine as is the case with fresh and canned products. The usual labor involved in preparing fresh vegetables for cooking is eliminated for the housewife. All that she need do is to soak the vegetables several hours in water and they are ready for cooking.

However, the principal argument advanced by housewives against dehydrated foods is the fact that they must be soaked in water before cooking. Dehydrator operators are now attempting to develop methods of drying that will permit cooking of the dried products without preliminary soaking. Considerable progress has been made upon this problem.

DEHYDRATION DEFINED

There is considerable confusion regarding the proper terminology for dried products. Manufacturers of equipment used for drying foods almost universally style their machines "dehydrators" and speak of the process as "dehydration." The producers of dried fruits and vegetables use the terms dehydration, evaporation and desiccation. It is probable that "dehydration" is the term most commonly used.

A committee² of representative producers, investigators and dealers in dehydrated products in California adopted the following recommendations:

1. That "drying" be considered the general term applying to all methods.

2. That "sun drying" be used to designate the drying of fruits by the sun's heat.

¹"Commercial Dehydration: A Factor in the Solution of the International Food Problem," by S. C. Prescott and L. D. Sweet; *Annals of the American Academy of Political and Social Science*, May, 1919, No. 1294.

²Committee consisting of A. W. Christie, University of California; P. F. Nichols, U. S. Department of Agriculture, Division of Dehydration Investigations; F. C. Simonds of E. C. Horst Co.; E. W. Sheehan, dealer in dried fruits; H. C. Rowley, Editor *California Fruit News*.

3. That "evaporation" and "dehydration" be considered of equal value in designating the drying of foods by artificially produced heat.

Prof. S. C. Prescott, former chief of the Division of Dehydration Investigations of the U. S. Department of Agriculture, prefers to give modern dehydration a meaning somewhat different than that of evaporation. He considers that dehydration is a more carefully controlled process and results in a superior dried article to that produced by evaporation. His definition follows: "When we speak of 'modern' dehydration we mean foods which either with or without previous treatment have been subjected to the action of carefully regulated currents of air in which the temperature and humidity are both properly controlled, a process which results in the food gradually losing water, but without giving up its color or flavor or having its cellular structure injured."

The writer believes that the word dehydration will in time displace in popular favor the word evaporation, judging from the marked present tendency.

Many of the processes used in dehydration are based upon the results of empirical experiments, but there are certain underlying fundamental principles which afford a rational basis for study of the subject.

HEAT EFFICIENCY

Dehydration involves the change of water from the liquid to the vapor state. This change requires the expenditure of a definite amount of heat, which is about 965 B.t.u. per pound of water evaporated at 212 deg. F.



FIG. 2. STACK EVAPORATOR

and 1,102 B.t.u. at 60 deg. F. From 50 to 75 B.t.u. must be added for each pound of fruit to account for heating the fruit from room temperature to the temperature used in the evaporator. The fuel efficiency of an evaporator can be judged by its approach to the theoretical minimum in its use of heat. We may take this minimum as approximately 1,075 B.t.u. For field purposes A. W. Christie and the writer use the following formula for arriving at an approximate measure of the efficiency of evaporators:

$$E = \frac{F - D \times 1075}{G \times 135000}$$

In this formula

E = fuel efficiency of the evaporator.

F = pounds of fresh fruit placed in the evaporator during the test.

G = gallons of fuel oil used during the test with an assumed calorific value of 135,000 B.t.u. per gal.

D = pounds of dry fruit removed from the evaporator during the test.

Most evaporators tested show an efficiency of less than 50 per cent. An efficiency of 40 per cent is considered good. One reason for this relatively low efficiency is found in the fact that the air must be allowed to leave the evaporator from 20 to 60 deg. F. above the outside air—e.g., air will often be taken into the furnace room at 80 deg. F., then heated to 165 deg. F., used in drying and leave the evaporator at 110 deg. F. It has been raised 85 deg. F. and the air still retains unused 30 deg. F. of the original rise in temperature as it leaves the evaporator.

Many evaporator designers fail to take into account these facts and equip their plants with too small an air-heating system.

AREA OF HEATING SYSTEM

If air is to be heated by steam coils or furnace pipes the total area of the heating surface required may be arrived at by means of the following formula.³

$$H = \frac{Cg}{tm(2 + 10\sqrt{c})}$$

where

H = heating surface in square meters.

tm = mean difference in temperature of the surface and air.

c = velocity in meters per second.

Cg = calories per hour required.

The heating system is more efficient the greater the difference in temperature tm .

The heat transfer varies with the square root of the air velocity—that is, the coefficient of heat transmission is

$$K = 2 + 10\sqrt{c}$$

where c = velocity of the air.

The area of the heating system must be large enough for the coldest weather of the drying season and should allow for a generous safety factor in addition.

VOLUME OF AIR REQUIRED

Air is preferred for dehydration purposes to the use of directly applied heat because overheating of the product is easily avoided; air is convenient to use; equipment for its use is cheap and it permits of easy regulation of the rate of drying and other conditions. It performs two functions in the dehydrator. It conveys heat to the material to be dried, thereby causing evaporation of the moisture, and secondly, it carries away this moisture.

The air must leave the evaporator at a high enough temperature to hold all of the moisture absorbed by it during its passage through the evaporator. Therefore there is a limit to the temperature drop in the evaporator, and for the same reason a limit to the fuel efficiency attainable under usual drying conditions. On hot summer days it is possible to obtain rapid drying by means of a blast of air not artificially heated, or such air may be artificially heated a few degrees only before use. In such cases use is made of the sun's heat, and any

³E. Hausbrand, "Drying by Means of Air and Steam," translated by Wright and published by Scott Greenwood & Co.

calculation of fuel efficiency would have to take this fact into account.

The capacity of air to take up water vapor increases rapidly as the temperature rises. The moisture-absorbing power is approximately doubled by each 27 deg. F. rise in temperature. For example, at 128 deg. F. 350 cu.ft. of air will contain at saturation about 2 lb. of water vapor and at 155 deg. F. about 4 lb. Therefore in calculating the volume of air necessary to carry away from the evaporator the liberated moisture it is necessary to take into account its temperature.

In designing an evaporator, however, the volume of air necessary is not determined by the amount needed to carry away the liberated moisture, but rather by the volume necessary to convey sufficient heat to the product to be dried to cause the desired rapidity of evaporation, because a much larger volume of air is required to furnish the necessary B.t.u. than is required for removal of moisture. For example, at drying temperatures in most common use about 63,000 cu.ft. of air dropping 1 deg. Fahrenheit is required to furnish heat to evaporate 1 lb. of water. Under average conditions the temperature drop will be about 50 deg. F., or the amount of air required to evaporate each pound of water will be $63,000 \div 50 = 1,260$ cu.ft. Since air expands upon heating, larger volumes are required for each 1 deg. F. drop at higher than at lower temperatures.

An evaporator, holding five tons of fresh fruit, which must be dried to one-fifth its original weight in a drying time of fifteen hours, under a temperature drop of 50 deg. F. for the air used, would require an air flow of $\frac{8,000 \times 63,000}{15 \times 50 \times 60} = 11,200$ cu.ft. per minute, since the amount of water to be removed is 8,000 lb.

Experience demonstrates that this amount of air is a minimum for the conditions cited.

EFFECT OF HUMIDITY

For evaporation of water from a free surface the rate of evaporation varies inversely with the relative humidity of the air. This rule does not always hold for the evaporation of water from fruits or vegetables, because of the tendency of some products to "case-harden." Case-hardening is a toughening of the surface—i.e., formation of a semi-impervious film—and greatly retards the rate of evaporation. Case-hardening is caused by the water evaporating more rapidly from the surface than it can be replaced by diffusion from the tissues. It is a result of use of air of too low relative humidity and can be corrected by increase of the relative humidity to the point where diffusion to the surface keeps pace with evaporation from the surface. Pears and potatoes are notable examples of products which case-harden badly. Control of humidity in drying is, therefore, of very great importance and is one of the fundamental principles which are urgently in need of further investigation. Preliminary experiments indicate that the use of air of relatively high humidity (30 to 50 per cent) has very much wider application than was formerly supposed.

AIR VELOCITY

Other things being equal, the rate of evaporation of water from a free surface varies directly in proportion to the rate of application of heat. Since the transfer of heat from air to the material to be dried varies with the square root of the velocity of the air, then the rate

of evaporation should vary in like ratio, that is, in proportion to the square root of the air velocity.

There is a practical limit to the air velocity to be used in practice because of rapid increase of static pressure at high velocities. According to Hausbrand¹ a velocity of 1,150 ft. per minute over the drying trays and of 570 in flues between the fan and drying tunnel should not be exceeded. Our own observations confirm Hausbrand's recommendations.

Less air, and therefore a lower velocity, is required at higher temperatures than at lower temperatures. Thus at 158 deg. F. and 122 deg. F. the relative volumes of air required for the evaporation are in the ratio 5,775 : 9,809 if the outside air is at 58 deg. F. Some evaporators tested by the writer are capable of delivering an air velocity of 900 ft. per minute across the drying trays, but the usual flow is less than 400 ft. per minute. The writer would recommend a velocity 700 to 1,000 ft. per minute.

RECIRCULATION

Since less than 25 per cent as much air is required to carry away evaporated moisture as is necessary to furnish the necessary heat units, it is, theoretically at least, economical to return at least 75 per cent of the spent air to the heating chamber, reheat it and use it again. This has been proved in commercial operation to be good practice. A large flue above or below or beside the drying tunnel can be used to return the air, and air outlets and intakes can be adjusted to maintain the desired ratio of intake to outlet air.

Where case-hardening is encountered, recirculation affords one means of increasing the humidity of the air.

The return flue should be large and the air velocity therein should not exceed 500 ft. per minute.

CRITICAL TEMPERATURES

Although high temperatures of drying give more rapid drying and more efficient use of fuel, there is a temperature for each product either at the beginning or the end of the drying period above which rapid breaking down of the tissues occur or caramelization takes place. We may term this maximum temperature as the critical temperature for the product in question. Caramelization and injury to flavor are more apt to occur near the end of the drying period. Freshly cut apples, or peaches or fresh grapes will withstand very satisfactorily temperatures of at least 195 deg. F., but near the end of the drying period, when the moisture content is low, caramelization will occur rapidly at 175 deg. F. For most fruits a finishing temperature above 150 deg. F. should not be used. Dried vegetables "come back" or "refresh"—that is, reabsorb water more rapidly and return to the more nearly the fresh weight and appearance—if dried at temperatures below 150 deg. F. than if dried at 160 to 165 deg. F.

Higher air velocities and lower drying temperatures will improve the quality of all dehydrated products without lengthening the drying time. These changes are badly needed in many plants.

TYPES OF DEHYDRATORS

There are in use on the Pacific Coast two important types of air current dehydrators. In one of these the heated air rises naturally between and across the pieces of product to be dried. In the other the air by means

¹E. Hausbrand, "Drying by Means of Air and Steam"; Longmans, Green & Co.

of a fan is blown or drawn across or between the pieces of material to be dried.

There are many forms of each type. The Oregon tunnel is the most important form of natural draft evaporator in use on Pacific Coast. One form of Oregon tunnel consists of a concrete or brick furnace room about 18 x 10 ft. in size and about 10 to 12 ft. high, surmounted by several sloping tunnels each about 3 x 5 x 20 ft. in size. The furnace room contains two wood burning furnaces and about 35 ft. of 12 or 14 in. sheet metal pipe. The air is admitted at the base of furnace room walls; is heated by contact with the furnaces and pipes, and rises through the tunnel and across the trays to a ventilator at the upper end of the tunnel.

The stack evaporator consists of a cabinet containing trays set over a furnace room similar to that used for the Oregon tunnel. The air rises through the trays.

The apple kiln form of evaporator consists of a grated floor above a furnace room.

Any of these three forms may be equipped with a fan and the air flow thereby increased, but it has been found much more satisfactory to construct longer and nearly horizontal tunnels through which a blast of heated air is passed across the trays or conveyor of material to be dried. This form permits of recirculation of the air and accurate control of temperature and humidity. To date, the car and tray system of handling the drying fruit or vegetables has proved more satisfactory than the endless metal cloth or belt conveyor system, because of waste of space, sticking of dried material and non-uniformity of drying in the latter.

Many patents have been issued for evaporators and attachments. One man holds a patent upon the use of drying temperatures between 125 and 156 deg. F. Everyone who dehydrates fruit is infringing on his patent. Another holds a patent for drying by means of air drawn across the product to be dried. Infringements are numerous. A few patent suits would clear the situation.

The writer prefers the tunnel type of drier, recirculating air flow, suction fan, and car and tray system. It has proved much more efficient than the natural draft types by actual test.

RESULTS OF EXPERIMENTS

Very important results have been obtained by investigators of the U. S. Department of Agriculture, the state experiment stations, and commercial engineers and chemists. All of these cannot be enumerated here. A few typical results only will be offered.

As before intimated, the horizontal (or nearly horizontal) blast, tunnel type of drier with a recirculation system has proved more efficient and more economical of labor than the natural draft types.

High relative humidity of the air used in drying has been found necessary for products which case-harden—e.g., for pears, potatoes, tomatoes, large prunes and peaches. Most vegetables must be dried to a very low moisture content (less than 8 per cent) to prevent considerable changes in flavor and color.

Vacuum fumigation with CS₂ or heating to 145 deg. F. is effective against insect eggs. Not only the product but also the container (carton, box or can) should be treated, as the latter often contains eggs of the Indian meal moth, the most serious pest to dehydrated products. Low moisture content discourages their growth. Storage at 32 deg. F. will destroy insects and eggs.

Moderate temperatures (below 150 deg. F., preferably below 140 deg. F.) give the best products.

Static pressure (air resistance) has been greatly underestimated by many builders of dehydrators. Tests have shown that flues must be large and sharp angles in flues or tunnels avoided.

Higher velocity of air than is now in common use has proved economical and desirable. A velocity of 800 ft. per minute is recommended.

Blanching (partial precooking) of most vegetables has been shown to be desirable, because it hastens drying, destroys enzymes which would otherwise cause darkening and loss of flavor in the dried product, and because blanching improves and "sets" the color.

Very little sulphuring before drying is necessary for fruits to be dehydrated—much less than for sun-drying. Immersion in dilute salt solution still further reduces the length of sulphuring.

Dipping grapes in boiling dilute lye for a few seconds cracks the skins and shortens the drying period to half or quarter the time required for undipped grapes.

Wine grapes have been dehydrated in enormous quantities in California. (For the preparation of home-made "grape juice"? Draw your own conclusions!) Tests have shown that such raisins may be stemmed, seeded and used for making pies, puddings, etc.

The antiscorbutic value of dehydrated vegetables, especially spinach, is being studied by several investigators. Definite statements on this point would be premature at this time.

Canadian Gas Industry in 1918

The Canadian Bureau of Statistics has just issued an account of the illuminating and fuel gas industry in 1918, being advance sheets of Chemical and Allied Products of Canada in 1918.

There were thirty-eight plants in operation during the year, representing a capital investment for lands, buildings and equipment of \$23,577,224, and employing 1,932 persons at an average wage of \$957 per year. Five kinds of gas were manufactured—namely, straight coal gas and carburetted water gas, which sold at an average of \$1.20 per 1,000 cu.ft.; mixed coal and water gas, and mixed coal and oil gas, which sold at an average price of 85c. per thousand; and acetylene, which brought an average of \$16 per thousand. The average price obtained for the coke produced was \$5.66 per ton. The cost of the coal, oil, calcium carbide and other supplies was \$3,456,396; wages amounted to \$1,849,167; and rent, taxes, upkeep, etc., \$982,306, making a total of \$6,287,869. The sale of gas, coke and byproducts realized \$7,282,147, and the rent and sale of meters, lamps, etc., \$810,826, making a total of \$8,092,937, and showing a profit of \$1,805,104, which amounts to 7½ per cent interest on the capital investment.

Twenty of the thirty-eight plants are situated in Ontario, eight in Manitoba, four in Saskatchewan, three in British Columbia, two in Quebec and one in Nova Scotia. It is a little curious that the principal coal-producing provinces of the Dominion—Nova Scotia, Alberta, and British Columbia—should have only four plants among them, while Ontario, Manitoba and Quebec, which produce no coal, have thirty of the thirty-eight plants. The report does not deal with natural gas, which is used extensively in Alberta, Saskatchewan and Ontario, and in smaller quantities in New Brunswick.

Water-Cooled Acid Chambers Adopted in England

Description of the Mills-Packard Water-Cooled Sulphuric Acid Chambers—Seven Years' Industrial Expansion—Design of the Frustum Chamber—Lead, Steel and Cooling Water Used—Economic Advantages Obtained

By ANDREW M. FAIRLIE*

THE first acid chambers of the Mills-Packard type¹ were built for Edward Packard & Co. at Bramford, near Ipswich, England, in the year 1914. There were two of these chambers, built as replacement of part of an old plant, and they have a rectangular chamber of the ordinary type operating in conjunction with them. However, before connecting these two new chambers to the old rectangular chamber, they were operated for some time by themselves, as an experiment, which proved so successful that it led to the construction of similar chambers at other plants. In 1916 twenty-four chambers of this type were built at eight different plants, all in England, for six different companies. Of these eight plants, three had these chambers exclusively and five had rectangular chambers of the ordinary type in conjunction. In 1917 eighteen Mills-Packard chambers were built, at seven different plants for five different companies, all in England. In 1918 only nine of these chambers were erected, and these were for three different companies, all in England, making a total, up to the close of 1918, of fifty-three Mills-Packard chambers, built or under construction.

While the expansion of the invention had proceeded quite rapidly in England, the war had interfered with its development in foreign countries. The first installation of these chambers outside of the British Isles was at Auckland, New Zealand, where a plant of eight chambers was built in 1918-19. During 1920, in addition to nineteen chambers built at four different plants in England, sixteen of the chambers were erected for two different companies in France, and fourteen for two different companies in Italy—a total of forty-nine chambers for the year 1920, of which all but seven were still under construction at the close of the year. P. Spence & Sons of Farnworth, England, have this year (1921) constructed one additional chamber. Altogether, since 1914 a total of 111 Mills-Packard chambers have been installed or contracted for, located at twenty-seven different plants, and built for twenty-two different companies in four different countries.

OPERATION OF COOLING EFFECT

The invention of this water-cooled chamber was due to the observation of a very common occurrence. In Great Britain it had for many years been the custom to have no building inclosing the acid chambers. A heavy rain in the summer time, following a period of heat, has a marked effect on such chambers, unprotected by so much as a roof, and the cooling of the atmosphere, combined with the effect of the cool rain

flowing over the chamber sides, causes a sudden drop in chamber temperatures through the plant, with much easier operation of the process and evidence of excess of nitrous gas within the chambers, which excess could have been saved had allowance been made for the effect of the rain. Mills and Packard had observed this and wondered why water applied continuously to the outside of the chamber curtains might not increase the production capacity of a plant, or reduce the niter consumption, or both. This thought led to the necessity for a chamber of such design as would be appropriate for the application of water on the outside, and the new chamber was the outcome.

DESIGN OF THE CHAMBER

The Mills-Packard chamber is formed in the shape of the frustum of a cone, with either a raised or slightly dished top. The curtains are supported by either wood or steel columns, but steel is preferred. The bottoms of the curtains dip into the acid contained in a lead pan, forming the familiar liquid seal. Fig. 1 shows respectively the elevation, sectional plan and sectional elevation of this type of chamber.

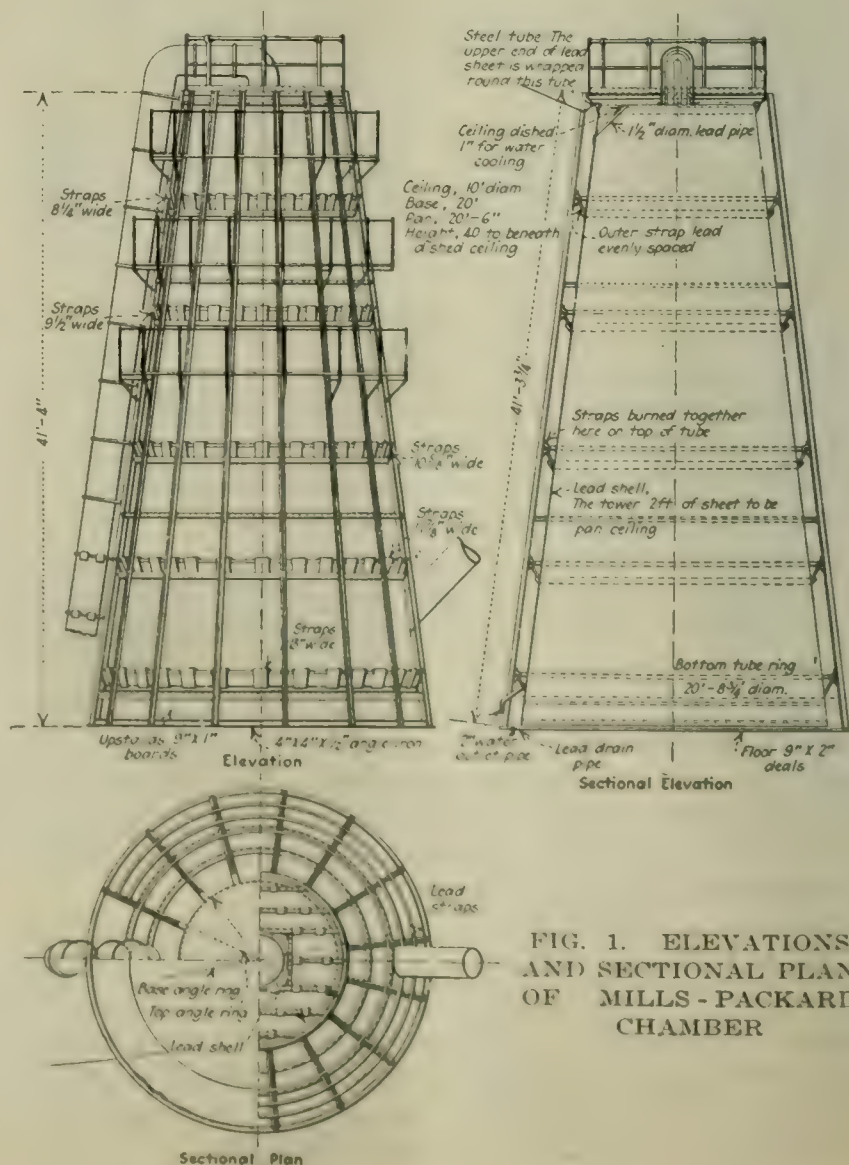


FIG. 1. ELEVATIONS AND SECTIONAL PLAN OF MILLS-PACKARD CHAMBER

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¹The Mills-Packard patented water-cooled sulphuric acid chamber is the invention of Willie George Mills and Charles Turner Packard, both of Ipswich, County of Suffolk, England. The invention is protected in the United States by U. S. Pats. 1,112,546 (Oct. 6, 1914), 1,312,741 and 1,312,742 (Aug. 12, 1919), and is owned by the firm of Packards & James Fison (Thetford), Ltd., Ipswich, England.

Tabulation of Data on Mills-Packard Installations

Name of Company	Location	Date Built	No. of Chambers	Size of Chambers Cu.Ft.	Kind of Chambers	Source of Sulphur	Cu.Ft. Chamber Space per lb. Sulphur per 24 Hours	Nitrate of Soda Consumption Per Cent on Sulphur	Ground Space Occupied by M.-P. Chambers Ft.	Remarks
Ed. Packard & Co., Ltd.	Bramford, England	1914	2	7,330	2 M.-P. and 1 rectangular	Spent oxide	6.4 to 6.6	3 to 3.5	55x30	Replacement of old plant coupled to existing plant.
F. W. Berk & Co., Ltd.	Stratford, England	1916	4	7,330	All M.-P. chambers	Spent oxide	3.8 to 4		100x30	Replacement of plant.
F. W. Berk & Co., Ltd.	Stratford, England	1916	1	7,330	M.-P., combined with several rectangular chambers	Brimstone			30x30	
J. & J. White	Glasgow, Scotland	1916	3	7,330	M.-P., with one rectangular chamber	Pyrites	5.6		80x26	Replacements of old plant coupled to existing plant.
Spencer Chapman & Messel, Ltd.	Silvertown-London, England	1916	3	7,330	M.-P., with one rectangular chamber	Pyrites	5.8	Abt. 2.8	80x28	Renewal of old plant coupled to existing plant.
Chance & Hunt, Ltd.	Oldbury, England	1916	3	7,330	All M.-P. chambers	Zinc blende	4.4	2.4*	80x30	Complete new plant erected.
Chance & Hunt, Ltd.	Oldbury, England	1916	2	7,330	M.-P., with rectangular chambers	Pyrites			50x30	Renewal of old plant coupled to existing plant.
Bolehow Vaughan & Co., Ltd.	Ferry Hill, England	1916	6	7,330	All M.-P. chambers	Pyrites	3.6*	4.02*	80x54	*12 months average actually reported.
Egglescliffe Chemical Co., Ltd.	Yarm-on-Tees, England	1916	2	7,330	M.-P., with rectangular chambers	Pyrites	9 to 10		55x30	Addition to plant. Total cham. space = 227,000 cu.ft. (one unit). M.-P. cham. = 6.4% of total chamber space.
Cwmbran Chemical Co., Ltd.	Cwmbran, England	1917	2	7,330	M.-P., combined with 3 rectangular chambers	Pyrites or spent oxide	Abt. 10		55x30	No report other than installation is entirely satisfactory.
Cwmbran Chemical Co., Ltd.	Cwmbran, England	1917	1	7,330	M.-P., combined with "OPL" plant	Pyrites	Abt. 2.7		27x27	
W. Norfolk Farmers Manure Co.	Kings Lynn, England	1917	2	7,330	M.-P., combined with rectangular chambers	Pyrites	Abt. 12 to 13	Abt. 3.0	55x29	Rectangular chambers = 172,424 cu.ft. M.-P. Chambers = 14,660 cu.ft.
Wm. Pearce & Sons, Ltd., amalgamated with Spencer Chapman & Messel, Ltd.	Bow-Common, London, Eng.	1917	3	7,330	M.-P., combined with one rectangular chamber	Spent oxide	Abt. 6.5	Abt. 3.8	80x30	Addition to existing plant (renewal).
Thomas Jackson & Co., Ltd.	Manchester, England	1917	1	7,330	M.-P., with one rectangular chamber	Spent oxide or brimstone				Addition to existing plant (renewal).
P. Spence & Sons, Ltd.	Farnworth, nr. Widnes, England	1917	6	11,890	All M.-P. chambers	Pyrites	3.66	3.62*	93x93	*2 months' average (6 chamber unit).
P. Spence & Sons, Ltd.	Farnworth, nr. Widnes, England	1917	3	11,890	All M.-P. chambers	Pyrites	3.66	3.62	93x93	(No definite information re 3 ch. plant)
Ed. Packard & Co., Ltd.	Bramford, England	1918	3	7,330	M.-P., with 2 rectangular chambers	Pyrites	8 to 10	3 to 4	80x30	Addition to existing plant (renewal).
Odams Nitre Phos. & Chem. Co.	London, England	1918	3	7,330	M.-P., with two small rectangular chambers	Pyrites			80x28	
Forbes, Abbot & Lennard	Shoreham-by-Sea, England	1918-19	3	7,330	All M.-P. chambers	Spent oxide and sulphuretted hydrogen				
New Zealand Farmers Fertilizer Co., Ltd.	Auckland, New Zealand	1918-19	8	18,750	All M.-P. chambers	Jap. brimstone	Basis: 3.6 to 4		80x29	No report re working of plant. Built but not yet started (information early 1920).
Cleckheaton Chem. Co., Ltd.	Cleckheaton, Eng. and	1920	7	7,330	All M.-P. chambers	Pyrites	3.6	2 to 3	170x80	Complete new plant erected
Establishment Kuhlmann	Lille, France	1920	12	7,330	All M.-P. chambers	Zinc blende	Basis: Abt. 4.6		150x57	In course of erection, complete plant.
Co-operative Cremonese	Cremona, Italy	1920	6	7,330	All M.-P. chambers	Pyrites	Basis: 3.6 to 4		81x56	In course of erection, complete plant.
Primo Consorzio Agrario	Piacenza, Italy	1920	8	7,330	All M.-P. chambers	Pyrites	Basis: 3.6 to 4		105x56	In course of erection, complete plant.
Usines de Produits Chimique D' Hautmont	Hautmont, France	1920	4	7,330	M.-P., with rectangular chambers	Spent oxide				In course of erection.
Sheffield Chemical Co., Ltd.	Sheffield, England	1920	3	7,330	M.-P., with 3 rectangular chambers	Spent oxide			80x29	In course of erection.
Midland Acid Co., Ltd.	Pye Bridge, England	1920	3	7,330	M.-P., with 3 rectangular chambers	Spent oxide			80x30	In course of erection.
Cwmbran Chemical Co., Ltd.	Cwmbran, England	1920-21	6	7,330						In course of erection.
P. Spence & Sons, Ltd.	Farnworth, England	1921	1	11,890						Addition to plant.

Referring to Fig. 1, it will be noted that the total height of the chamber curtains or walls is divided into five sections, and that at the bottom of each section there is a lead trough completely encircling the chamber. While Fig. 1 shows the chamber walls divided into five sections by five lead troughs, it may be explained that the figure is a drawing of the smallest size chamber and that the larger sizes have a larger number of lead troughs, dividing the chamber walls into a greater number of water-cooled sections. The detail of the lead trough is shown in Fig. 2, an elevation and a section reproduced from the patent specification.²

In Fig. 2 a lead gutter 8 is burned to the lead curtain 1 at the bottom of each lead trough 7, and both gutter and trough completely encircle the chamber. The cooling water flowing down the chamber side is collected in the trough 7, from which it flows, through hole 6, into gutter 8, and then escapes from gutter 8 through the serrated notches at the upper outer edge 9, to flow again down the chamber sides to the next trough below. The lead strap hanging vertically in front of the hole 6 is to prevent splashing of water.

MATERIALS REQUIRED

These chambers have been built in three sizes, of 7,330, 11,890 and 18,750 cu.ft. capacity each, respectively. The smallest size (7,330 cu.ft.) is 20 ft. in diameter at the base and 10 ft. in diameter at the top and is 40 ft. high. The total weight of lead required for such a chamber, including pan, gas connections, etc., is approximately 12.75 long tons, and the total weight of steel is approximately 5.5 long tons. The storage capacity of the pan of such a chamber is 22.4 tons of chamber acid. The quantity of cooling water required is 250 gal. per hour per chamber.

A larger chamber (11,890 cu.ft. capacity) is 47 ft. high and has a diameter of 23.5 ft. at the base and 11.75 ft. at the top. This chamber requires approximately a total of 8.25 long tons of steel and 19.25 long tons of lead, using throughout lead weighing 7 lb. per sq.ft. The quantity of cooling water required for such a chamber is 350 gal. per hour.

Only one plant consisting of chambers of the largest size (18,750 cu.ft.) has ever been built. That plant was erected at Auckland, New Zealand. A chamber of this largest size requires approximately 23 long tons of lead.

²U. S. Pat. 1,312,741.

The tonnage of steel for such a chamber is not known, as the chambers at Auckland had timber supports. The weights given here for the lead required for the three sizes of chambers do not include the lead in false bottoms. If false bottoms are installed, the lead requirements given would be increased by the following weights: For the smallest chamber, 1.1 tons; for the medium chamber, 1.45 tons, and for the largest chamber, 1.6 tons. False bottoms have not been installed except where the platform has been of steel construction. The water used for cooling the outside of the chambers should be reasonably clean, as foreign matter may interfere with the equal distribution of the water

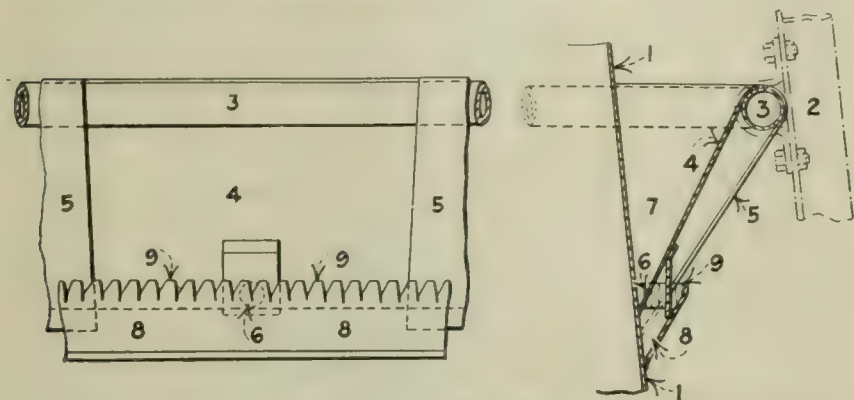


FIG. 2. ELEVATION AND SECTION OF LEAD TROUGH

over the chamber sides, or muddy water may leave a deposit on the lead. Where the cooling water is subject to rapid growth of algæ, the trouble can be eliminated by treatment with a small quantity of copper sulphate. In cleaning the gutters or troughs, care must be taken not to pull them out of shape.

ECONOMIC ADVANTAGES OBTAINED

The advantages claimed for these chambers are:

1. The chamber space required per unit of sulphur burned is reduced to from one-half to one-third the usual space.
2. A very material saving in cost of chamber construction per unit of capacity for making acid. The reduction in cost of chamber construction is said to be from 30 to 40 per cent.
3. A substantial saving in ground space per unit of production capacity.
4. Longer life of the lead chambers.
5. Usually no building is required for housing the chambers.
6. Niter consumption, per unit of sulphur made into acid, is no higher than with the ordinary type of chamber.

7. Feasibility of combining one or more Mills-Packard chambers with rectangular chambers of existing plants, or with tower systems, to increase production capacity at small construction cost.

The principal one of these advantages is the reduction in initial cost of plant for producing a given quantity of acid, brought about by the greatly diminished chamber space required per unit of acid made. Actual operating results for plants composed of these chambers exclusively show only 3.5 to 4.5 cu.ft. of chamber space per pound of sulphur burned per twenty-four hours. Built as an adjunct to the rectangular chambers of an old plant, these water-cooled chambers are effective in reducing the total chamber space required.

Operated at a rate of 3.5 to 4.5 cu.ft. per pound sulphur per twenty-four hours, the niter consumption is stated to be no greater than in the ordinary plant employing 8 to 10 cu.ft. per pound of sulphur. Actual operat-

ing results show a niter consumption of from 3 to 4 per cent, based on the sulphur burned. It is possible if a Mills-Packard plant were operated at a less intense rate—at a rate, for instance, of 6 to 8 cu.ft. per pound of sulphur in twenty-four hours—that considerable economy in niter consumption might result. No data are available on this point, however, as the demand for acid has been so great that Mills-Packard chambers have been run at the intensive rate of about 3.5 to 4.5 cu.ft. of space per pound of sulphur per day.

WIND PROTECTION SOMETIMES REQUIRED

A view is shown in Fig. 3 of an installation of nine Mills-Packard acid chambers. It is the customary practice, in erecting these chambers, to leave them unhoused. In exceptionally exposed places, however, a light wind screen, to protect the chambers about half way up, is advisable, and such a screen is generally recommended for the chambers of the larger sizes, if the location is at all exposed. With timber framework, complete housing would be considered necessary in some climates, and for this reason steel framework is preferred. The chambers at Auckland, New Zealand, having timber framework, are completely housed, and this is the only fully housed Mills-Packard chamber in existence at the present time. In the case of the nine chambers of the medium size erected for P. Spence & Sons, England, a



FIG. 3. VIEW OF NINE-CHAMBER MILLS-PACKARD PLANT

wind screen of light construction about 25 ft. high was built around the chambers.

SOME TYPICAL DATA

The operation of this type of chamber, it is claimed, involves no greater supervision than the operation of chambers of the ordinary type. The following table, quoted from a letter dated May 25, 1920, from an English acid manufacturer, gives the chamber temperature for each of six of a set of Mills-Packard chambers of the intermediate size (47 ft. high):

Chamber No.	Temp. Deg. C.	Chamber No.	Temp. Deg. C.
1	77-84	4	50-60
2	62-72	5	30-40
3	60-70	6	20-30

The same manufacturer quoted for these chambers a total chamber space used of 3.66 cu.ft. per pound sulphur burned per twenty-four hours, with a niter consumption of 3.62 per cent, based on sulphur burned, as average

figures for March and April. This manufacturer allowed the chamber drips, in the front chamber, to run as high as 124-132 deg. Tw. (55-57 deg. Bé.). The Packard company, however, recommend chamber drips of not more than 100-115 deg. Tw. (48-53 deg. Bé.), which corresponds to the usual practice in this country.

The maintenance cost for these chambers is said to be very light. As some of the chambers have been erected for seven years, it is possible to get some idea as to upkeep expense. A letter from E. Packard & Co. states that repairs to the lead have been limited, so far as experience at their own plant goes, to a few cracks where the straps were burned to the curtains, and these cracks were easily repaired. Of two samples of lead taken from the curtains of a chamber after five years one showed a loss of 1.89 per cent and the other no loss.

One chamber has been erected in connection with an Opl tower plant in England, and the same company has two Mills-Packard chambers operating in connection with rectangular chambers of the ordinary type. This firm is now building six additional Mills-Packard chambers.

So far no Mills-Packard chamber has been erected in the United States. It has already become quite popular in England, however, and last year the popularity began to spread into continental Europe, indicating sound foundation for the peculiar merits claimed for the external water-cooling.

Legal Notes

BY WELLINGTON GUSTIN

U. S. Supreme Court Holds Burchenal Patent Void for Anticipation by the Normann Process

The decision of the Supreme Court of the United States in the patent case between the Berlin Mills Co. and the Procter & Gamble Co. (41 S. C., 75) presents some interesting facts. The suit was brought by the latter company for infringement of the patent of John J. Burchenal for a food product, issued in 1915, No. 1,135,351, and assigned to it. The District Court held the patent void for lack of invention, but the Circuit Court of Appeals held the patent valid and infringed. (167 C. C. A., 295.)

The patent relates to a product consisting of vegetable oil partially hydrogenized to a homogeneous whitish yellowish product. The record in the case discloses that the making of lard substitutes has been accomplished by mixing melted fat with vegetable oils containing glycerides—olein, linolin and stearin. The hydrogenation, or hardening process, has the effect of increasing the proportion of the solid glycerides of high saturation. Stearin is called a saturated glyceride, for the reason "that there are present in the molecule as many hydrogen atoms as possibly can be joined to the carbon atoms." Linolin and olein are called unsaturated glycerides, and can be converted by the addition of hydrogen into hardened glycerides.

PURPOSES SET OUT BY INVENTOR

The purposes set out and the inventor's intention are as follows: "The special object of the invention is to provide a new food product for a shortening in cook-

ing, in which the liability to become rancid is minimized, and in which the components of such vegetable oils which are inferior and detrimental to use as such a food product have been to a large extent converted into a higher and more wholesome form. All such vegetable oils contain glycerides of unsaturated fatty acids and, among these, notable quantities of fatty glycerides of lower saturation than olein. It is the presence of these glycerides of lower saturation that seriously affects the rancidity, which oxidation weakens the fat at the point of absorption at the double bonds, and these glycerides of lesser saturation readily absorb oxygen from the air at ordinary temperatures, while the more highly saturated glycerides, as olein, only absorb oxygen at elevated temperatures. It is evident, therefore, that oils or fats containing notable quantities of glycerides of linolic acid, or of lesser saturation, are distinctly inferior as an edible product to those containing a minimum of these glycerides with a larger per cent of olein. On the other hand, while it is important to get rid of the readily oxidizable glycerides of lower saturation, it is also important not to supply too large a per cent of fully saturated glycerides. . . . Oil, liquid at the ordinary temperatures, does not make the best shortening because the oil remains liquid, keeping the food in a soggy condition, and the oil will even settle to the under part of the cooked product and soil the cloth, paper or whatever it may come in contact with. Moreover, fats of a melting point above the temperature of the human body, 98 deg. F., are not so digestible as fats which are liquid at this point, or which have a melting point below 98 deg. F. It is therefore my object in the preparation of my new lardlike composition and food product, and in preparing same from cottonseed oil, to change the chemical composition of the oil to obtain a product with a high percentage of olein, a low percentage of linolin and the lesser saturated fats, and with only sufficient stearin to make the product congeal at ordinary temperatures.

PROCESS AS DESCRIBED IN THE PATENT

"In manufacturing this product cottonseed or other vegetable oil is caused to absorb chemically a limited amount of hydrogen by reacting on the oil with hydrogen in the presence of a catalytic agent and at an elevated temperature. The oil is preferably agitated in a closed vessel in the presence of an atmosphere of compressed hydrogen, a catalyzer of finely divided nickel carried by kieselguhr being maintained in suspension in the oil and its temperature being raised to about 155 deg. C.

"According to the present invention the amount of hydrogen absorbed is carefully regulated and limited. In practice, the operation is stopped when the oil has been converted into a product which cools to a white or yellowish semi-solid more closely resembling lard than do the commercial mixtures of cottonseed oil and animal oleostearin, while in many respects the product is superior to the best leaf lard as a shortening. It is not so liable to become rancid, and the product can be heated to a considerably higher temperature than lard without smoking or burning. . . . The high temperature to which my product can be raised without smoking or burning makes the product ideal for frying, inasmuch as a crust forms almost instantly on the food fried, which prevents any absorption of the shortening. A lardlike product thus prepared from cottonseed oil has a saponification value of about 195

and an iodine value ranging from about 55 to about 80. The product having an iodine value of 55 has a titer of about 42 deg. and a melting point of about 40 deg. C., that having an iodine value of 80 has a titer of about 35 deg. and a melting point of about 33 deg. C. While but partially hydrogenized, containing from about 1.5 per cent to 2.5 per cent of additional hydrogen more than in the non-hydrogenized material, it shows no free cottonseed oil when subjected to the Halphen test, thereby differing from all commercial lard substitutes containing this oil. It contains from 20 to 25 per cent of fully saturated glycerides, from 5 to 10 per cent linolin, and from 65 to 75 per cent olein, and an average of a number of samples gives 23 per cent of saturated fats, 7.5 per cent linolin and 69.5 per cent olein, while the cottonseed oil before treatment contained 17 per cent saturated fats, 37 per cent linolin and 46 per cent olein. It will thus be seen that I have produced an ideal food product which is high in olein, low in linolin and lesser saturated fats, and with only enough stearin to make the product congeal at ordinary temperatures."

TWO BROAD CLAIMS INVOLVED

There are two broad claims of the patent involved in this case. They are:

(1) "A homogeneous lardlike food product, consisting of an incompletely hydrogenized vegetable oil."

(2) "A homogeneous lardlike food product, consisting of incompletely hydrogenized cottonseed oil."

It was necessary for the Supreme Court of the United States to consider what was theretofore known and disclosed in the act. Burchenal, the patentee, was not a chemist, it is said, and was the general manager of the Procter & Gamble Co. One Edwin C. Kayser, who had been in the employ of Crossfield & Son, an English firm, and familiar with the Normann process, to be considered hereinafter, came to this country in 1907 and entered into a contract with Mr. Burchenal whereby an experimental plant was erected at the Procter & Gamble works for hydrogenating oil.

It was the contention of the Procter & Gamble Co. that Burchenal was the first to originate and develop the process involved. The District Court found that he, in fact, invented nothing, and that all that was real invention came from Kayser. But, said the court, considering for the purpose of this discussion that the thought occurred to Burchenal, which he developed in the production of a food product, the primary question presented is whether what Burchenal accomplished amounted to invention within the meaning and protection of the patent law.

This was not claimed to be a process patent, but a product patent of a new and useful thing within the meaning of the patent law. Said the court, if this product were the result of mechanical improvement only, when viewed in the light of that which was previously disclosed and open to public use, the step in advance being only that which one skilled in the art might well make, without the exercise of the originating or inventing faculty, then the achievement is not within the protection of the patent law.

THE NORMANN PATENT

The English patent to Normann of October, 1903, disclosed to the world the process of converting unsaturated fatty acids or their glycerides into saturated compounds.

One expert witness gave his views on the Normann process as follows, in part:

"Dr. Normann discovered, and set forth in the patent, that unsaturated acids or unsaturated oils by the action of hydrogen in the presence of finely divided nickel may be converted into corresponding saturated compounds. He says, for instance, if fine nickel powder obtained by reduction in a current of hydrogen is added to chemically pure oleic acid, then the latter heated over an oil bath, and a strong current of hydrogen is caused to pass through it for a sufficient length of time, the oleic acid may be completely converted into stearic acid."

Dr. Normann himself said:

"By causing actylene, ethylene or benzene vapor in mixture with hydrogen gas to pass over one of the said metals, the said investigators obtained from the unsaturated hydrocarbons saturated hydrocarbons, partly with simultaneous condensation.

"I have found that it is easy to convert by this catalytic method unsaturated fatty acids into saturated acids. This may be effected by causing vapors of fatty acid together with hydrogen to pass over the catalytic metal, which is preferably distributed over a suitable support, such as pumice stone. It is sufficient, however, to expose the fat or the fatty acid in a liquid condition to the action of hydrogen and the catalytic substance.

"For instance, if fine nickel powder, obtained by reduction in a current of hydrogen, is added to chemically pure oleic acid, then the latter heated over an oil bath, and a strong current of hydrogen is caused to pass through it for a sufficient length of time, the oleic acid may be completely converted into stearic acid."

Dr. Normann did not specify in his patent any of the purposes for which his patents are intended, or what these products should be used for. It was said they might be used for any purpose for which fats of that general character could be utilized—as for candles, for soaps or for edible purposes. The court found Normann's process was a practicable one, and may be used for making food products of the kind involved in this case.

WAS NOT INVENTION, SAYS COURT

With the knowledge disclosed in the Normann patent, was it invention to apply the known process to vegetable oils? The record in the case established that it was known before Burchenal took up the subject that a vegetable oil could be changed into a semi-solid, homogeneous substance by a process of hydrogenation arrested before completion, and that it might be edible. This much of the art was public property and open to general use. The product of this process was known and open to public use, says the court, and to supply such products as the patentee has described in the broad claims in suit may have been new and useful, but did not, in the Supreme Court's opinion, rise to the dignity of invention, and is an advance step which would readily occur to one skilled in the art when he was investigating and considering the subject.

Therefore the Supreme Court reversed the decree of the Court of Appeals and the cause was remanded to the District Court with directions to dismiss the bill on the grounds that claims (1) and (2), set out above, were void.

Constitution of Chromium: Tungsten Steels

Recent Japanese Work Throwing Light Upon the Complex Reactions Giving Self-Hardening and Red-Hardness Properties to Modern High-Speed Steels—Edwards' Views on Like Subjects Are Also Briefly Given

HONDA and Murakami¹ have followed these investigations by a series of tests of steels containing both chromium and tungsten to determine the forms in which these two elements exist after normal slow cooling, their effect upon hardening and tempering and changes in the constituents during heating and cooling.

Three series of steels were used:

(1) W and Cr nearly constant at about 18 per cent and 5 per cent respectively, the carbon varying from 0.33 to 1.26 per cent.

(2) W and C nearly constant at about 18 per cent and 0.65 per cent respectively, the chromium varying from 0 to 7.35 per cent.

(3) Cr and C nearly constant at about 5 per cent and 0.65 per cent respectively, the tungsten varying from 0 to 18.8 per cent.

By similar experimental methods as used in their studies of chromium and tungsten steels as described briefly in *CHEMICAL & METALLURGICAL ENGINEERING*, vol. 24, pp. 703 and 745, these investigators reached the following conclusions:

1. In steels normally cooled from 900 deg. C. the Ar_2 or Ar_1 transformations occurring at 750 to 700 deg. C. decrease in magnitude almost to suppression. The lowered $Ar_{3,2}$ transformation² becomes conspicuous with increase in carbon from 0.33 to 0.57 per cent. If, however, the carbon content increases beyond 0.85 per cent the normal $Ar_{1,2,3}$ transformation once more begins to manifest itself at the expense of $A'_{3,2}$ and finally again is the only one noticed, occurring at the normal point in a steel containing 1.26 per cent carbon, about 18 per cent tungsten and 5 per cent chromium.

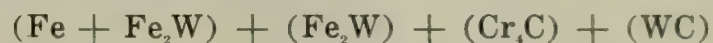
In steels similarly cooled from 1,200 deg. C. transformation Ar_2 of low-carbon steels is partially suppressed in magnitude with increasing carbon content. With carbon greater than 0.57 per cent the normal transformation has disappeared. As carbon content increases the temperature of lowered transformation ($A'_{3,2}$) gradually falls, reaching 100 deg. C. with 1.26 C steel.

2. Chromium in combination with carbon effects the suppression of the Ar_1 transformation, upon which self-hardening depends. With about 0.6 per cent carbon and 18 per cent tungsten 3 per cent of chromium is sufficient to suppress the 700 deg. change, and to effect self-hardening. Higher chromium is only effective in lowering $A'_{3,2}$ if more carbon is added, which agrees with Edwards' conclusions³ to the effect that hardness of hardened steels containing 0.6 per cent carbon and 18 per cent tungsten rapidly increases with the addition of chromium from 0 to 3 per cent, but when this

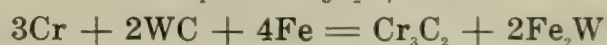
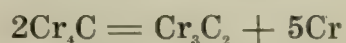
element is further increased the effect of this latter increase is almost nil.

3. The effect of adding tungsten to these high-speed steels is principally to diminish the maximum temperature at which, during cooling, the lowering of the transformation takes place. Its effect on the lowering or self-hardening property is small, provided chromium and carbon contents are as given for the steels described by Honda and Murakami. Edwards³ found the hardness of hardened steels containing definite proportions of chromium and carbon to be nearly constant as tungsten varied up to 12 per cent, but with further increase the hardness gradually became greater.

4. After normal slow cooling from 900 deg. C. a high-speed steel containing about 18 per cent tungsten, 5 per cent chromium and 0.6 per cent carbon consists of iron dissolving tungstide Fe_2W , free tungstide, tungsten carbide (WC), together with the non-magnetic chromium carbide Cr_4C , all in a free state. These may be represented as follows:



If the steel be heated a little above Ac_1 the carbides dissolve in austenite, but are reprecipitated at the normal Ar_1 point if the maximum temperature does not materially exceed Ac_1 . As the temperature of reheating increases, however, chromium carbide dissociates:



The higher the temperature the more the change proceeds from left to right, the products dissolving in austenite, except remnants of Fe_2W . In normal slow cooling from a high temperature the reverse change takes place to only a small degree, and therefore at room temperature the steel contains the carbides, chromium and part of the tungstide all in solid solution, which condition results in a hardened steel.

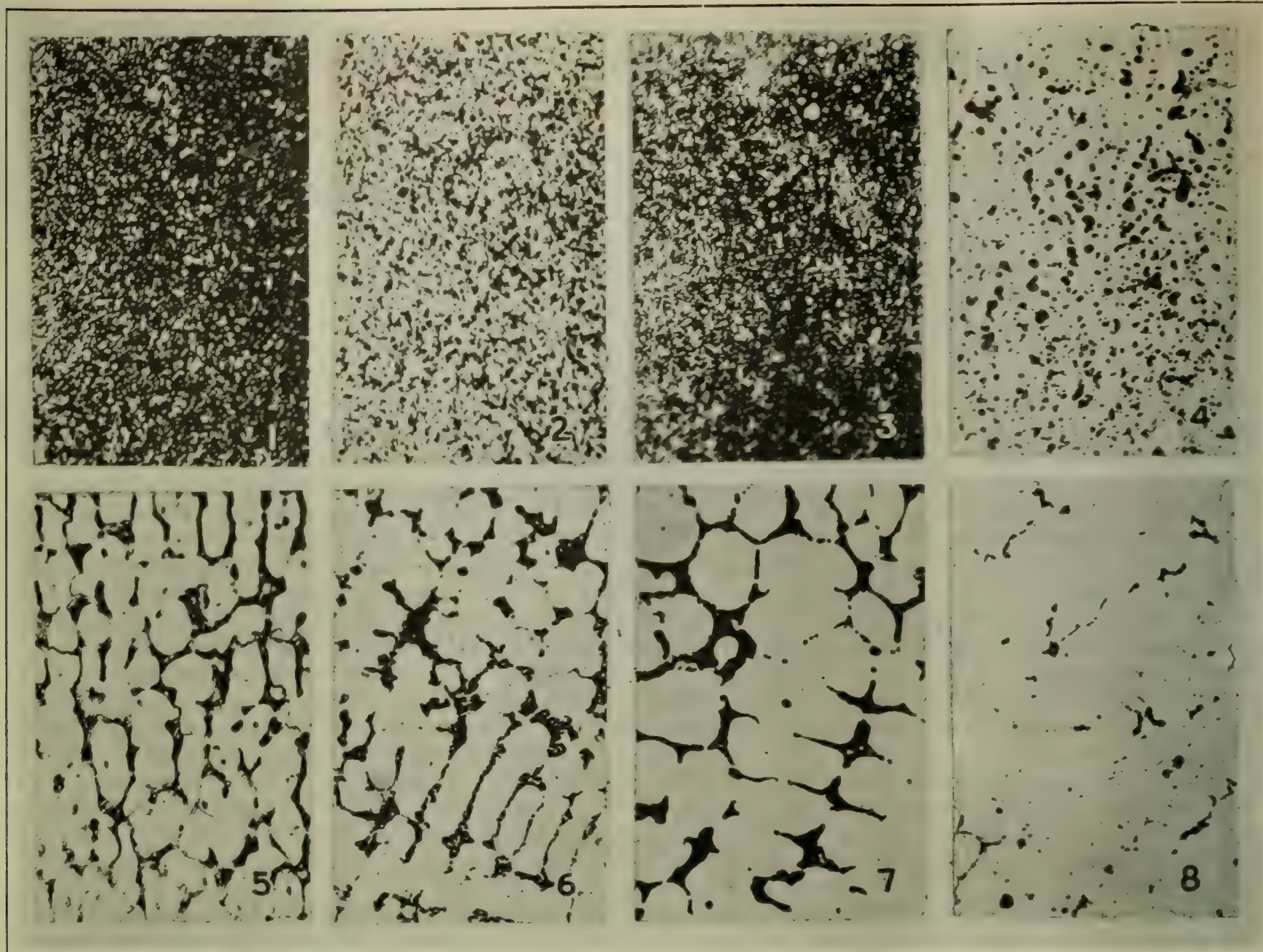
If the specimen thus thermally treated be again heated the dissolved carbide gradually separates, and the steel is tempered in two steps at about 400 deg. C. and 700 deg. C. If the specimen is further heated to the Ac_1 point the free carbide dissolves and the reactions given above proceed from right to left, Cr_4C and WC being formed. Hence by cooling from a temperature a little above the Ac_1 point the carbides Cr_4C and WC separate in the Ar_1 range and we thus obtain the normal structure. The same structure can also be obtained by a sufficiently slow cooling from a very high temperature through the range of 700 deg; because the carbides Cr_4C and WC are slowly formed in this range.

This does not agree, however, with the conclusions reached by Edwards³ that the lowered critical point ($A'r$) which occurs in cooling from a high initial temperature is not the cementite change lowered by the presence of tungsten or chromium but a change in a carbide of tungsten which is slowly formed at 1,200

¹Sci. Reports, Tohoku University, vol. 9 (1920), p. 143.

²Called by these authors $A'r_{3,2}$ since they regard it as the superimposed Ar_3 and Ar_2 changes lowered from their position as called for on the Fe: C diagram to 400 deg. C. or less.

³J. Iron & Steel Inst., 1908, No. 2, p. 104.



FIGS. 1 TO 8

Fig. 1. Novo steel, 2.86 Cr, 18.81 W, 0.59 C. Annealed, etched with acid. $\times 190$.

Fig. 2. Same as Fig. 1, except etched with $K_3Fe(CN)_6$.

Fig. 5. Steel containing 3.32 Cr, 18.2 W, 0.61 C; cooled from melt. Etched with acid. $\times 190$.

Fig. 6. Steel containing 5.12 Cr, 17.2 W, 0.62 C; cooled from melt. Etched with $K_3Fe(CN)_6$. $\times 190$.

Fig. 3. P. S. high-speed steel, 3.98 Cr, 13.49 W, 0.67 C. Annealed, etched with acid. $\times 190$.

Fig. 4. Same as Fig. 3, except etched with $K_3Fe(CN)_6$.

Fig. 7. Steel containing 4.85 Cr, 16.01 W, 1.0 C; cooled from melt. Etched with $K_3Fe(CN)_6$.

Fig. 8. Steel containing 4.88 Cr, 9.74 W, 0.55 C; cooled from melt. Etched with $K_3Fe(CN)_6$.

deg. C. The absence of the A'r point in specimens cooled from 1,320 deg. C. was ascribed by him to a double carbide of tungsten and chromium formed at high temperatures and held in solid solution even on very slow cooling. Thus he thinks that chromium in high-speed steels forms a double carbide with tungsten, which if held in solid solution imparts high hardness and resistance to tempering. This line of reasoning cannot yet, however, be considered as a true explanation of the function of chromium in high-speed steels.

5. Self-hardening and resistance to tempering increase with chromium and carbon contents conjointly. Increase in maximum temperature or rate of cooling is also intimately connected with the lowering of the transformations. The specific properties of high-speed steel depend principally upon the quantity of dissolved Cr_3C_2 in iron containing chromium and tungstide.

The fine globules appearing under the microscope in slowly cooled high-speed steels in a pearlitic, sorbitic or even troostitic matrix are considered by many investigators to be double carbides of tungsten and chromium or tungsten carbide, because they are colored black in boiling sodium picrate solution. Some investigators, however, believe them to be tungstide, in which opinion Honda and Murakami concur for the following reasons:

1. They have the same properties for chemical reagents as the tungstide found in carbonless iron-tungsten alloys⁴ (colored black by picrate or a ferricyanide solution, but remain white when etched in acid).

2. In steels of given carbon and chromium contents they increase in quantity with tungsten content.

3. In steels of given and constant tungsten and chromium contents the globules do not increase but rather decrease with increasing carbon.

As an etching reagent for the globules an alkaline solution of potassium ferricyanide (10 g. KOH and 10 g. $K_3Fe(CN)_6$ in 100 c.c. water) was found satisfactory by these Japanese investigators. Immersion in cold solution for fifteen to twenty seconds colors the globules brown to black, leaving the matrix white. The solution of sodium hydroxide and hydrogen peroxide used by Yatsevitch⁵ also colors the globules black in cold solution, but was found to be unstable. It also requires ten to fifteen minutes immersion.

Figs. 1 to 8 inclusive show typical structures obtained by Honda and Murakami in their study of high-speed steels. Figs. 1 to 4 show tungstide globules, white when

⁴See CHEM. & MET. ENG., vol. 24, No. 17, April 27, 1921, p. 746.

⁵Rev. Met., vol. 15 (1918), p. 65.

etched with acid and black when ferricyanide is used, the quantity being greater in the steel of highest tungsten content. Figs. 5 to 8 show the cast structure of various chromium : tungsten steels where the tungstide has segregated in a eutectic form in the primary grain boundaries. This constituent does not increase with carbon and is absent in steels containing less than about 8 per cent tungsten, its quantity being very small in the steel containing 9.74 per cent W shown in Fig. 8.

The action of tungsten, according to Honda and Murakami, when present over 12 per cent, is purely mechanical through the globules of free tungstide, which in a good tool must be uniformly distributed.

Not only are the researches carried on by Honda, Murakami and others of considerable interest but they should react to stimulate further investigation of the fundamentals of the constitution of high-speed tool steels and publication of results obtained. While their various conclusions will be disputed and hypotheses may be successfully overthrown, great credit is due these men in their pioneer work, directed toward the solution of problems involving reactions of great complexity connected with series of steels of the greatest importance.

Electric Furnaces for Melting Non-Ferrous Metals

TESTS on two new types of electric furnaces developed by the General Electric Co. for melting non-ferrous metal show a percentage of metal loss for yellow brass of less than 1.5 per cent and less than 0.75 per cent for red brass. The thermal efficiency is high, and the expense for refractories and electrodes is reduced to a low value.

These furnaces have been designed in two sizes, a 1,500-lb. unit and a 50-lb. unit. Either will melt practically any metal requiring a pouring temperature not exceeding 1,500 deg. C. (2,732 deg. F.).

Both furnaces work on the muffled arc principle, the main difference in construction and design being due to the variation in size and the fact that the 1,500-lb. type is three-phase and the 50-lb. is single-phase. The power factor for both is 0.95 or better.

The 1,500-lb. furnace melts yellow brass, pouring at 1,100 deg. C., with a power consumption not exceeding 270 kw.-hr. per ton, operating twenty-four hours a day, with one heat every hour. This gives a total capacity for the furnace of 18 tons of metal in a 24-hour day. The 50-lb. furnace melts yellow brass, pouring at 1,100 deg. C., at the rate of from 100 to 125 lb. per hour, with a power consumption of from 35 to 40 kw.-hr. per 100 lb. of metal, providing the furnace is up to temperature at the beginning of the run.

The 1,500-lb. furnace forms a balanced and very steady load on a polyphase circuit, and is equipped with electrode regulators which automatically maintain the desired power input. It has a shell built of steel plate, lined with standard fireclay shapes, and having a bulged boiler head bottom. The roof frame is hinged to a bar, the shell at the front of the furnace, the same bar carrying a three-legged cast-iron spider which mounts the electrode-supporting mechanism. This permits the whole top of the furnace to be lifted for inspection or repair of the lining without disturbing the electrodes.

Fig. 1 shows the interior arrangement of the three D-shaped muffles, wearing blocks, cross-electrodes and vertical electrodes, which comprise the heating elements.

As shown, the space in the muffle between the electrode and wearing block and the side of the muffle is filled with crushed graphite to muffle the arc. The triangular space where the cross-electrodes meet in the middle is filled with a mixture of graphite and tar to insure a good electrical connection.

The 50-lb. furnace is constructed on much the same principle except that in this case the hearth is flat, designed to receive standard graphite crucibles. There

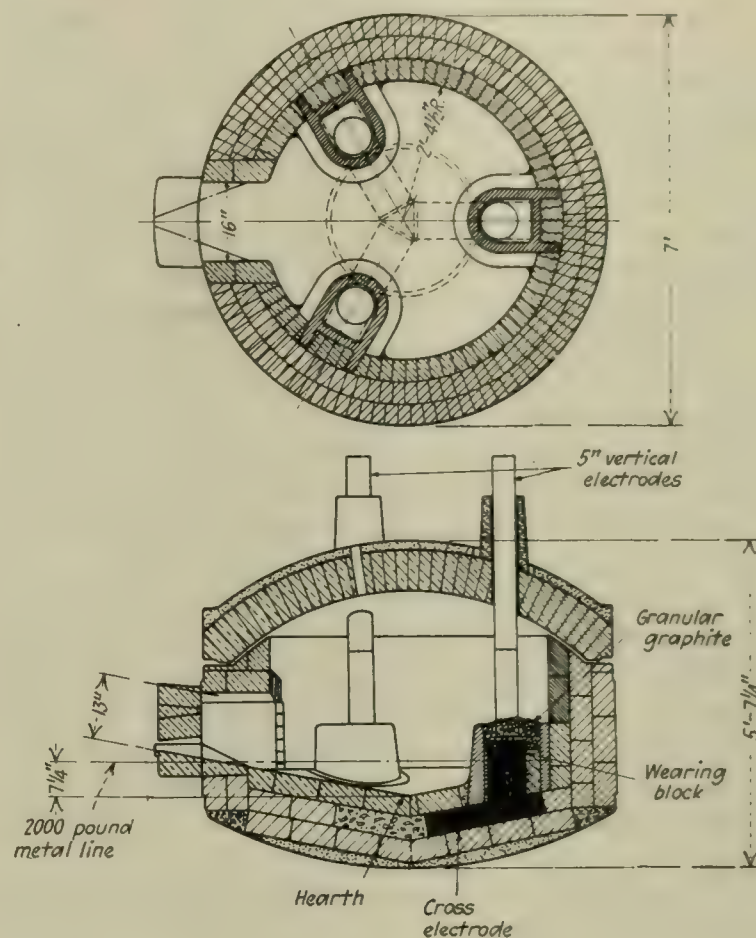


FIG. 1. INTERIOR ARRANGEMENT OF 1,500-LB. HEARTH CAPACITY NON-FERROUS MELTING ELECTRIC FURNACE

is also some difference in the electrode and block arrangement, since the furnace is for single-phase operation. A horizontal carbon block, imbedded in crushed graphite, extends across the bottom, carrying a wearing block on each end. Between these wearing blocks are four carborundum bricks which form the hearth. Two graphite electrodes extend through the roof to the wearing blocks, the arcs being smothered in the graphite surrounding the blocks. The electrode regulation is entirely manual. In operation the crucible containing the metal to be melted is set on the carborundum bricks forming the hearth.

The metal is heated by the same action in both furnaces. The current flows from the vertical electrodes through arcs to the crushed graphite and the wearing blocks. These arcs are smothered by the graphite in the muffles, the whole mass becomes heated, forming a heat source of large area and uniform temperature. The heat is radiated to the metal from all directions as well as being absorbed from the muffles and the hearth.

Not the least of the advantages of the electric furnace are those which influence shop conditions for the better. The absence of dirt and the fumes both from the metal and from burning fuel make the shop atmosphere much more bearable; in addition the electric furnace is practically noiseless. Furthermore, there is comparatively little external heat radiation, and the temperature of the foundry is not raised appreciably.

Acid vs. Basic Electric Furnace For the Foundry

BY F. W. BROOKE*

ACID operation should be adopted when

(1) The sulphur in the scrap is and *always will be* less than the sulphur required in any castings you will be required to make.

(2) The phosphorus in the scrap is and *always will be* less than the phosphorus required in any castings you will be required to make.

A prospective purchaser of an electric furnace, in looking over his available scrap supply, often feels he can obtain all the scrap he requires of a sulphur and phosphorus content low enough (say below 0.04 per cent sulphur and phosphorus) to meet his requirements. The scrap market and the freight situation, it has been our experience, only too often upset his calculations, and he is confronted with the problem of having a high-sulphur and phosphorus scrap and a furnace which cannot eliminate these all-important injurious elements. It has often meant one of three things: (a) paying an excessive price for low-sulphur and phosphorus scrap; (b) a shut-down until proper scrap can be obtained; or (c) bad castings and a dissatisfied customer.

Let us assume that the above situation can be satisfactorily met. There is still the subject of requiring a low-sulphur for special occasions, as for instance the making of a specially difficult casting where the foundry has its own particular difficulties and where a low-sulphur steel would be of particular value in helping out the foundry. This can only be done in a basic furnace.

(3) When the range of carbon and silicon contents will always be wide.

(4) When close physical tests have not to be met.

It is much easier to control the carbon, silicon and manganese in the basic furnace, which means that where specifications have to be met the rejections are much less, particularly on physical tests, such as a good relation between the maximum stress and yield point, and a good elongation with a relatively high maximum stress. This is because of the inherent value of an electric furnace for making refined steels of a quality better than the converter steel, the open-hearth steel and at least equal to crucible quality, which is only present in the basic operation.

Refining can be done in the acid furnace to a limited extent, but calls for skillful operation and is not reliable.

(5) When power consumption and rate of operation are of prime importance.

The acid operation gives a better power consumption in the relation of about 100 to 112, because there is practically no refining in the acid operation. It also gives a less refractory cost, as the cost of raw material is less and the repairs are less frequent.

(6) When very small castings are the sole output.

In making all small steel castings, three important points must be kept in view:

(a) Do not have the furnace of too large a capacity—install smaller units and more of them; for instance, where the castings do not exceed 10 to 15 lb. a 1-ton furnace should be the maximum.

(b) "Hot" metal is essential, because of the necessity of pouring into shank ladles where the transfer

losses and the ladle losses are high and because of the number of "pours" required.

(c) It must be easy to hold back the slag and acid slag will keep back and separate more readily.

This does not mean that small castings cannot be made in the basic furnace, but means that in foundries where castings weighing ounces and a maximum of say 25 lb. are to be made, the acid operation is easier and more economical, providing, of course, that the other clauses can be met satisfactorily.

Basic furnaces should be installed for reasons (1) to (4) opposite of those given above, and

(5) When alloy steels are ever to be made in the furnace.

If alloy steels are ever contemplated, a basic furnace is required. Manganese steels, for instance, so often required in the steel foundry industry, can only be economically made in the basic furnace. The use of other elements, particularly chromium, vanadium, etc., can be handled only in the basic furnace, and while the making of alloy steel castings may not be of immediate consideration, their use is becoming more general every day, especially for parts requiring uniform wearing qualities, resistance to shock and resistance to alternating stresses.

(6) When steady load is essential.

A basic furnace invariably has a steadier load than an acid furnace, for two reasons:

(a) Higher secondary voltages are used in the acid to bring about more rapid melting.

(b) The resistance of an acid slag is higher than the resistance of a basic slag, and therefore also requires a higher voltage.

Both of these calling for a higher secondary voltage causes in practice longer arcs and higher surges because the electrode travel cannot pick up as rapidly.

(7) When refining of cast iron is being considered.

Probably the latest field which is making very rapid strides for the electric furnace in the foundry is for the refining of cast iron. This is particularly applicable to the making of engine cylinders, high-pressure valves, piston rings and parts requiring uniform wearing qualities, etc., and the practice now being adopted is to pass the molten pig iron from the cupola through the electric furnace for a refining period of twenty to forty minutes, which gives: (a) A rapid desulphurization. (b) Elimination of occluded gases. (c) An accurate pouring temperature.

These causes will speak for themselves to the progressive foundryman, who in the past on particular work had gone through periods of worry in his: Sulphur in the coke; blowholes; and "hot" metal and "cold" metal.

Only the basic furnace can be considered for this purpose.

In looking over the number of furnaces recently installed in foundries, it must be surprising to find the large percentage of acid installations. These furnaces were only too often installed by foundries that used electricity as a "fuel" and the electric furnace as the melting pot. They sold their product during a time when there was a loud cry for steel castings and when inspection was either entirely missing or at least lenient. The sulphur and phosphorus specifications and physical requirements were seldom met. This does not mean that the acid furnace had not its own field, but decision should be reached after a careful study of all the existing conditions and as many of the future conditions as possible.

*Vice-President, Electric Furnace Construction Co., Philadelphia.

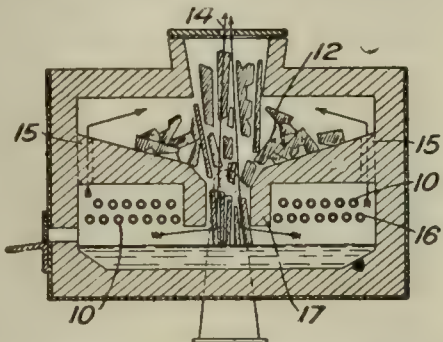
Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office Southampton Buildings, Chancery Lane, London, England.

Electrolytic Copper.—Elastic or tempered copper is produced by deposition from a sulphate solution on a cathode rotating at a peripheral speed not less than 1,000 ft. per minute. Hardness may be increased by the use of higher speeds, or by addition of say 0.1 per cent of an organic substance such as glue or gelatine, or of arsenic, preferably to the amount of $\frac{1}{16}$ oz. to 1 gal. of 12 per cent copper sulphate solution containing free sulphuric acid. The arsenic may be added in the form of oxide dissolved in 10 per cent caustic soda solution. (Br. Pat. 154,373; S. O. COWPER-COLES, Sunbury on Thames, Jan. 26, 1921.)

Electric Furnace.—In a furnace having resistance bars, free to expand or contract, arranged in the form of one or more grids above the charge, a slight reduction of pressure is maintained to prevent condensation in the openings through which the bars enter the furnace. The charge may consist of copper, nickel, iron, aluminum, brass or materials to be distilled. As shown, the resistance bars 10, which may be of carbides such as silicon carbide, pass loosely through refractory sleeves 16 in the furnace walls. The furnace may be tilted by worm gear so that parts of the charge may be brought nearer to the resistance. The trunnions may form axles for a pair of large wheels which thus support the furnace. In some forms, a hopper 17 is provided in the middle of the roof and between two parts of the resistance. Above the hopper 17 there may be a preheating chamber 12. A slight suction is produced in the furnace by providing an adjustable vent 14 in the cover of the hopper or of the preheating chamber for the vapors which may pass through the hopper or through outlets 15 in the furnace roof. (Br. Pat. 154,444. A. M. ERICHSEN, Porsgrund, Norway. Jan. 26, 1921.)



Cracking and Purifying Oils.—Hydrocarbon oils are purified or cracked and purified by heating in presence of sodium or other alkali metal or of an alkali amalgam or alloy such as sodium-lead alloy. The oil and metal may be heated in an autoclave and the oil afterward distilled in the presence or not of the metal; the oil vapor may be passed through the molten metal, or the oil may be fractionated or cracked from a still or retort containing the metal. The process may be continuous or intermittent, and the distillation may be carried out at, above or below atmospheric pressure. (Br. Pat. 154,464; N. V. S. KNIBBS, London, Jan. 26, 1921.)

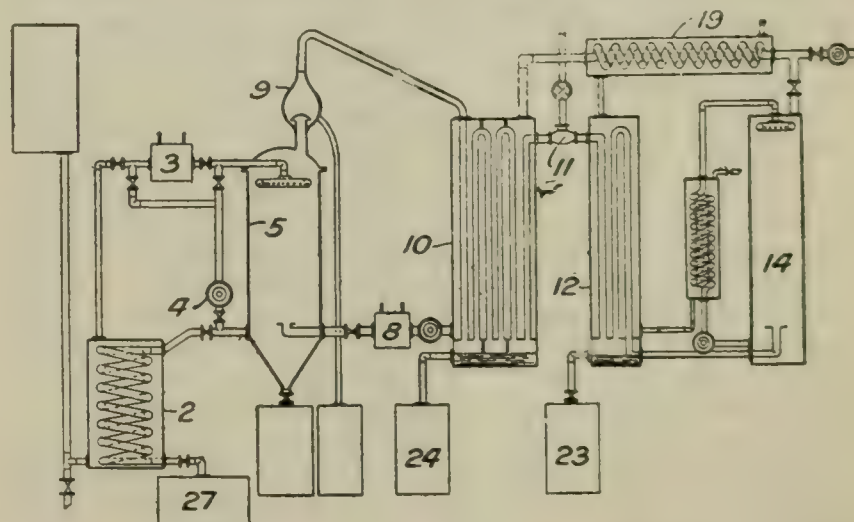
Electrolytic Nickel.—In a cyclic process, nickel is dissolved from ore, matte, or the like to form a solution having an optimum acidity for deposition—i.e., a percentage of free acid between 0.1 and 0.4. The solution is passed in series through the cathode compartments of a number of vats, while a nickel salt solution is passed in series through the anode compartments, the diminution of acidity of the catholyte through electrolysis being compensated for by partial transfusion of the anolyte, which increases in acidity in successive vats. When the acidity of the anolyte has become incompatible with the maintenance of the catholyte acidity below 0.4 per cent, the anolyte is withdrawn and, without concentration, is used for preparing fresh solution to be added to the circulating catholyte. The anolyte may be replenished from the fresh solution or from the catholyte. Each vat preferably contains a number of alter-

nating cathode compartments and insoluble anodes within a single anode compartment, electrolyte being fed in parallel through the cathode compartments of each vat but in series through those of different vats. Diaphragms of clay, wood or paper, or of framed millboard which may be treated with water-glass, are suitable. The catholyte may be at a higher level than the anolyte, so as partly to percolate through the diaphragms. The current density may be 10 amp. per sq.ft. (Br. Pat. 154,471; C. HEBERLEIN, London. Jan. 26, 1921.)

Potassium and Sodium Carbonates.—Technically pure potassium carbonate is obtained by a wet process in which potassium bicarbonate is decomposed with nascent potassium sulphide. The bicarbonate, preferably in granular form, is intimately mixed with finely ground potassium sulphate and barium sulphide and the resulting mixture is added to boiling water. The sulphuretted hydrogen produced is eliminated by boiling or by the passage of steam. The bicarbonate goes into solution with difficulty, but reacts with the nascent potassium sulphide immediately the latter is produced from the barium sulphide. Barium sulphide is regenerated from the precipitated barium sulphate after its removal from the potassium-carbonate solution, from which crystalline or amorphous potassium carbonate may be prepared. By using sodium bicarbonate and sodium sulphate in the place of the corresponding potassium salts, technically pure sodium carbonate may be obtained in a similar manner. (Br. Pat. 154,498; S. LARUM, Brussels. Jan. 26, 1921.)

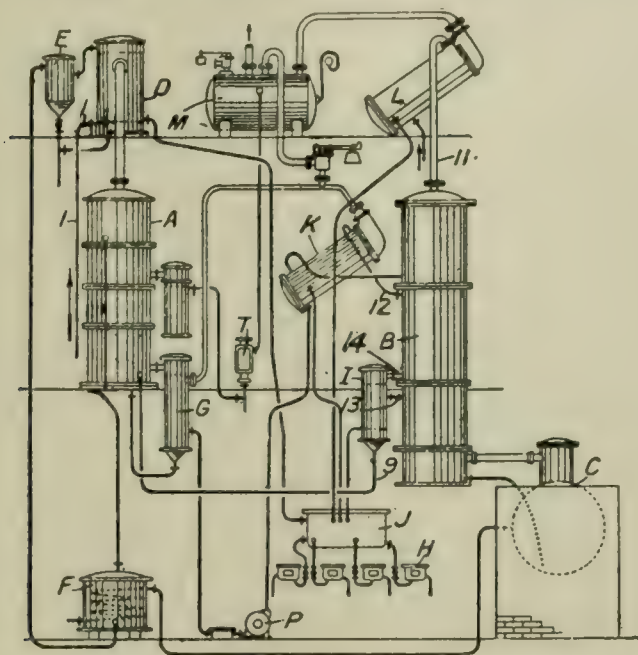
Aldehyde; Acetic Acid.—Acetylene, air and steam are passed over a catalyst at 300 to 400 deg. C. and the resulting aldehyde and acetic acid are condensed fractionally, or first oxidized completely to acetic acid. The weak aldehyde fraction is used to produce the necessary steam. As catalysts are specified basic metallic salts, particularly vanadates, molybdates and chromates. In an example, basic zinc vanadate is precipitated from alkaline ammonium vanadate solution by zinc chloride and deposited on rubbered pumice, the rubber being then burned off in air. (Br. Pat. 154,579, not yet accepted; A. WOHL, Dantzig. Feb. 2, 1921.)

Refining Oils and Fats.—In refining and removing fatty acids from vegetable, animal and fish oils and fats the oil is heated to 200 to 300 deg. F. by passage through a heat exchanger 2 and an electric heater 3, and is sprayed into a refining tower 5, in which it meets an ascending current of carbon dioxide or of carbon dioxide and nitrogen heated if necessary by a heater 8. The partly refined oil may be circulated by a rotary pump 4 and is discharged through the heat exchanger 2 to a reservoir 27. The carbon dioxide and the vapors pass through a separator 9 to a heat-exchanger 10 and thence, after admixture with steam, in



a jet 11, to a condenser 12. Fatty acids condense and collect in receivers 23, 24. The gases may be scrubbed with oil in a scrubber 14, and are led to a gasholder or are returned through the heat exchangers 19, 10 to the tower 5. Cooling-water passes first through a cooler through which the oil from the scrubber 14 is circulated, then through the condenser 12, and then through the heat exchanger 19. (Br. Pat. 154,514; K. H. VAKIL, Bombay, India. Feb. 2, 1921. See also Pat. 155,020, Feb. 9, 1921.)

Distilling Hydrocarbons, Alcohol, etc.—The condensation of vapors in apparatus for distilling crude mineral oils, volatile hydrocarbons, alcoholic liquids, etc., is utilized to generate steam which may be used for heating or power producing. When distilling liquids with a boiling point lower than water, steam is generated under reduced pressure and may be compressed. As applied to a continuous apparatus for distilling crude mineral oil, the oil is passed by a pipe 1, through a dephlegmator *D*, a water separator *E* and a preheater *F* to a column *A* in which petrol vapors are driven off and condensed in the dephlegmator *D*. The oil passes from the column *A* through a pipe 9, heater *I* and pipe 14 to a column *B*. The oil passes from the base of the column to a boiler *C*, the residues from which pass to the preheater *F*. Vapors pass from the column *B* by three pipes 11, 12, 13. The heavy vapors from pipe 13 are condensed in the heater *I*, those from the pipe 12 pass to a steam-generator *K*, which is kept, for example, under a pressure of 6 atmospheres, so that steam is generated at about 189 deg. C. by vapors at a temperature slightly above



this—namely, about 163 to 165 deg. C. The light vapors from the pipe 11 pass to a second steam generator *L*. The steam from the generator *K* may be used in the heater *G*, the condensed water from which is returned to the generator *K* by a pump *P*. Residual steam and the steam from the generator *L* pass to a cylinder *M*, from which the steam may pass for the production of motive power, or may be compressed by a device *T* and used for heating purposes. The various oils condensed pass through a refrigerator *J* to the test glasses *H*. In non-continuous apparatus the vapors from a still are passed through a steam generator on their way to a condenser. (Br. Pat. 154,558, not yet accepted; L. GRANGER, C. MARILLER and SOC. ANON. D'EXPLOITATION DE PROCÉDÉS ÉVAPORATOIRES, Paris. Feb. 2, 1921.)

Phenol-Aldehyde Condensation Products.—The condensation of phenols with aldehydes, such as formaldehyde solution or paraformaldehyde, is effected or completed in the presence of the following condensing agents which react with the water present or produced—namely, metal carbides, nitrides, cyanamides, silicides or phosphides. Where such bodies are used only for completion of the process, the initial stage of the condensation may be carried out with aqueous formaldehyde by the usual methods, the layer of condensation product separated from the aqueous layer and then treated with the specified condensing agents. According to examples there are employed: Phenol, paraformaldehyde and calcium carbide; cresol, paraformaldehyde and calcium cyanamide or aluminum nitride; an example is also given in which cresol is condensed with aqueous formaldehyde in the presence of ammonium chloride, and the separated resin is treated with calcium carbide. The insoluble infusible products finally obtained are water-free and have high insulating properties. The provisional specifications are not confined to the specific condensing agents mentioned above, and refer also to the use of sodamide, metal alcoholates and the compounds of ammonia with zinc or calcium chloride. (Br. Pat. 154,656, VICKERS, LTD., Westminster,

and IOCO RUBBER & WATERPROOFING CO and W. H. NUTTALL, Glasgow. Feb. 2, 1921.)

Alkali Bichromates.—Sodium and potassium chromates are converted into their respective bichromates by the addition of the corresponding acid sulphate. For example, by adding sufficient potassium hydrogen sulphate in the form of a coarse powder to the hot solution of potassium chromate, all the latter is converted into potassium bichromate. After filtering, the solution is concentrated, when potassium sulphate separates. From the mother liquor, after all sulphate has been removed, potassium bichromate is obtained by crystallization. (Br. Pat. 154,810, R. L. DATTA, Calcutta. Feb. 2, 1921.)

Concentrating Ores.—In a froth flotation process for concentrating ores, particularly oxidized ores of copper, lead, etc., the ore is suspended in water to which is added a minute proportion of oleic acid or its near homologues, and a minute proportion of sodium silicate, with or without sodium carbonate, caustic soda or other alkali, and agitation and aëration are effected as usual. The oleic acid or the like may be added at the stage of wet-grinding as described in specification 18,937 (1913). The concentrate may be re-treated with the addition of more sodium silicate but without further addition of oleic acid, etc. The apparatus used may be such as that described in specification 18,937 (1913). (Br. Pat. 154,870, not yet accepted; MINERALS SEPARATION, LTD., London. Feb. 2, 1921.)

Strengthening Organic Tissues and Substances.—The tensile strength of organic tissues and substances such as leather, horsehair, catgut, flax, cotton, etc., is increased by impregnating with "diatomic phenols such as guaiacol, veratrol, etc., in alcoholic or other solutions of varying concentrations." The subsequent evaporation or sublimation of the phenols may be prevented by treating the impregnated material with sodium or potassium formate, carbonate or oxalate, which reacts with the guaiacol or other substance or the surface of the material forming insoluble compounds. (Br. Pat. 154,881, not yet accepted; C. HENRY, Paris. Feb. 2, 1921.)

Alkali and Alkaline Earth Cyanides and Cyanamides.—In the fixation of nitrogen as cyanides or cyanamides of alkali or alkaline earth metals by the reaction of nitrogen on mixtures of alkali or alkaline earth metal compounds and carbon, the materials, which may be briquetted, are introduced into the furnace in a dry condition, that is, containing not more than 2.5 per cent of water so as to be of sufficient electrical conductivity to avoid the production of arcs. When a shaft furnace is employed, the dry condition of the charge prevents the blocking of the furnace by the formation of lumps. (Br. Pat. 154,896, not yet accepted; C. T. THOSSELL and H. L. R. LUNDEN, Gothenburg, Sweden. Feb. 2, 1921.)

Treatment of Waste Micanite.—Scrap micanite and similar insulating materials are treated as follows for the recovery of the resins and the mica. The scrap micanite is autoclaved with a dilute aqueous solution of ammonia or other alkali, or with a solution of a salt having an alkaline reaction such as borax, and the live steam is admitted at a pressure of 4 to 6 atmospheres for fifteen to thirty minutes. Under this treatment the varnish is softened, and owing to the tendency of the mica to regain its original form before compression the solvent penetrates between the layers and dissolves the varnish. Alternatively the micanite is autoclaved with water instead of the alkali and the varnish dissolved after this treatment by immersing the mica while still hot in a cold alkaline solution. The strained alkaline solution, preferably after concentration, is then neutralized and heated to precipitate the resins. (Br. Pat. 155,318; H. C. S. DE WHALLEY and MICANITE & INSULATORS CO., London. Feb. 16, 1921.)

Aromatic Amines.—The reduction of aromatic nitro, nitroso or azo compounds is effected by means of cast-iron borings or turnings and an aqueous solution of a metal chloride, such as sodium, calcium or ferrous chloride; the treatment of nitrobenzene and of nitrophenol benzylethers or their homologues or halogen derivatives is excluded. (Br. Pat. 155,319; T. S. MOORE, Egham Hill, Surrey. Feb. 16, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Study of Non-Metallic Structural Materials Proposed

Congress has been asked by the Bureau of Mines for a supplemental appropriation of \$47,000 to undertake a study of the structural clay products and other non-metallic building materials. The proposed work is to be under the immediate direction of Dr. R. B. Moore, chief chemist of the bureau. The appropriation is asked as a result of the many requests which have come to the bureau for information as to the technological phases of structural materials.

KILN DESIGN AND FUEL ECONOMY

An important factor contributing to the market increase in costs of brick and tile is the added expense of fuel. Coal is selling at the mines for three times its pre-war price. The cost of laying it down at clay products plants has doubled, largely due to the increase in freight rates. A large percentage of brick and tile plants is located unfavorably with respect to fuel supplies. Most kilns now in use are very wasteful of fuel. With fuel affecting the price so importantly, the makers of clay products are clamoring for information as to how kiln design may be improved so as to use the minimum amount of coal.

The Bureau of Mines is in a particularly good position to furnish information along the lines set out in the foregoing, as it conducted extensive specialized research work in fuel economy during the war and always has given the general problem much attention.

Breakage of finished brick and tile results in very considerable losses. It is believed that systematic experimentation will develop that this breakage can be reduced materially.

MANUFACTURE OF BRICK

There are other economies and efficiencies which it is believed the clay industries can adopt. Generally speaking very few important improvements have been made in the manufacture of brick during the past twenty years, it is declared. It is believed that machinery can be improved and that more efficient methods of handling raw materials and finished commodities can be introduced. The matter of a more intelligent selection of raw materials also opens a wide field for research that is likely to be helpful to these industries.

Brick production this year is going forward at one-third the rate of production maintained in 1906. Prices are said to be four to five times higher than those obtained in 1913. Even with the limited amount of construction done in 1919, the country produced \$184,000,000 worth of clay structural products. In view of those facts, it is held that any improvement in the practices of the industry will have a direct effect in reducing prices of the finished materials—the greatest obstacle impeding housing construction on a scale commensurate with the country's needs.

Since brick and tile are manufactured for the most part by small operators, the amount of research and experimentation has been relatively much smaller than in the case of industries where there are a limited number of large producers.

CEMENT, SLATE AND FELDSPAR

Cement, slate and feldspar studies also will be undertaken if Congress will make the appropriation. It is proposed to study the extension to building construction the use of "sand cement," which has been employed so successfully in Reclamation Service projects. Improvement is believed possible in the proportioning of materials used in many cements and in the methods used in mixing and grinding.

In such limited investigations of the slate industry as

already have been undertaken by the Bureau of Mines, it has been established that the solution of that industry's greatest problem is the finding of uses for waste slate. It has been found that it can be ground and made into a very durable roofing material. It is believed that means can be found for utilizing much of the waste material. The result would be the placing of the industry on a more substantial footing and make possible price reduction.

With the growth of the pottery industry, there is an increasing demand for feldspar of high quality and uniform grade. A thorough survey of the industry is declared to be imperative. The plan is to determine the probable reserves of high-grade feldspar in the United States. Methods of quarrying and grading would be studied with the idea of suggesting improvements. It also is proposed to establish standard grades of this material. It is suggested that the material suitable for electrical porcelain and vitrified whiteware could be graded differently than that suitable for the lower grades of pottery.

New Chemistry Building for Columbia University

Initial steps have been taken by the trustees of Columbia University to carry out the big building program outlined by President Nicholas Murray Butler two years ago. Preparation of plans for two new buildings, one to be devoted to the department of chemistry and the other for use as a faculty club, has been authorized.

The new chemistry building will be thoroughly modern in construction and equipment and will be built on Broadway immediately north of Havemeyer Hall. It will contain provision for instruction and research in chemistry and chemical engineering and allied subjects. The faculty club building, the cost of which two years ago President Butler estimated at \$300,000, will be located at Morningside Drive and 117th St., adjoining the president's house. The building program indicated by President Butler at that time called for an expenditure of several million dollars.

It is proposed to erect the chemistry building and the faculty club building with funds recently received by the university in unrestricted legacies.

In a statement prepared for the University Council Dr. Butler says that some of the more urgent physical demands of the university should be satisfied. The weakest point in the university at the present moment is the lack of sufficient equipment for instruction and research, particularly in those fields where extensive laboratories are required.

"Probably no one will dispute the statement that the central science just now," added Dr. Butler, "the one that is likely to remain the central science for some time to come, is that many-sided body of knowledge called chemistry."

Quebec Pulp-Wood Business at Standstill

The pulp-wood business in Quebec, like the lumber trade, is practically at a standstill, reports Vice-Consul Arthur B. Giroux, at Quebec. Quebec dealers interviewed say they cannot account for the lack of demand from the United States except that American mills are still stocked with wood and paper products. The dealers, however, are waiting for readjustment, and state that they can and will wait until conditions are better and the prices assert an upward trend.

Quebec farmers, who for some years past have cut pulp wood from their farm woodlands, have stopped cutting. The tendency is to wait for a settlement of conditions, and it was stated that no more pulp wood would be cut until the prices are increased.

Plan to Extend ad Interim Dye Control

After having heard testimony to the effect that German dyes would be dumped upon the American market if the authority of the War Trade Board were not extended, Senator Knox introduced the following amendment to his peace resolution:

Provided further, that on and after the day following the passage of this act, for the period of six months, no sodium nitrite, dyes, dyestuffs, including crudes, intermediates and other products derived directly or indirectly from coal tar, and no finished or partly finished products, mixtures and compounds of coal-tar products, and no other synthetic organic drugs, or synthetic organic chemicals, shall be admitted to entry or delivered from customs custody in the United States or in any of its possessions unless the Secretary of the Treasury shall determine that such article or a satisfactory substitute therefor is not obtainable in the United States or in any of its possessions on reasonable terms as to quality, price and delivery, and that such article in the quantity to be admitted is required for consumption within six months by an actual consumer in the United States or in any of its possessions, and the Secretary of the Treasury may make all rules and regulations necessary and proper for the accomplishment of the purposes of this proviso. And upon the day following the approval of this act the War Trade Board Section of the Department of State shall cease to exist; all clerks and employees of the said War Trade Board Section shall be transferred to and become clerks and employees of the Treasury Department; all books, documents and other records of the said War Trade Board Section shall become books, documents and records of the Treasury Department; all individual licenses issued by the War Trade Board Section prior to the passage of this act shall remain in effect and the importations under such licenses shall be permitted; all unexpended funds and appropriations for the use and maintenance of the said War Trade Board Section shall become funds and appropriations available to be expended by the Secretary of the Treasury in the exercise of the power and authority conferred upon him by this proviso; and for carrying out of the purposes of this proviso during the fiscal year ending June 30, 1922, the sum of \$50,000 is hereby appropriated.

The anti-dumping bill, which was made a part of the emergency tariff legislation, does not protect the chemical industry, since it is so distinct from other classes of production whose protection is sought by that legislation.

Deputation of Engineers Will Present the John Fritz Medal to Sir Robert Hadfield

To express the obligation which the world owes to the engineers of Great Britain for the part they played in winning the war, the organized engineers of America will send a mission to London this summer. This mission, consisting of nationally known engineers and representing the so-called Founder Societies, will make the award of the John Fritz Medal to Sir Robert Hadfield at the opening meeting of the British Institution of Civil Engineers on June 29.

The inability of Sir Robert to come to the United States to receive the medal moved the trustees of the board to make the ceremony of presentation in England the occasion for an international expression of appreciation by the engineers of the United States to the engineers of Great Britain.

The deputation to England will consist of a representative of each of the four Founder Societies represented on the John Fritz Medal Board of Award as follows:

Charles T. Main of Boston, the American Society of Civil Engineers; Colonel Arthur S. Dwight of New York, the American Institute of Mining and Metallurgical Engineers; Ambrose Swasey of Cleveland, the John Fritz Medal Board of Award and the American Society of Mechanical Engineers; Dr. F. B. Jewett of New York, the American Institute of Electrical Engineers. Dr. Ira N. Hollis, president of Worcester Polytechnic Institute and past president of the American Society of Mechanical Engineers, will accompany the deputation and bear the message from the American engineers.

The John Fritz Medal is a gold medal presented for achievement in applied science as a memorial to the engineer whose name it bears. Previous recipients of the medal have been John Fritz, Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas Alva Edison, Charles Talbot Porter, Alfred Nobel, Sir William Henry White, Robert Woolston Hunt, John Edson Sweet, James Douglas, Elihu Thomson and Henry Marion Howe. The medal is awarded to Sir Robert Hadfield this year because of his invention of manganese steel.

The medal was established by the professional associates and friends of John Fritz of Bethlehem, Pa., on Aug. 21, 1902, his eightieth birthday, to perpetuate the memory of his achievements in industrial progress. There are no restrictions on account of nationality or sex. The trust funds supporting the medal are held and administered by a board of sixteen directors, consisting of four from each of the four national engineering societies represented on the mission to England.

The admiration felt by the American engineer for his British fellow-worker is expressed by Calvin W. Rice, secretary of the American Society of Mechanical Engineers, in a communication to Dr. J. H. T. Tudsbery, secretary of the Institution of Civil Engineers, London, in response to cabled greetings:

"There is a very deep sense of gratitude and obligation on the part of the engineering societies of the United States for the part played by the engineers of Great Britain in the war, and it has been a great deprivation to us that we could not have sooner expressed this in an adequate manner. It is the desire on the part of the engineers of the United States that the presentation be as simple as possible and yet be sincere."

In response to this communication the British Institution of Civil Engineers cabled that it would "welcome and appreciate very highly greetings from the engineers of America at the opening meeting on June 29," and that they "found the occasion very suitable for the presentation of the John Fritz Medal to Sir Robert Hadfield."

License Required for Importation of Sodium Nitrite From Enemy Territory

The War Trade Board Section of the Department of State announces that General Import License PBF37 has been corrected to include importations of sodium nitrite among the materials, products and commodities importations of which are excepted from its provisions. Specific individual licenses are now required for: (a) sodium nitrite, (b) synthetic organic drugs, (c) synthetic organic chemicals, (d) dyes and dyestuffs, including crudes and intermediates, (e) all products (whether embraced in the above or not) derived directly or indirectly from coal tar, including crude, intermediate and finished or partly finished products and mixtures and compounds of coal-tar products.

The action in regard to sodium nitrite was taken after conferences between F. S. Dickson, acting chairman of the board, other Government officials, representatives of the American Nitrogen Products Co. of Seattle and representatives of American dye manufacturers. Importation of Norwegian sodium nitrite will not be affected by this ruling.

In addition, a revised and simplified form of instructions for filing applications for licenses has been issued.

Fellowships in Metallurgy

Several fellowships are to be awarded at the University of Utah, Salt Lake City, each having an annual value of \$720, open to college graduates with good training in chemistry and metallurgy. The work will be in the department of metallurgical research, University of Utah, which is maintained in connection with the Utah Station of the United States Bureau of Mines. The problems to be studied are in general ore dressing, or special problems bearing on the flotation of ore, application of volatilization process to gold, silver, lead or copper ores, the hydrometallurgy of zinc, or investigations on oil shale. Full details may be had from Joseph F. Merrill, director.

Hoover Requests Additional Funds

To make possible additional assistance to the export industries, the Secretary of Commerce has requested supplemental appropriations aggregating \$618,728.34. Of that sum \$250,000 is to be used by twelve new divisions which it is proposed to establish in the Bureau of Foreign and Domestic Commerce. It is planned to have a separate division to be of direct assistance to each of the following industries: chemicals (including dyestuffs), cotton and cotton goods, paper and paper products, leather and leather products, machinery, electrical goods, automobile and accessories, lumber and lumber products, metal products, vegetable oils, hardware, jewelry, and silverware. The entire time of two specialists would be devoted to each of the industries mentioned, if Congress should approve Secretary Hoover's plan. In addition each division could make specialized use of the mass of foreign trade information which is constantly reaching the bureau and would keep up to date the market investigations which the bureau has been conducting during the last five years.

An additional \$100,000 is requested by Secretary Hoover for an investigation by the Bureau of Standards into industrial wastes and the development of commercial uses for byproducts.

Another \$100,000 would be allotted to the Bureau of Standards for an extension of its work in the matter of standardization of equipment. Mr. Hoover holds that it is of first importance to those engaged in foreign commerce to establish manufacturing and commercial standards of machinery, equipment and devices, including the elimination of unnecessary forms, varieties and qualities. He points out that the Department of Commerce is in a position to co-operate with both manufacturers and users in bringing about voluntary standards of this kind.

It is proposed further by Mr. Hoover to allot \$50,000 to the Bureau of Standards for the standardization of housing construction, the development and dissemination of knowledge concerning building materials and their uses and the establishment of building codes. Since building codes are of a highly scientific character, Mr. Hoover points out that extensive investigation is necessary so that they may be formulated with due regard to economy, durability, safety and the materials locally obtainable.

The remainder of the fund requested is allotted largely to salary increases throughout the department. Mr. Hoover has stated frequently since taking charge of the department that inadequate salaries form the basis of many of the department's difficulties.

Philadelphia Section Meeting, A.C.S.

A varied program was presented at the regular monthly meeting of the Philadelphia Section of the American Chemical Society, held at the Engineers' Club on Thursday evening, April 21. The dinner speaker was Richard Spillane, editor of the Business Section of the *Public Ledger*. He presented a very interesting and comprehensive survey of business conditions in Europe and of our foreign trade possibilities throughout the world. He emphasized particularly the splendid opportunity that China offers us in her enormous undeveloped mineral and agricultural resources. South America, with its untapped reservoirs of oil, also offers excellent possibilities. In conclusion, Mr. Spillane made a special appeal to chemists "to meet our friends the public by talking and writing in plain, simple English, so that ordinary people can understand it. Chemistry is enveloped in too much of a fog. Let there be the sun of understanding."

WORK OF BUREAU OF STANDARDS

At the formal meeting of the section, W. C. Wagner of the Philadelphia Electric Company spoke on "Recent Developments in the Work of the Bureau of Standards." His talk was illustrated with a large number of slides, many of which were prepared and released expressly for this meeting. Balances were shown ranging from a small assay balance accurate to 0.001 mg. up to a large railroad machine for calibrating track scales. In steel-testing work

moving pictures of the gages are taken and the instantaneous readings thus obtained are proving very valuable.

In the electrical work, standards of resistance are in use which are accurate to one millionth of an ohm, and potential differences can be measured with an accuracy of 0.00001 volt. In calibrating electrical instruments a magnifying camera is used for projecting the face of the instrument, and thus, by avoiding parallax, an accurate reading is easily obtained. A magnetic device has been developed for determining the integrity of steel. This was especially applicable during the war in detecting internal flaws in steel for rifle barrels. The relative hardness of different steels can also be determined magnetically. The speaker predicted that one of the important developments along this line in the near future would be the use of this device by the railroad companies for detecting flaws in rails. In studying the electrolytic corrosion of pipe, it has been found that if the moisture content of the earth rises, through faulty drainage, above 18 to 20 per cent, the rate of corrosion increases very rapidly.

In the aeronautical work at the Bureau of Standards, special attention has been paid to the testing of airplane motors. A "stethoscope of the gas engine" has been developed by which a great deal of valuable information has been obtained on the performance of different types of motors. For example, it has been possible to determine the relation between the viscosity of the lubricating oil and the electric power required to start the motor. Pictures were shown of the "vacuum chamber" where Liberty motors were tested under the same conditions as would be encountered in actual service.

Several other interesting phases of the work were mentioned. In the radio work, antennae were developed for use on airplanes, so that, with the instruments in the landing field sounding a certain keynote, a safe landing could be made in total darkness. In the radium section, flaws in steel plates are detected by means of radium photographs. The photographic section has developed improved plates for taking airplane pictures in smoky or foggy weather. Mr. Wagner concluded by praising the Bureau of Standards for its excellent work on optical glass.

REFRACTOMETRY

The last speaker on the program was Warren P. Valentine, who gave an illustrated talk on "Refractometry." He discussed the principles of refraction and the different types of instruments that are based on the principle of total reflection. There is a definite relation between the percentage of solid in a solution and the refractive index. The refractometer can therefore be used for the analysis of almost any solution that is clear enough to transmit light. It can also be used to determine specific gravity, and when used for this purpose special scales can be set on the instrument. Mr. Valentine has manufactured the first American Abbe-type refractometer, and the Bureau of Standards has certified that the accuracy of his instrument is greater than that of any refractometer heretofore imported from Europe.

Oil-Fired Converters

Three Scottish firms have installed the Stock oil-fired converter for the manufacture of steel castings, according to *The Iron Monger* for March 26, 1921. The Stock is a small side-blow converter in which the cold pig iron and scrap can be melted before deoxidation by means of oil fuel, which is introduced at a pressure of about 40 lb. per sq.in., and for the combustion of which a suitable supply of air is admitted. Melting occupies from forty minutes to an hour, and when this is completed the oil is cut off and the converter is rotated into a slanting position. A blast of heated air is then introduced from the side of the converter at such a level that it produces agitation only at the surface of the metal. Blowing usually occupies about a quarter of an hour. The main advantages of this method are that no impurities are taken up by the pig iron during melting, and that the high temperature obtained results in a very fluid metal which makes the process very suitable for the production of castings.

Inspection Trips at A.S.M.E. Spring Meeting, Chicago

Industrial Chicago has many things to show the mechanical engineer, and is going to throw them open to inspection by those attending the spring meeting of the American Society of Mechanical Engineers, May 23 to 26. The places which offer to entertain guests in this way are too numerous to be seen by all within the four days of the meeting, so several are scheduled for each day, so arranged, as far as possible, that the individual may suit his taste by selection daily without feeling that he is missing something he would like to see.

Tuesday: International Harvester Co., McCormick and Deering plants; Sears, Roebuck & Co., wall paper manufacture, handling and shipping merchandise; Mandel Bros., package handling, coal and ash handling, connection to sub-street tunnel system; Western Electric Co., manufacture of telephone apparatus and cable for the bell telephone system.

Wednesday: Illinois Steel Co., South Works, South Chicago, plate mill, rail mill, bessemer converters and general steel mill equipment; Commonwealth Edison Co., modern turbine central station at Fisk St.; Pennsylvania Lines terminal, freight handling plant, in connection with which there may be visited the neighboring warehouse of Marshall Field & Co. and the U. S. Terminal Building; Crane Co., manufacture of valves and fittings in cast iron, malleable iron, steel and brass, the fabrication of pipe work.

Thursday: Chicago Mill & Lumber Co., 120-in. paper machine, manufacture of fiber, corrugated board and paper boxes; Clemetsen Co., manufacture of veneers and "Clemco" office desks; Pullman Co., Pullman cars, passenger coaches and freight cars; Underwriters Laboratories, testing of appliances and devices for fire prevention; Yellow Cab Manufacturing Co., where the ubiquitous cabs come from.

Friday: Milwaukee Railway & Light Co.'s Lakeside plant, trip by rail to Milwaukee, boilers fired with powdered coal; Joseph T. Ryerson & Sons Co., warehouses of about 1,000,000 sq.ft. devoted to machinery and steel products.

Chicago Chemists Discuss Photochemistry and Elect Officers

On Friday evening, April 22, the Chicago section, A.C.S., met in Steven's Restaurant, having as guest of the evening Prof. J. H. Mathews of the University of Wisconsin. Members of the Chicago Microscopical Society and of the Camera Club also attended. In the absence of Prof. W. Lee Lewis, Dr. Ethel M. Terry presided.

The speaker's topic was Photochemistry. He pointed out that the use of chlorophyll in vegetation as a photochemical sensitizing agent does not preclude the possibility of finding other chemical agents which may be much superior. Furthermore, the sun is not a satisfactory source of light for photochemical research, because of its inconsistency of energy intensity. The best approach so far to an ideal is a mercury vapor lamp. The spectrum lines in this lamp can be increased by the addition of various other metals, forming amalgams. Of interest is the fact that because the eye is sensitive to only a portion of the spectrum, benzene and acetone are looked upon as colorless, though they both yield definite lines in the spectrum.

In reference to the bactericidal action of rays, Prof. Mathews' belief is that the ultra-violet ray will never be of commercial value for the sterilization of milk. He also spoke of a "new" method of pasteurization recently announced in Detroit whereby milk is treated by the electric current—but, as he cleverly pointed out, the heat generated is equal to that employed in the usual pasteurization plants!

Preceding the talk, the annual balloting for officers occurred. W. Lee Lewis was re-elected chairman; H. G. Walker was elected first vice-chairman, O. C. Stanger second vice-chairman, S. L. Redman secretary, Otto Berndt treasurer, Paul Van Cleef editor, R. E. Doolittle, P. N. Leech, H. N. McCoy, C. S. Miner, L. V. Redman, W. R. Smith, A. M. Taylor, L. M. Tolman and G. L. Wendt councilors. The Willard Gibbs jurors chosen were W. D. Harkins, Julius Stieglitz, E. W. Washburn and David Wesson.

Molybdenum Steel

"Molybdenum Steel" was the subject at the April meeting of the American Society for Steel Treating, Washington Section, on April 22. Dr. George W. Sargent of the Molybdenum Corporation of America discussed the occurrence and characteristics of the richer ores of molybdenum now being mined in this country. By comparisons with other metals and assisted by lantern slides, he brought out some of the history of the uses and the present practice which has led to the application of molybdenum in various carbon and alloy steels. He emphasized particularly the possibility of substitution of molybdenum for carbon in some of the heavier rails now used and in some structural metal.

Martin H. Schmid, speaking at the same meeting, brought out some of his experiences as the metallurgist of the United Alloy Steel Corporation. He emphasized particularly the substitution of molybdenum in smaller percentages than formerly deemed the best practice. The possibilities of molybdenum in chromium, nickel or other alloy steels were also pointed out, with particular attention to the formation of double carbides and the beneficial effect due to diffusion in the ferrite in chrome-molybdenum alloys. Some of the considerations guiding a customer in his selections of an alloy steel were stated by Mr. Schmid as follows:

(1) Compliance with specifications. (2) Availability of raw materials. (3) Freedom from patent litigation. (4) Uniformity of commercial product. (5) Responsiveness to thermal manipulation with reasonably wide temperature ranges. (6) Satisfactory mechanical performance and machinability.

The several methods of adding molybdenum to steel were considered and the advantages of each procedure pointed out. The standard practice suggested by Mr. Schmid is the addition to the charge in the furnace while melting down, as this is claimed to give better diffusion and superior uniformity of finished product. Mr. Schmid also discussed the possibilities of molybdenum steels from the standpoint of the shop and the rolling mill. This metal apparently rolls well without special precautions and permits of wide temperature ranges during working, either rolling or forging. The scale is loose and is easily eliminated, as it flakes freely from the metal and does not show a tendency to roll into the surface. As a result cleaner forgings which require a minimum of expense for cleaning are generally obtainable. The wide range of quenching temperatures which can be used is also cited as an advantage in contrast with certain other steels, the preparation of which requires very close temperature control.

The Washington Section at its next meeting, May 18, will have two speakers dealing with the heat-treatment of ordnance steel and heavy forgings. P. E. McKinney of the Washington Navy Yard, and Lawford H. Fry, production manager of the Standard Steel Works, will be the speakers. At the June meeting, Dr. Enrique Touceda will speak on malleable iron.

Dyes Discussed at Meeting of Connecticut Valley Section, T.A.P.P.I.

The April meeting of the Connecticut Valley Section of the Technical Association of the Pulp and Paper Industry, held in Holyoke April 20 was featured by an address on "Dye Manufacture" by W. F. Van Riper of E. I. du Pont de Nemours & Co. Mr. Van Riper exhibited motion pictures showing various steps in the manufacture of dyes.

In his talk he outlined the growth of the American dye industry during and since the war and stressed the importance of dyestuff manufacture to a nation not only because of its peculiar situation as a key industry on which many other products are dependent but also because of its potential value as a source of military explosives in case of war.

Of particular interest to the paper makers gathered to hear him was his description of factory standardization of colors, for a paper maker must know that one lot of color will be like another in tone and shade, else there is trouble.

After the address many questions were asked the speaker and some interesting experiences with colors brought out.

Personal

HOWARD C. ARNOLD, formerly chief chemist and plant manager of B. F. Drakenfeld & Co., manufacturer of ceramic colors, 50 Murray St., New York, has joined the staff of Arthur D. Little, Inc., Cambridge, Mass.

H. FOSTER BAIN has been nominated by the President to continue his present incumbency as Director of the U. S. Bureau of Mines.

Dr. OSKAR BANDISCH, formerly Privat Docent in the University of Zurich and student under Profs. Werner and Bamberger, has accepted a position as research associate in biochemistry in the Graduate School of Yale University. Dr. Bandisch will affiliate with the department of chemistry and co-operate with Prof. T. B. Johnson in the promotion of biochemical research.

EINAR CHRISTENSEN has recently been placed in charge of the chemical developments of the Cinder Products Corporation, Rochester, N. Y., a new corporation engaged in the manufacture of building material from cinders.

HERBERT G. CLOPPER, formerly with the New Jersey Zinc Co. and more recently vice-president of the Eagle-Picher Lead Co., has become president and treasurer of the Multiple Storage Battery Co., Jamaica, L. I.

DALTON M. GOETSCHUS, who was engaged by B. F. Drakenfeld & Co., Inc., to take charge of its plant at Washington, Pa., will continue his research and experimental work on radium extraction for the Standard Chemical Co. Howard B. Goetschius has taken over the management of the Drakenfeld plant.

Prof. F. GOWLAND HOPKINS of Cambridge University, England, addressed the graduate students of Yale University on the afternoon of April 4, 1921.

M. E. KESSLER has resigned from the chemical staff of the Niagara Alkali Co., and is now associated with the Waste Products Co., Niagara Falls, N. Y.

Dr. PAUL E. KLOPSTEG, who has been connected with the sales and advertising department of Leeds & Northrup for several years, has recently accepted a position with the Central Scientific Co. of Chicago, as manager of development and manufacturing.

H. M. MINER has been appointed New York representative of the Cleveland Cliffs Iron Co., Cleveland, Ohio, producer of methanol and wood chemicals.

O. E. RUHOFF, formerly chemical engineer for the French Battery & Carbon Co. of Madison, Wis., has severed his connection with this company in order to associate himself with the Industrial Research Laboratories of Chicago.

DAVID T. SCHULTZ has left his position as chemist in charge of the analytical laboratories of the Atlantic Refining Co. to become chief chemist of the New England Oil Refining Co., Fall River, Mass.

ARTHUR C. TRASK has resigned as vice-president of the Marden, Orth & Hastings Co., Inc., to become vice-president of the Falk Co., Pittsburgh, Pa., which company plans to equip a plant at Carnegie, Pa., for the refining of menhaden fish oil and for the sulphonating and processing of oils.

Obituary

CHARLES S. HAWES, in charge of the Bureau of Research and Statistics of the War Trade Board Section of the Department of State, died suddenly on Friday, April 22, in Chicago, Ill., where he was on a special investigation for the department. Death was due apparently to apoplexy and occurred at the home of Philip O. Palmer. He is survived by his wife, Mrs. Frances Wilson Hawes.

New Jersey Ceramic Exposition

The Newark, N. J., Society of Ceramic Arts held its annual exhibition at the Free Public Library during the week of April 18-23. The display was arranged on the fourth floor in the museum department and presented many interesting exhibits. Luster ware was rather the predominating feature, and there were fewer examples of delicate china and porcelain than in previous years. The exhibit showed many attractive specimens of pottery of the more substantial varieties.

Air Reduction Co. Acquires National Carbide Corp.

On May 1 the Air Reduction Co., New York, manufacturer of oxy-acetylene cutting and welding apparatus, took over the control of the National Carbide Corporation of Virginia, and in the future will direct the operating policy and sales of the organization. The acquired company's plant at Ivanhoe, Va., will be continued in operation for the production of carbide. This location has proved decidedly advantageous with regard to low costs for water power, coke and lime, as used at the works. With this acquisition, the purchasing company is in direct control of all materials and equipment entering into the production of its specialties.

Current Market Reports

Chemical and Allied Industrial Markets

NEW YORK, May 2, 1921.

Weakness is still evident in the chemical market and inquiries have not changed in character to any unusual degree during the past week. The turn in the stock market has been taken as a hopeful sign by factors in heavy chemicals and while no actual increase in buying has been noted there seems to be a general feeling of optimism throughout the trade. Conservatism is the keynote among buyers. There was a fairly active demand for light and dense *soda ash* in carload lots and producers have placed considerable business because the spot market has been practically sold out and second hands have not been in a favorable position to force keen competition with the manufacturers. In some quarters, however, there was some shading on contracts for the light *soda ash* and business has been booked at \$1.62½ per 100 lb., basis 48 per cent, f.o.b. works, in single bags, instead of \$1.72½. Competition of English producers of ash is attracting attention in the American market. There has been a large tonnage sold at \$1.90 per 100 lb. laid down in N. Y. Contracts on *caustic soda* have been offered at 3¼c. per lb., basis 60 per cent, f.o.b. works for prompt and future shipments, with sales recorded a shade under this quotation. The demand for caustic has not been as active as that for ash. At any rate, spot prices have been generally maintained. First-hand sales of caustic have been made at 3¾c. per lb., basis 60 per cent, f.o.b. works. Spot lots of *bichromate of soda* have brought 7¼c. per lb. Buyers have not been eager to pay this price, but holders of resale goods have remained firm in their views. *Bleaching powder* has developed an easier tendency and prominent sellers have sold at 2¼c. per lb. in large drums. There was moderate trading at this figure and the inquiry has been of fair dimensions all week. There has been a strong evidence of German competition reflected in *caustic potash*. This material is offered so far below the American figures that competition is practically out of the question for the present. Sellers of the 88-92 per cent caustic potash stated that offers for shipment have been heard as low as 4¼c. per lb. Resale lots on spot have sold down to 5¼c. per lb. German *chlorate of potash* has been offered for shipment at 6c. per lb. These disturbing influences are sufficient to cause a cautious attitude among buyers. In the face of all this cut-throat competition the need of a protective tariff is readily seen.

unless American producers accept the inevitable and close their plants. It seems that this is the desire of German producers who are bent on controlling the chemical market. There is no doubt that if the American manufacturer were abolished no such prices as the present would be named. The outlook for prices is very uncertain and will remain so until the new tariff schedule becomes effective. Many authorities in the chemical market are of the opinion that we will not experience anything approaching a general revival of business until next fall.

CHEMICALS

Prices in *alum* have remained practically unchanged on routine trading. *Ammonia alum* prices are based on 4@4½c. per lb. for the lump. *Potash alum* is quoted on the basis of 5@5½c. per lb. *Ammonia chrome alum* is quoted at 13@14c. per lb. Price cutting in *bleaching powder* is widespread among holders of any sizable stocks and quotations of \$2.40@\$2.50 per 100 lb. is subject to considerable shading. Makers are holding for \$2.75 at the works. Rumors of prices as low as \$2.10 f.o.b. works could not be confirmed, but from the weak tone of the market these prices are not considered out of line. Prices on *copper sulphate* are quoted at 5½@6c. per lb., according to makers and quantity. The market has been somewhat weaker, but first hands are not inclined to force business by any price cutting. Scattered transactions in resale *bichromate of potash* were reported at 11½c. per lb. on spot. Dealers quoted the market at 11½@12c. Demand has not shown much activity during the week and the situation remained rather quiet. A further reduction on *permanganate of potash* brought the price down to 32@35c. per lb. Limited supplies of *yellow prussiate of potash* are holding the spot market steady and sellers are not eager to shade 26c. per lb., with some asking up to 27c. for small quantities. The red variety has remained quiet, with sellers quoting from 35@40c. per lb. Prominent sellers of prime *muriate of potash* quoted \$50 per ton, basis 80 per cent, delivered. A fair inquiry is reported for this chemical and transactions of large and small quantities have been recently booked. Leading factors of *chlorate of soda* have reduced the price to 7½c. per lb., f.o.b. works, for prompt shipment. This is the lowest price heard for domestic chlorate since before the war.

Spot prices for light *soda ash* in single bags are heard from \$2@\$2.10 per 100 lb. Resale offerings continued small and the market is reported steady in most quarters. Prominent dealers reported sales of *caustic soda* at 3½c. per lb. ex-store N. Y. The market while quiet looks steady, although it is admitted that odd lots can be purchased below this price. Resale goods f.a.s. steamer were quoted up to \$3.85@\$3.90 per 100 lb. Producers report sales at 3½@3¾c. per lb., basis 60 per cent, f.o.b. works, depending on quantity. The recent advance of *sodium nitrate* by importers has reflected itself by a further strengthening of the resale market. Resale nitrate is quoted at \$2.70@\$2.80 per 100 lb. on a very strong basis against an importers' price of \$3. Prices on *sodium nitrite* are slightly firmer following the restriction of imports by the war trade board. Some holders have been attempting to buy up large stocks so that openly quoted prices are around 5½c. per lb. for spot material. Consumers, in general, have not shown any unusual interest.

COAL-TAR PRODUCTS

The promise of early legislation looking toward a policy following along protective lines has created a better feeling in many quarters of the coal-tar products market and the tone throughout the week has appeared to be of a more hopeful nature. The period of waiting is surely growing shorter and definite action of some sort will put a stop to hesitancy. Fluctuations in intermediates have been narrow as far as producers' figures are concerned and second hands as well are steadier in their views. *Aniline oil* seems to show about the widest range of quotations, while *paranitraniline* and *beta naphthol* show a firmer tendency. The crude market does not show a very uniform volume of trading in the different products and while *naphthalene* and *benzene* are moving in a steadier manner other items are quiet and weak.

Prices on *benzene* quoted by refiners are held steady. Prices are quoted at 27@32c. per gal. for pure benzene in tank cars and drums. The 90 per cent grade is quoted at 25@28c. per gal. on the same basis. Buying in both grades has been of somewhat limited nature. Prices on *naphthalene* are unchanged, with the demand rated fair. Refiners are quoting 8½@9½c. per lb. for the flake and 9½@10½c. for the balls, according to quantity. Resale flake can still be had in some quarters as low as 8c. per lb. Prices on *phenol* are unchanged at recent levels with little demand noted. Quotations in the open market are around 10c. per lb., but stocks are light. Government surplus phenol is still to be had at 12c. per lb., according to quantity.

Resale *aniline oil* can be had around 19c. per lb. in fair quantity, but the quality of material at the low figure is very doubtful. Makers are offering goods as low as 20@28c. per lb., and those naming the lower figures are finding business in fair volume. Consumers are interested only in small lots for immediate requirements and in many cases are preferring to use the inferior grade offered on the spot. Prices for spot *beta naphthol* are very uncertain. Demand has been desultory and few orders of reasonable size have been booked. Resellers are generally quoting around 34c. per lb. with a variation of a few cents either way. Bids at 28c. per lb. have failed to bring out any stocks. Manufacturers are quoting unchanged prices at 40@42c. per lb., but report little interest at this level. Buyers are not inclined to increase holdings beyond immediate requirements. Quotations on *dimethylaniline* are around former levels, with 48c. per lb. quoted by resellers and 55c. quoted by makers. The resale market is subject to shading on firm business.

VEGETABLE OILS

Trading during the week in *castor oil* was inactive, but producers maintained prices on the basis of 10c. per lb. for the U.S.P. No. 1 and 9½c. per lb. for the No. 3 in barrels. Outside lots were available at slight concessions. The spot market for *chinawood oil* closed steady at 10c. per lb., while nearby material could be purchased at 9½c. The coast market for April-May shipment was nominal at 8½c. per lb. A good volume of business in *coconut oil* was placed during the week and prices were somewhat firmer. Some lots of Ceylon type oil sold locally on the basis of 9c. per lb. in drums. One lot of Ceylon type oil was offered during the week for immediate delivery at 9½c. per lb. Cochin quality oil was offered in some quarters on the basis of 10½c. per lb. in barrels, but several holders continued to quote the market at 11c. The production of *corn oil* has been augmented, but offerings are not pressing on the market and prices held on a steady basis. Crude oil locally was nominally unchanged at 7½c. per lb. Refined oil held at 9¼@10c. per lb. for carlots in barrels. *Lagos palm oil* for spot delivery was firmer, the market closing at 7¼@7½c. per lb., according to seller and quantity. On forward business there were offerings of 7c. per lb., with possible shading on firm orders. *Niger oil* was available at less than 6c. per lb., due to the presence of some distressed lots. Business was noted in crude domestic *peanut oil* at 5½c. per lb., buyers' tanks, f.o.b. mill. Some holders of crude oil advanced their prices to 5½c. and in some instances to 6c. per lb., but buyers showed no interest in the higher quotations. English refined *rapeseed oil* was offered on the spot at 91c. per gal. On nearby oil 88c. was possible to be done, with futures available on the basis of 86c. per gal. The market on *soya bean oil* for immediate shipment from the coast held around 5c. per lb. On futures 4½c. represented the nominal quotation, with no buying interest noted on account of the tariff situation.

The Iron and Steel Market

PITTSBURGH, April 29, 1921.

The volume of strictly new buying in steel products has been particularly light in the past week, this being a natural sequence to the price changes that occurred a fortnight and more ago. As the independents advanced their prices at that time buyers had an opportunity to close on quotations then outstanding, and thus a considerable volume of business was rounded up, the buyers having correspondingly less occasion to buy now, while the advance in prices

to such buyers is also a factor. As to the Steel Corporation, whose price change was a reduction, it is receiving specifications against old contracts at a somewhat heavier rate, though on the whole the increase does not seem to be as great as might have been expected.

The quantity of steel consumption has plainly not been affected one way or the other. If the present rate of consumption is equal to the rate of production, it is probably as great a rate as can reasonably be expected under present financial and industrial conditions generally, for the rate is nearly if not quite 40 per cent of capacity. The rate of production during the first nine months of 1920, when the appearance was of heavy consumption and an almost insatiable demand, was approximately 80 per cent of capacity. Comparing general conditions, one would not expect there to be more than one-half as much steel consumption now.

A test of the lightness of steel demand in general is the prominence that is given in trade circles to the steel requirements of the automobile trade, when it is known that the manufacture of automobiles did not consume more than about 5 per cent of the steel production in 1920 and the automobile industry cannot be expected to have nearly as large a production this year as it had last year.

PRICES

Finished steel prices remain quotable as follows: Bars, 2.10c.; shapes, 2.20c.; plates, 2.20c.; hoops, 2.75c.; plain wire, 3c.; wire nails, \$3.25; standard steel pipe, 62½ per cent basing discount; blue annealed sheets, 3.10c.; black sheets, 4c.; galvanized sheets, 5c.; tin plate, \$6.25.

There has been another revision in spike prices. The separate prices on standard spikes, small spikes and boat spikes named in this report a week ago have been withdrawn, and a single base price of 3.40c. has been substituted, this being a reversion to practice before the war, there being extras over the base price for small spikes and the various sizes of boat and barge spikes. The reduction in chain from 6.75c. to 6.35c. by one manufacturer has been followed by a reduction to 6.25c. by others, as a base price, while spreads on sizes ½ in. and smaller were decreased by ¼c.

Some question is already being raised whether the new prices on rolled steel products are being strictly maintained. Cases of apparent shading are usually attributed to "old quotations," though this may be really a sort of subterfuge. Strictly new demand is too light to give the market much of a test, requisitions being chiefly in the form of specifications against old contracts or of releases on orders previously suspended.

PIG IRON AND COKE

The stiffening in the independent market in steel products has not been reflected in any increased strength in pig iron or coke. Thus there is no general stiffening tendency in the iron and steel industry as a whole, the recent operation being simply one of equalization between the Steel Corporation and independent prices for steel products. Foundry iron, formerly quotable at \$25 valley, is being offered at \$24.50 by at least one merchant furnace. Basic iron has again been sold by a steel works interest at \$22.50, the nominal market quotation being \$23, while a quotation of \$22 is understood to have been made to the United Alloy Steel Corporation, which, however, has decided to blow in its furnace and make its iron itself, having the advantage of a byproduct coking plant, for which coal has just been bought.

As to Connellsville coke, which appeared recently to be established at \$3.50, it has sold at \$3.25, and in some quarters there are predictions that the next important sale will be at \$3.

The opening of sales of Lake Superior iron ore for the shipping season of 1921 appears to be no nearer than three months ago. Estimates of the tonnage of ore to be moved this year are still lower, and nearly all the estimated ore will be moved by the producer-consumer class. Early predictions were that there would be a reduction of \$1 a ton from the 1920 schedule, which set Mesabi non-bessemer at \$6.55. That would represent a restoration of the 1919 schedule, but the prospect now is that the reduction will be somewhat greater.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.	\$0 13	\$0 13½	\$0 40	\$0 45
Acetone.....lb.	2 50	2 75	3 00	3 25
Acid, acetic, 28 per cent.....100 lbs.	4 00	4 25	4 50	5 50
Acetic, 56 per cent.....100 lbs.	9 50	9 75	10 00	10 50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	13½	14	14½	15
Boric, crystals.....lb.	15	15½	16	16½
Boric, powder.....lb.			46	47
Citric.....lb.	1 50	1 65	1 75	2 00
Hydrochloric.....100 lb.	13	13½	14	14½
Hydrofluoric, 52 per cent.....lb.	10	11	11½	12
Lactic, 44 per cent tech.....lb.	04½	05½	06	07
Lactic, 22 per cent tech.....lb.	4 00	4 50	4 50	5 00
Molybdic, C. P.....lb.				
Muriatic, 20 deg. (see hydrochloric).....lb.	06½	06½	07	07½
Nitric, 40 deg.....lb.	07½	07½	07½	08½
Nitric, 42 deg.....lb.	17	18	18½	20
Oxalic, crystals.....lb.	17	17½	18	19
Phosphoric, Ortho, 50 per cent solution.....lb.	30	32	35	40
Picric.....lb.			1 90	2 15
Pyrogallol, resublimed.....lb.			12 00	13 00
Sulphuric, 60 deg., tank cars.....ton			14 00	15 00
Sulphuric, 60 deg., drums.....ton	19 00	20 00		
Sulphuric, 66 deg., tank cars.....ton	22 00	22 50	23 00	23 50
Sulphuric, 66 deg., drums.....ton				
Sulphuric, 66 deg., carboys.....ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23 00	24 00		
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25 00	26 00	26 50	27 00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32 00	35 00	40 00	
Tannic, U. S. P.....lb.			1 00	1 10
Tannic (tech.).....lb.	50	52	54	57
Tartaric, crystals.....lb.			35	39
Tungstic, per lb. of WO.....lb.			1 30	1 40
Alcohol, Ethyl.....gal.			4 75	5 25
Alcohol, Methyl (see methanol).....gal.			34	38
Alcohol, denatur. d., 188 proof.....gal.			40	45
Alcohol, denatured, 190 proof.....gal.			04½	04½
Alum, ammonia lump.....lb.	04	04½	05½	06½
Alum, potash lump.....lb.	13	13½	14	14½
Alum, chrome lump.....lb.	02½	02½	02½	03
Aluminium sulphate, commercial.....lb.	03½	03½	03½	04½
Aluminium sulphate, iron free.....lb.	07	07½	07½	08
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	30	32	33	35
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	07½	08	08½	10
Ammonium carbonate, powder.....lb.	06½	06½	07	07½
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	08½	08½	09	09½
Ammonium chloride, granular (gray salamoniac).....lb.	08	08½	09	10
Ammonium nitrate.....lb.	2 75	2 85	2 90	3 00
Ammonium sulphate.....100 lb.			4 00	4 25
Amylacetate.....gal.			3 00	3 25
Amylacetate tech.....gal.	07½	08	08½	09
Arsenic oxide, (white arsenic) powdered lb.	12	12½	13	14
Arsenic, sulphide, powdered (red arsenic) lb.	60 00	65 00	70 00	75 00
Barium chloride.....ton	19	20	21	22
Barium dioxide (peroxide).....ton	11	11½	12	12½
Barium nitrate.....lb.	04½	05	05½	06
Barium sulphate (precip.) (blanc fixe).....lb.				
Bleaching powder (see calc. hypochlorite).....lb.				
Blue vitriol (see copper sulphate).....lb.				
Borax (see sodium borate).....lb.				
Brimstone (see sulphur, roll).....lb.	40	41	42	45
Bromine.....lb.	1 90	2 00		
Calcium acetate.....100 lbs.	04½	05	05½	05½
Calcium carbide.....lb.	27 00	29 00	30 00	32 00
Calcium chloride, fused, lump.....ton	01½	01½	02	02½
Calcium chloride, granulated.....lb.	2 25	2 40	2 50	2 75
Calcium hypochlorite (bleach powder) 100 lb.			1 25	1 50
Calcium peroxide.....lb.			15	16
Calcium phosphate, tribasic.....lb.			61	63
Camphor.....lb.	07	07½	07½	08
Carbon bisulphide.....lb.	10	10½	11	12
Carbon tetrachloride, drums.....lb.			75	1 00
Carbonyl chloride (phosgene).....lb.				
Caustic potash (see potassium hydroxide).....lb.				
Caustic soda (see sodium hydroxide).....lb.	08	09	09½	10
Chlorine, gas, liquid-cylinders (100 lb.).....lb.			38	40
Chloroform.....lb.			3 00	3 10
Cobalt oxide.....lb.				
Copperas (see iron sulphate).....lb.	23	24	25	27
Copper carbonate, green precipitate.....lb.			50	62
Copper cyanide.....lb.	05½	05½	05½	06
Copper sulphate, crystals.....lb.				
Cream of tartar (see potassium bitartrate).....lb.				
Epsom salt (see magnesium sulphate).....lb.			90	1 00
Ethyl Acetate Com. 85%.....gal.				
Ethyl Acetate pure (acetic ether 98% to 100%).....gal.	14	14½	14½	15
Formaldehyde, 40 per cent.....lb.			3 25	3 50
Fusel oil, ref.....gal.			1 75	2 00
Fusel oil, crude.....gal.				
Glauber's salt (see sodium sulphate).....lb.			17	17½
Glycerine, C. P. drums extra.....lb.			3 75	3 85
Iodine, resublimed.....lb.			10	20
Iron oxide, red.....lb.	75	1 00	1 10	1 25
Iron sulphate (copperas).....100 lb.			11½	13½
Lead acetate.....lb.	08½	09	09½	10
Lead arsenate, paste.....lb.			15	20
Lead nitrate.....lb.	08½	09	09½	10
Litharge.....lb.			1 25	
Lithium carbonate.....lb.	10½	11	11½	12
Magnesium carbonate, technical.....lb.	2 75	3 00	1 40	2 25
Magnesium sulphate, U. S. P.....100 lb.			75	77
Magnesium sulphate, technical.....100 lb.			78	82
Methanol, 95%.....gal.			13	13½
Methanol, 97%.....gal.			14	14½
Nickel salt, double.....lb.				
Nickel salt, single.....lb.	45	46	47	50
Phosgene (see carbonyl chloride).....lb.			35	37
Phosphorus, red.....lb.	11½	11½	12	12½
Phosphorus, yellow.....lb.				
Potassium bichromate.....lb.				

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$.35 — .40	\$0.30 — \$0.35
Potassium bromide, granular..... lb.	.35 — .40	.20 — .40
Potassium carbonate, U. S. P..... lb.	.06 — .07	.08 — .09
Potassium carbonate, crude..... lb.	.08 — .09	.10 — .14
Potassium chlorate, crystals..... lb.	.05 — .06	.30 — .32
Potassium cyanide..... lb.	.05 — .06	.06 — .08
Potassium hydroxide (caustic potash)..... lb.	50.00 — 50.50	2.75 — 3.00
Potassium muriate..... ton		.10 — .12
Potassium iodide..... lb.	.09 — .09	.34 — .35
Potassium nitrate..... lb.	.32 — .33	.38 — .40
Potassium permanganate..... lb.	.35 — .37	.28 — .29
Potassium prussiate, red..... lb.	.26 — .27	1.75 — 1.80
Potassium prussiate, yellow..... lb.		
Potassium sulphate (powdered)..... per unit		
Rochelle salts (see sodium potas tartrate).....		
Salammoniac (see ammonium chloride).....		
Sal soda (see sodium carbonate).....		
Salt cake..... ton		35.00 — 35.00
Silver cyanide..... oz.		1.30 — 1.35
Silver nitrate..... oz.		.39 — .40
Soda ash, light..... 100 lb.	2.00 — 2.10	2.20 — 2.40
Soda ash, dense..... 100 lb.	2.30 — 2.35	2.40 — 2.60
Sodium acetate..... lb.	.04 — .05	.05 — .06
Sodium bicarbonate..... 100 lb.	2.50 — 2.60	2.70 — 3.00
Sodium bichromate..... lb.	.07 — .08	.08 — .08
Sodium bisulphate (nitre cake)..... ton	5.00 — 5.25	5.50 — 6.50
Sodium bisulphate powdered, U.S.P..... lb.	.05 — .05	.05 — .06
Sodium borate (borax)..... lb.	.06 — .06	.07 — .07
Sodium carbonate (sal sod.)..... 100 lb.	1.90 — 2.00	2.25 — 2.50
Sodium chl rate..... lb.	.07 — .08	.08 — .08
Sodium cyanide, 96-98 per cent..... lb.	.20 — .22	.23 — .30
Sodium fluoride..... lb.	.12 — .12	.13 — .14
Sodium hydroxide (caustic soda)..... 100 lb.	3.65 — 3.75	3.80 — 4.00
Sodium hyposulphite..... lb.		.03 — .04
Sodium nitrate..... 100 lb.	2.75 —	2.85 —
Sodium nitrite..... lb.	.05 — .06	.06 — .07
Sodium peroxide, powdered..... lb.	.25 — .26	.27 — .30
Sodium phosphate, dibasic..... lb.	.04 — .04	.05 — .05
Sodium potassium tartrate (Rochelle salts)..... lb.		.27 — .28
Sodium prussiate, yellow..... lb.	.11 — .11	.12 — .12
Sodium silicate, solution (40 deg.)..... lb.	1.25 — 1.35	1.40 — 1.50
Sodium silicate, solution (60 deg.)..... lb.	.02 — .03	.03 — .03
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 — 1.75	2.00 — 2.25
Sodium sulphide, f. sed, 60-62 per cent (conc.) lb.	.05 — .05	.06 — .06
Sodium sulphite, crystals..... lb.	.03 — .04	.04 — .04
Strontium nitrate, powdered..... lb.	.16 — .16	.17 — .18
Sulphur chl ride, red..... lb.	.07 — .07	.07 — .08
Sulphur, crude..... ton	20.00 — 22.00	
Sulphur dioxide, liquid, cylinders ex la..... lb.	.08 — .08	.09 — .10
Sulphur (sublimed), flour..... 100 lb.		2.25 — 3.10
Sulphur, roll (brimstone)..... 100 lb.		2.00 — 2.75
Tin bichloride, 50 per cent..... lb.	.18 — .19	.40 — .42
Tin oxide..... lb.		.19 — .20
Zinc carbonate, precipitate..... lb.	.16 — .18	.11 — .12
Zinc chloride, gran..... lb.	.11 — .11	.50 — .60
Zinc cyanide..... lb.	.12 — .13	.13 — .14
Zinc dust..... lb.	.08 — .09	.09 — .10
Zinc oxide, XX..... lb.	.03 — .03	.04 — .05
Zinc sulphate..... lb.		

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 — \$1.15
Alpha-naphthol, refined..... lb.	1.25 — 1.30
Alpha-naphthylamine..... lb.	.35 — .40
Aniline oil, drums extra..... lb.	.20 — .26
Aniline salts..... lb.	.26 — .29
Anthracene, 80% in drums (100 lb.)..... lb.	.75 — 1.00
Benzaldehyde U.S.P..... lb.	1.00 — 1.50
Benzidine, base..... lb.	.90 — 1.00
Benzidine sulphate..... lb.	.75 — .80
Benzoic acid, U.S.P..... lb.	.65 — .70
Benzoate of soda, U.S.P..... lb.	.65 — .70
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 — .28
Benzyl chloride, 95-97%, refined..... lb.	.28 — .30
Benzyl chloride, tech..... lb.	.25 — .27
Beta-naphthol benzoate..... lb.	3.50 — 4.00
Beta-naphthol, sublimed..... lb.	.70 — .75
Beta-naphthol, tech..... lb.	.33 — .45
Beta-naphthylamine, sublimed..... lb.	2.00 — 2.25
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)..... lb.	.25 — .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.90 — .95
Cresylic acid, 75-97%, dark, in drums..... lb.	.85 — .90
Cresylic acid, 50%, first quality, drums..... gal.	.55 — .60
Dichlorobenzene..... lb.	.06 — .09
Diethylaniline..... lb.	1.20 — 1.25
Dimethylaniline..... lb.	.44 — .55
Dinitrobenzene..... lb.	.32 — .35
Dinitrochlorobenzene..... lb.	.20 — .30
Dinitronaphthalene..... lb.	.30 — .40
Dinitrophenol..... lb.	.35 — .40
Dinitrotoluene..... lb.	.25 — .27
Dip oil, 25%, tar acids, car lots, in drums..... gal.	.40 — .45
Diphenylamine..... lb.	.60 — .70
H-acid..... lb.	1.30 — 1.50
Meta-phenylenediamine..... lb.	1.20 — 1.25
Monochlorobenzene..... lb.	.12 — .14
Monoethylaniline..... lb.	1.75 — 1.85
Naphthalene crushed, in bbls. (250 lb.)..... lb.	.08 — .08
Naphthalene, flake..... lb.	.08 — .09
Naphthalene, balls..... lb.	.09 — .10
Naphthionic acid, crude..... lb.	.70 — .75
Nitrobenzene..... lb.	.12 — .15
Nitro-naphthalene..... lb.	.30 — .35
Nitro-toluene..... lb.	.16 — .18
Ortho-amidophenol..... lb.	3.15 — 3.40
Ortho-dichlor benzene..... lb.	.15 — .20
Ortho-nitro phenol..... lb.	.75 — .80
Ortho-nitro toluene..... lb.	.17 — .20
Ortho-toluidine..... lb.	.20 — .25
Para amidophenol, base..... lb.	1.60 — 1.75
Para amidophenol, HCl..... lb.	1.75 — 1.85

Para-dichlorobenzene..... lb.	.15 — .20
Paranitroaniline..... lb.	.85 — 1.05
Para-nitrotoluene..... lb.	.85 — 1.00
Para-phenylenediamine..... lb.	1.95 — 2.00
Para-toluidine..... lb.	1.25 — 1.60
Phthalic anhydride..... lb.	.50 — .60
Phenol, U. S. P., drums (dest.), (240 lb.)..... lb.	.11 — .13
Pyridine..... gal.	2.00 — 3.50
Resorcinol, technical..... lb.	1.75 — 1.85
Resorcinol, pure..... lb.	2.25 — 2.30
Salicylic acid, tech., in bbls. (110 lb.)..... lb.	.22 — .23
Salicylic acid, U. S. P..... lb.	.21 — .22
Salol..... lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 — .16
Sulphanilic acid, crude..... lb.	.30 — .35
Tolidine..... lb.	1.35 — 1.45
Toluidine, mixed..... lb.	.40 — .45
Toluene, in tank cars..... gal.	.25 — .28
Toluene, in drums..... gal.	.28 — .31
Xylidines, drums, 100 gal..... lb.	.40 — .45
Xylene, pure, in drums..... gal.	.42 — .45
Xylene, pure, in tank cars..... gal.	.45 — .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 — .35
Xylene, commercial, in tank cars..... gal.	.30 — .35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.23 — \$0.25
Beeswax, refined, light..... lb.	.25 — .27
Beeswax, white pure..... lb.	.40 — .45
Carnauba, Flora..... lb.	.62 — .64
Carnauba, No. 2, North Country..... lb.	.29 — .30
Carnauba, No. 3, North Country..... lb.	.18 — .18
Japan..... lb.	.18 — .19
Montan, crude..... lb.	.07 — .08
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.04 — .04
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.03 — .03
Paraffine waxes, refined, 118-120 m.p..... lb.	.04 — .04
Paraffine waxes, refined, 125 m.p..... lb.	.04 — .04
Paraffine waxes, refined, 128-130 m.p..... lb.	.05 — .05
Paraffine waxes, refined, 133-135 m.p..... lb.	.06 — .06
Paraffine waxes, refined, 135-137 m.p..... lb.	.06 — .06
Stearic acid, single pressed..... lb.	.09 — .09
Stearic acid, double pressed..... lb.	.10 — .10
Stearic acid, triple pressed..... lb.	.11 — .11

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.25 —
Rosin E-I..... 280 lb.	5.35 —
Rosin K-N..... 280 lb.	5.60 —
Rosin W. G.-W. W..... 280 lb.	6.50 —
Wood rosin, bbl..... 280 lb.	6.25 —
Spirits of turpentine..... gal.	.66 —
Wood turpentine steam dist..... gal.	.64 —
Wood turpentine, dest. dist..... gal.	.62 —
Pine tar pitch, bbl..... 200 lb.	7.00 —
Tar, kiln burned, bbl. (500 lb.)..... bbl.	12.50 —
Retort tar, bbl..... 500 lb.	12.50 —
Rosin oil, first run..... gal.	.40 —
Rosin oil, second run..... gal.	.44 —
Rosin oil, third run..... gal.	.47 —
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	1.70 —
Pine oil, pure, dest. dist..... gal.	1.60 —
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.48 —
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 —
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 —
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.36 —
Turpentine, crude, sp. gr. 0.900-0.970..... gal.	1.20 —
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.37 —
Pinewood creosote, ref..... gal.	.55 —

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41 —
70-72 deg., steel bbls. (85 lb.)..... gal.	.39 —
68-70 deg., steel bbls. (85 lb.)..... gal.	.38 —
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30 —

Crude Rubber

Para-Upriver fine..... lb.	\$0.17 —
Upriver coarse..... lb.	.11 — .12
Upriver caucho ball..... lb.	.14 — .14
Plantation—First latex crepe..... lb.	.20 —
Ribbed smoked sheets..... lb.	.17 —
Brown crepe, thin, clean..... lb.	.18 —
Amber crepe No. 1..... lb.	.20 —

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.09 — \$0.09
Castor oil, AA, in bbls..... lb.	.10 — .10
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.08 — .09
Cocoonut oil, Ceylon grade, in bbls..... lb.	.09 — .10
Cocoonut oil, Cochiti grade, in bbls..... lb.	.10 — .11
Corn oil, crude, in bbls..... lb.	.07 — .08
Cottonseed oil, crude (f. o. b. mill)..... lb.	.05 — .05
Cottonseed oil, summer yellow..... lb.	.07 — .07
Cottonseed oil, winter yellow..... lb.	.07 — .07
Linseed oil, raw, car lots (domestic)..... gal.	.60 — .61
Linseed oil, raw, tank cars (domestic)..... gal.	.53 —
Linseed oil, in 5-bbl lots (domestic)..... gal.	.63 — .65

Olive oil, Denatured.....	gal.	\$1.40	—	\$1.60
Palm, Lagos.....	lb.	.07	—	.07½
Palm, Niger.....	lb.	.05½	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.05½	—	.05½
Peanut oil, refined, in bbls.....	lb.	.10	—	.10½
Rapeseed oil, refined in bbls.....	gal.	.90	—	.92
Rapeseed oil, blown, in bbls.....	gal.	1.00	—	1.05
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07½	—	.07½
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.04½	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.42	—	\$0.43
Yellow bleached menhaden.....	gal.	.45	—	.....
White bleached menhaden.....	gal.	.48	—	.....
Blown menhaden.....	gal.	.80	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	11.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	.....
Blanc fixe, dry.....	lb.	.05	—	.05½
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.16
Chalk, domestic, extra light.....	lb.	.05	—	.05½
Chalk, domestic, light.....	lb.	.04½	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04½	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mires.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	25.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07½	—	.08
Graphite, Ceylon chip.....	lb.	.06	—	.06½
Graphite, high grade amorphous crude.....	lb.	.02½	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.57	—	.....
Shellac, orange superfine.....	lb.	.60	—	.....
Shellac, A. C. garnet.....	lb.	.46	—	.....
Shellac, T. N.....	lb.	.50	—	.....
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	14.00	—	15.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	35.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	.....
Carborundum refractory brick, 9-in. { less than carlot	1,000	1250.00	.....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	80-100	.....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	45- 50	.....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	.....	55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55- 60	.....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45- 50	.....
Magnesite brick, 9-in. straight.....	net ton	90	.....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105	.....
Magnesite brick, soaps and splits.....	net ton	120	.....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	45- 55	.....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	45- 55	.....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	45- 55	.....

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.15	—	.16
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.16	—	.17
Ferromanganese, 76-80% Mn, domestic.....	gross ton	85.00	—	90.00
Ferromanganese, 76-80% Mn, English.....	gross ton	85.00	—	90.00
Spiegeleisen, 18-22% Mn.....	gross ton	32.00	—	35.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50	—	.....
Ferrosilicon, 10-15%.....	gross ton	50.00	—	55.00
Ferrosilicon, 50%.....	gross ton	80.00	—	85.00
Ferrosilicon, 75%.....	gross ton	145.00	—	150.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45	—	.50
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	.....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00	—	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	45	—	50
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	45	—	50
Coke, foundry, f.o.b. ovens.....	net ton	4.50	—	5.00
Coke, furnace, f.o.b. ovens.....	net ton	3.25	—	3.75
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00	—	16.00
Fluorspar, lump, f.o.b. Heathden, New Mexico.....	net ton	17.50	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.50
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01½
Manganese ore 50% Mn, c.i.f. Atlantic seaport.....	unit	25	—	30
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.14	—	.14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.14	—	.14
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.13
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	—	3.25
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	.....
Zircon, washed, iron free.....	lb.	.03	—	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.50 @ 12.75
Aluminum, 98 to 99 per cent.....	28.00 @ 28.5
Antimony, wholesale lots, Chinese and Japanese.....	5½ @ 5½
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	0.35
Monel metal ingots.....	0.38
Monel metal, sheet bars.....	0.40
Tin, 5-ton lots, Straits.....	31.50
Lead, New York, spot.....	4.35 @ 4.50
Lead, E. St. Louis, spot.....	4.35
Zinc, spot, New York.....	5.50
Zinc, spot, E. St. Louis.....	5.00

OTHER METALS

Silver (commercial).....	oz.	\$.60½
Cadmium.....	lb.	1.00-1.10
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.65
Cobalt.....	lb.	4.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00-75.00
Iridium.....	oz.	250.00 @ 300.00
Palladium.....	oz.	65.00 @ 70.00
Mercury.....	.75 lb.	45.00-46.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per Lb.

Copper sheets, hot rolled.....	20.50-20.75
Copper bottoms.....	28.00-28.25
Copper rods.....	19.25-20.00
High brass wire.....	18.25
High brass rods.....	15.25
Low brass wire.....	20.25
Low brass rods.....	20.25
Brazed brass tubing.....	29.00
Brazed bronze tubing.....	34.25
Seamless copper tubing.....	22.00
Seamless high brass tubing.....	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	8.50 @ 9.00	18.50	10.00	10.50
Copper, heavy and wire.....	8.00 @ 8.25	16.50	9.50	9.50
Copper, light and bottoms.....	7.00 @ 7.50	14.50	9.00	8.50
Lead, heavy.....	3.25 @ 3.50	7.25	4.00	4.00
Lead, tea.....	2.15 @ 2.30	5.25	3.00	3.00
Brass, heavy.....	4.25 @ 4.50	9.50	7.00	10.00
Brass, light.....	3.00 @ 3.25	8.00	5.00	5.50
No. 1 yellow brass turnings.....	4.00 @ 4.25	9.50	5.50	6.00
Zinc.....	2.00 @ 2.50	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.50	\$3.23	\$3.23
Soft steel bars.....	2.50	3.00	3.13
Soft steel bar shapes.....	2.50	3.13	3.13
Soft steel bands.....	2.85	3.83	3.83
Plates, ½ to 1 in. thick.....	2.50	3.30	3.30

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

ANNISTON.—The Alabama Mica & Mfg. Co., recently organized, is planning for the erection of a new local plant for the reduction and grinding of mica. A portion of the works will be devoted to the manufacture of mica products. The company has a large tract of mica lands in Randolph Co., which will be developed for raw material supply. Harry H. Wand, Chattanooga, Tenn., is president; A. Albert Tapley, Heflin, Ala., is treasurer.

ALABAMA CITY.—The Birmingham Slag Co., Birmingham, Ala., is considering plans for the erection of a new plant for the manufacture of brick and tile products.

Arkansas

EL DORADO.—The El Dorado Refining Co., Texarkana, Tex., recently organized, is considering the erection of a new plant in the vicinity of El Dorado, with initial capacity of about 5,000 bbl. W. H. Locker, Duluth, Minn., is president.

MENA.—The Cooper Mining & Development Co., Cooper, Tex., is planning for the construction of a manganese ore development plant in the vicinity of Mena. The company has a large tract of property in this section.

EL DORADO.—The Constantin Oil & Refining Co. is reported to be planning for extensions and improvements in its plant, including the installation of a new oil refinery. The work is estimated to cost in excess of \$500,000.

Georgia

ATLANTA.—The Morgan Chemical Co., Ogdensburg, N. Y., is reported to be planning for the construction of a new plant in the vicinity of Atlanta, to cost about \$1,000,000 with machinery. The factory will be devoted to the manufacture of insecticides and other chemical specialties. E. R. Hariman is president.

Indiana

ELKHART.—The American Coating Mills, manufacturer of enameled paper products, is taking bids for the erection of a new 3-story plant at the foot of Division St. It will be known as Plant No. 2, and is estimated to cost about \$300,000 with machinery. James L. Carey, 208 North Laramie Ave., Chicago, Ill., is engineer. C. C. Colburn is president.

Kansas

KANSAS CITY.—The Kansas City Foundry Co., manufacturer of small iron castings, etc., has taken bids for the erection of a new 1-story foundry, 65 x 130 ft., at Water and Walker Sts. E. C. Austin is secretary.

Kentucky

ASHLAND.—The Olive Hill Refractories Co., recently organized, is planning for the construction of a new plant at Olive Hill, Ky., for the manufacture of firebrick and other refractory products. The initial plant will have a capacity of about 30,000 bricks per day. John F. Hager is president and J. William Stewart treasurer.

LOUISVILLE.—The Dixie Belle Refining Co., 105 Inter-Southern Bldg., will soon award the contract for its proposed new oil refinery, estimated to cost about \$500,000 with machinery. The company was organized recently with a capital of \$650,000. G. H. Murphy is president. Carl B. Haun, Blackwell, Okla., is engineer for the project.

Louisiana

NEW ORLEANS.—The J. S. Long Co. is planning for the erection of a new 1-story plant, 100 x 300 ft., to be equipped for the manufacture of soap products.

Massachusetts

AMHERST.—The Massachusetts Agricultural College is having plans prepared for

the construction of a new chemical laboratory at the institution to cost about \$125,000. J. H. Ritchie and G. E. Jonesburg, 15 Ashburton Pl., Boston, Mass., are architects.

Maryland

SILVERHILL.—The Silverhill Sand & Cement Products Co., recently organized, has plans under way for the construction of a new plant for the manufacture of tile, sills, steps and other cement products for structural service. Three 1-story buildings will be erected. John Campbell is president and Frank Bell manager.

Michigan

ST. JOSEPH.—The Fay Foundry Co., manufacturer of iron and brass castings, etc., has awarded a general contract to Max Stock & Sons, Benton Harbor, Mich., for the erection of a 1-story foundry addition to cost about \$25,000. John Fay is president.

Minnesota

ST. PAUL.—The Northwestern Spring Mfg. Co., 3720 University Ave., N. E., has awarded a contract to P. C. Giguere, Minneapolis, for the rebuilding of its spring manufacturing plant in the Columbia Heights section, 2-story, recently destroyed by fire. The new plant will cost about \$100,000. J. W. Hines is head.

Missouri

KANSAS CITY.—The Husted Syndicate Oil Co., 16th St. and Cookson Ave., is planning for the rebuilding of the portion of its oil refinery, destroyed by fire, April 14, with loss of about \$25,000.

Montana

BILLINGS.—The Montana Refining Co. is planning for the construction of a new oil refinery with initial capacity of about 1,000 bbl. The plant is estimated to cost about \$125,000. The company is capitalized at \$500,000. Rudolph Molt is president.

New Jersey

NEW BRUNSWICK.—The Department of Ceramics, Rutgers College, has made a list of machinery and equipment to be installed in the new ceramic school building and will make purchases at an early date. Bids for the new school will be taken at once. It is estimated to cost about \$100,000, and a state appropriation for this amount has been granted. George H. Brown is director of the department.

BAYONNE.—The Standard Oil Co., 26 B'way, New York, has acquired property on East 22d St., between Ave. H and Central Ave., in the vicinity of its oil refinery, Constable Hook, Bayonne, for a consideration said to be about \$270,000. Present buildings on the site will be demolished and the property used for plant extensions.

NEWARK.—The Flexible Cork Co. has leased a portion of the former plant of the Universal Caster & Foundry Co., 124-32 Adams St., for the manufacture of cork specialties. The space totals about 8,000 sq. ft., and the company will take possession about May 1. Equipment will be installed at an early date.

New York

DUNKIRK.—The Thatcher Mfg. Co., manufacturer of glassware, is planning for the erection of modern, fireproof plant to replace its factory destroyed by fire, April 19, with loss of about \$100,000, including machinery. The former works comprised a number of buildings on West Second St.

NEW YORK.—The Mexican Petroleum Co., 120 B'way, has arranged for a bond issue of \$10,000,000, the proceeds to be used for general operations, extensions and improvements in oil refineries, etc. The company is a subsidiary of the Pan-American Petroleum & Transport Co., same address, of which E. L. Doheny is president.

BUFFALO.—The Warner Jewelry Case Co., 682 Michigan Ave., manufacturer of cardboard and fiber containers, etc., is reported to be planning for the immediate establishment of a new local plant to replace its works destroyed by fire, April 19, with loss estimated at about \$125,000.

Ohio

CANTON.—The Whitaker-Greer Fireproofing Co., manufacturer of fireproof building products, has resumed operations at full capacity at its plants at Magnolia and Waynesburg, O., following a shutdown of several months due, in part, to labor troubles.

Ontario

TRENTON.—The Chemical Products Co., Ltd., Toronto, is planning for the construction of a new acid phosphate plant at its local chemical works.

Pennsylvania

CHESTER.—The Cellulose Silk Co. of America is planning for the early installation of machinery at the local Patterson mills, recently acquired, for the manufacture of artificial silk under an improved copper-ammonia process. The property is located on Sixth St., fronting on the Chester River, comprising a number of 2-story buildings with a total of 50,000 sq. ft. of floor area. M. H. Avram, head of M. H. Avram & Co., Inc., 360 Madison Ave., New York, is president.

PITTSBURGH.—The International Cork Co. has leased the 3-story building, 25 x 70 ft., at 511 First Ave., near Grant St., for a local works.

PHILADELPHIA.—The B. F. Goodrich Rubber Co., Akron, O., has leased the plant of Reyburn Mfg. Co., 23d St. and Allegheny Ave., comprising about 100,000 sq. ft., for a local plant. The lease is for a period of years and totals \$250,000. The Reyburn company, manufacturer of tags, is building a new plant at 32d St. and Allegheny Ave., and plans to occupy the structure at an early date. It will total about 250,000 sq. ft. in manufacturing area.

Texas

WICHITA FALLS.—The Keystone-Ranger Producing & Refining Co., Pittsburgh, Pa., is planning for extensions in the local plant of the Southwestern Producing & Refining Co., recently acquired. The plant has a capacity of about 1,000 bbl., and this will be increased.

CASTROVILLE.—The Gulf Portland Cement Assn., recently organized with a capital of \$300,000, is planning for the construction of a large cement manufacturing plant in this section. The company is headed by L. C. Ihnken and John J. Shorp, Castroville; and W. S. Campbell, San Antonio, Tex.

WICHITA FALLS.—J. G. Kilgore and O. B. Manross are organizing a company to construct a new oil refinery at Wichita Falls, with initial capacity of about 500 barrels.

FORT WORTH.—The Invincible Oil Corp. is planning for a bond issue to total about \$3,000,000. A portion of the proceeds will be used for the erection of an addition to the present oil refinery. George W. Lull is president.

Virginia

RICHMOND.—The Master Products Co., 1107 East Cary St., recently organized, has acquired a local building for its proposed new plant for the manufacture of chemical specialties, including insecticides and other products. Machinery will be installed at an early date. The company is capitalized at \$50,000. E. R. Aiken is president.

West Virginia

ELLENSBORO.—The Insulite Co., manufacturer of molded composition products, has arranged for the establishment of a new local plant, 80 x 160 ft., and for which a contract recently has been let. A power house will also be installed in connection with the works. Considerable machinery will be installed for general production. Edward J. White is president and manager.

BARBOURSVILLE.—The Barbooursville Clay Mfg. Co., is considering the rebuilding of the portion of its plant, destroyed by fire on April 13.

HUNTINGTON.—The Specialty Glass Co., recently organized, will construct a new local plant for the manufacture of bent glass products, such as automobile headlights, etc. Glass presses, cutting machinery and other equipment will be installed. E. W. Miller is vice-president and treasurer; William Shaw is manager.

Wisconsin

MILWAUKEE.—The L. J. Mueller Furnace Co., 197 Reed St., has awarded a contract to Paul Riesen & Sons, 1018 Humboldt Ave., for the erection of a 1-story plant at Fifteenth and Oklahoma Sts., 60 x 100 ft., to be equipped as a japanning works.

Industrial Notes

THE NATIONAL ASSOCIATION FOR THE PROTECTION OF AMERICAN RIGHTS IN MEXICO has removed its offices to 32 Bway, New York City.

THE EQUITABLE EQUIPMENT Co., a new concern, has just completed its organization for the purpose of handling locomotives, cars, machinery of all kinds, etc. Offices are located at 411 Whitney-Central Bldg., New Orleans, La.

DWIGHT P. ROBINSON & Co., INC., has recently opened branch offices in Montreal, in the Dominion Express Bldg. Alexander C. Barker, vice-president, is in charge of the office.

THE AMERICAN AMINO CORP., Garwood, N. J., has just completed its plant at Matawan, N. J., and is ready to submit samples and dyestuff intermediates.

THE RUGGLES-COLES ENGINEERING Co. has moved from 50 Church St. to 120 Bway, New York City.

FRANK D. CHASE, INC., Chicago, Ill., has just completed work on four buildings of the new West Milwaukee plant for the Chain Belt Co. of Milwaukee.

C. LORENZ AKTIENGESSELLSCHAFT, Berlin, has purchased the Weld-Barfield patent rights for Germany, Poland and the former Austria-Hungary. Messrs. Lorenz have already placed an order with Automatic & Electric Furnaces, Ltd., for various parts to complete nearly 100 furnaces.

OHIO EXPORT & TRADING Co. has established its main office at 33 West 17th St., New York City, maintaining a branch office at its former headquarters in Cleveland. O. J. H. Schmidt, manager of the chemical equipment department, has his headquarters in the New York office.

THE NEW ENGLAND TANK & TOWER Co., Everett, Mass., opened a branch office on March 7 at 30 Church St., New York City. A. E. Hall, vice-president of the company, is in charge.

THE BLAW-KNOX Co., Blawnox (Pittsburgh), Pa., on April 1 opened a new sales territory in the Southwest, with headquarters in Kansas City, Mo. The new office, which is located in the Interstate Bldg., is in charge of R. B. Randall, formerly connected with the company's Chicago office, who will be known as manager of the Southwestern territory.

AMERICAN HINGE Co., incorporated under the laws of Oklahoma, has established a manufacturing plant at Memphis, Tenn. The modern cement and glass factory building, constituting the future plant, is now being constructed on the corner of Maple and Dunlap Sts. The approximate cost is \$100,000. The company will manufacture a complete special line of hinges, hardware and mining specialties. All material will be furnished by the Memphis Iron & Steel Co., which has recently established a new rolling mill in Memphis. The capacity of the new plants will be 10,000 hinges per day.

METALS COATING Co. OF AMERICA, which issues licenses for the use of the Schoop metal spraying process, is now located at 495-497 North Third St., Philadelphia, Pa. Richard L. Binder is president of the company.

ARTHUR D. LITTLE, INC., Cambridge, Mass., is publishing as a reprint from the *Paper Trade Journal* the Bibliography of Papermaking Materials which was compiled by Clarence Jay West. This will be a pamphlet of 170 pages. While the company is desirous of furnishing this to all members of the Technical Association of the Pulp and Paper Industry, the cost of production makes it advisable that it be sent only to those members who are really interested in the question of fibers, other than wood, used for the manufacture of paper. If, therefore, a copy of this bibliography is desired (Bibliographic Series No. 6) a postcard addressed to the firm will insure its receipt.

THE AUSTIN MACHINERY CORP. furnishes the information that on March 22 fire destroyed its Winthrop Harbor, Ill., plant, and while extensive damage was done there will not be any interference with production and prompt delivery of Austin trenching machines, backfillers, building mixers, pavers, draglines and shovels, as practically all lines of Austin machinery are also being built at the plants at Muskegon, Mich., as well as at the former plant of the Toledo Bridge & Crane Co., Toledo, O. It has been arranged to have the plants at Toledo and Muskegon increase their stock production orders to take care of the shortage which would otherwise occur through the loss of the Winthrop Harbor plant.

THE PEASE LABORATORIES, INC., 39 West 38th St., New York City, announces that Dwight Tenney, chief engineer of the Franklin Baker Co. of New York, has become associated with it as head of the newly organized department of engineering. He will continue his connection with the former company as consulting engineer, having charge of all technical development work.

THE JOSEPH DIXON CRUCIBLE Co. announces that Herbert L. Hewson has been placed in charge, as special representative, of the sale of crucible factory products in Ohio, southern peninsula of Michigan, Pittsburgh and adjacent cities and towns. Mr. Hewson first became associated with the Dixon company in 1909 in the San Francisco office.

THE STIMPSON EQUIPMENT Co., Salt Lake City, Utah, announces that Clinton Clark has been transferred to the New York office, Grand Central Palace.

SKINNER, SHERMAN & ESSELEN, INC., 248 Boylston St., Boston, Mass., has been organized and equipped to furnish counsel on all matters relating to the application of chemistry and biology to industrial operations. The new corporation has acquired the business and good will of the Boston Bio-Chemical Laboratory and will hereafter direct its activities. Prof. Samuel C. Prescott has been retained as consulting industrial biologist, and Burton G. Philbrick as laboratory director. The personnel of the corporation comprises Hervey J. Skinner, Herbert L. Sherman and Gustavus J. Esselen, Jr.

THE ENGINEERING BUSINESS EXCHANGE, New York City, announces the opening of a Southeastern branch, with offices in the McLachlen Bldg., Washington, D. C., with Marshall O. Leighton as director. Mr. Leighton was for twelve years one of the officers of the U. S. Geological Survey. Associated with Mr. Leighton will be A. C. Oliphant, who has been active in the work of Engineering Council's National Service Committee.

F. J. RYAN & Co., Philadelphia, announces that it has secured control of engineering, sales and installation of all Mirco fuel-fired equipment of the Lancaster Iron Works, Lancaster, Pa. Sales and engineering headquarters are at Philadelphia; manufacturing headquarters are at Lancaster, Pa.; New York office is retained at 501 Fifth Ave. W. W. Posey, president of the Lancaster Iron Works, has been elected a director of F. J. Ryan & Co., and A. C. Scully, secretary and treasurer of the Lancaster Iron Works, has been elected a director and treasurer.

THE BROWN HOISTING MACHINERY Co., Cleveland, O., announces the opening of a Southern office for Texas, Louisiana, Mississippi, Alabama, Georgia and Florida to be located at 530 Whitney-Central Bldg., New Orleans; Charles H. White, manager.

THE TECHNICAL SERVICE Co. has been organized, with offices in the Colonial Bldg., Allentown, Pa., to handle chemical and metallurgical problems and to provide sales service in technical equipment, materials and supplies. This company was formed by Edgar S. Genstein, who was previously metallurgist for the Treadwell Engineering Co., Easton, Pa., in chemical and metallurgical work during several years with the U. S. Navy and Army Departments.

O. S. SLEEPER & Co. announces its formation for the purpose of placing on the market a line of drying and chemical apparatus of improved design. The members of the company recently resigned from the engineering staff of the Buffalo Foundry & Machine Co. and include O. S. Sleeper, president; H. E. Neubauer, vice-president, and C. B. Brown, secretary and treasurer. Mr. Sleeper was chief engineer of the Buffalo County & Machine Co. for fourteen years. This company is prepared to furnish a line of vacuum self driers, vacuum rotary driers, direct heat driers, flaking machines, crystallizers and special apparatus.

M. P. BURT & Co. has established offices as mechanical engineer at 206 Falls Bldg., Memphis, Tenn. Included in the personnel of the new company are Milton T. Burt, mechanical engineer; J. Paul Gaines, civil engineer, and Louis G. Carlisle, architect. The company will specialize in packing house and cold storage designing and consultation on power and operating costs. Mr. Burt was formerly with the Memphis Packing Co.

THE LIMESTONE PRODUCTS Co., incorporated under the laws of Missouri, recently organized to operate quarries at Black Rock, Ark., has established headquarters in the Randolph Bldg., Memphis, Tenn. John G. Woodruff of Springfield, Mo., is president, and R. F. Alessi is secretary.

THE INTERNATIONAL PULVERIZED FUEL CORP. announces that since April 20 its general offices were located in the National City Bldg., 17 East 42d St., New York City.

THE SUPERHEATER Co. announces that on May 1 its general offices will be moved from 30 Church St. to 17 East 42d St., New York City.

THE INTERNATIONAL TRADING Co., LTD., announces the removal on May 1 to its former address, 60 B'way, New York City.

VICTOR T. GOGGIN, late New England sales manager of Fred T. Lev & Co., Springfield, Boston and New York, has severed his connection with that concern to associate himself as contracting engineer with Dwight P. Robinson & Co., Inc., New York.

O. L. MOORE, chief cement inspector of the Universal Portland Cement Co., has been appointed engineer, inspection bureau, with headquarters at 210 South La Salle St., Chicago.

THE AIRCO organization (Air Reduction Sales Co.), manufacturer of oxygen, acetylene and welding and cutting apparatus, moved its executive offices on May 1 to 342 Madison Ave., New York City. Coincident with the announcement of the general office change is another to the effect that the New York district office is located at the Airco factory, 191 Pacific Ave., Jersey City, N. J., since May. Announcement is also made that the Air Reduction Co. has obtained control of the National Carbide Corp. of Virginia, with a new plant at Ivanhoe, Va.

THE GAGE PUBLISHING Co., INC., publisher of *Electrical Record*, *Electrical Export* and *Raw Material*, located at 114 Liberty St., New York, for twenty-three years, has moved its executive and editorial offices to the Printing Crafts Bldg., 461 Eighth Ave., between 33d and 34th St.

THE EMPLOYERS MUTUAL INSURANCE Co., 61 B'way, N. Y., announces the appointment of E. C. Jacobs, formerly chief chemical risk inspector of the New Jersey Rating and Inspection Bureau, as insurance expert in charge of the inspection and underwriting of chemical risks.

THE HARRY M. HOPE ENGINEERING Co., of Boston, has established offices in the Dominion Express Bldg., Montreal, to handle its Canadian business. George W. Saunders, formerly with S. Pearson & Sons, London, is Canadian manager.

SCHWARZ LABORATORIES, analytical and consulting chemist, advises its clients of its removal on May 1 to 113 Hudson St., New York City.

THE THERMAL SYNDICATE, LTD., manufacturer of fused silica ware for chemical plant and laboratory use, announces its removal on May 1 to the New Borden Bldg., 350 Madison Ave., New York City.

THE CONVEYORS CORP. OF AMERICA, Chicago and New York, announces the appointment of Robert B. M. Wilson as sales engineer of the Chicago district. With him will be associated E. M. Wolfe. Headquarters will be maintained in the corporation's main office at 326 West Madison St., Chicago.

THE ELECTRIC FURNACE Co., Alliance, O., has just installed three Baily electric brass-melting furnaces of different size and capacity. The Bagley & Sewall Co., Watertown, N. Y., has installed a 50-kw. electric furnace with 500 lb. hearth capacity, the Alliance Brass & Bronze Co. a 75-kw. furnace with 800 lb. capacity, and the Empire Brass Works of London, Ont., a 105-kw. furnace of 1,500 lb. hearth capacity. All these furnaces are to melt yellow and red brass alloys. It is also announced that the Lorain Steel Co., Johnstown, Pa., is installing a 200-kw. Baily electric furnace for heat-treating railroad bolts and similar parts. This furnace is of the continuous pusher type with motor-operated control mechanism and will have a capacity sufficient to heat-treat 14 tons of material per day.

ELECTRIC FURNACE CONSTRUCTION Co., Philadelphia, Pa., has received an order from the Sociedad Espanola de Construcción Naval for a new design of electrically heated car-type annealing furnace for heat-treating large steel ingots and forgings. It will be 6.8 m. long by 4.75 m. wide by 4.14 m. high, and will heat a charge of 60 tons of steel to 1,700 deg. F. every 24 hours. T. H. Watson & Co., Ltd., Sheffield, England, and the Electric Furnace Construction Co., Philadelphia, announce that arrangements have been made with the General Combustion Co., of Canada, Ltd., New Kirks Bldg., Montreal, to handle, build and sell their various electric smelting, melting and refining furnaces in Canada. The Canadian rights of the Greaves-Etchells type of furnace are also included in the arrangements made.

New Companies

THE CENTRAL PAPER Co., Newark, N. J., has been incorporated with a capital of \$50,000 to manufacture and deal in paper products. The incorporators are Benjamin S. Berkowitz, Morris W. Shapiro and Louis Weiss, 148 Mulberry St.

THE IMPERIAL BEARING BRONZE Co., Flushing, L. I., has been incorporated with a capital of \$20,000 to manufacture brass and bronze products. The incorporators are L. Osabon, J. M. Partmann and S. O. Wood, Jamaica, L. I.

THE MISSOURI OXIDE & CHEMICAL Co., New York, N. Y., has been incorporated under Delaware laws with a capital of \$800,000 to manufacture chemicals and chemical byproducts. The company is represented by Arthur W. Britton, 65 Cedar St.

THE EASTERN TABLET Co., Boston, Mass., has been incorporated with a capital of \$775,000 to manufacture paper products. The incorporators are Alexander W. Murray, Wellesley Farms, Mass.; Marcus E. Mahon, Quincy, Mass.; and Ray Henry, Cambridge, Mass.

THE RIVERWAY MFG. CORP., Cambridge, Mass., has been incorporated with a capital of \$50,000 to manufacture chemicals and byproducts. The incorporators are A. Hollander, Brookline, Mass.; Cyril M. and J. Hollander, Boston.

THE PABST CHEMICAL CORP., 324 Sherman St., Chicago, Ill., has been incorporated with a capital of 200 shares of stock, no par value, to manufacture chemicals and affiliated products. The incorporators are William W. Allan, George W. Andress and Theodore Harbeck.

THE HOLYOKE GUMMED PRODUCTS Co., Holyoke, Mass., has been incorporated with a capital of \$100,000 to manufacture paper, strawboard and kindred products. The incorporators are Charles F. Moriarty, Nashua, N. H.; Martin J. Judge and Maurice J. Moriarty, South Hadley Falls, Mass.; and Charles B. Dunbar, Holyoke.

HANSON, DUNN & Co., INC., Providence, R. I., has been incorporated with a capital of \$20,000 to manufacture soaps and kindred products. The incorporators are Louis W. and John F. Dunn, and Samuel Hanson, 11 Evergreen St., Providence.

THE VAN SICLEN CHEMICAL LABORATORIES, INC., Brooklyn, N. Y., has been incorporated with a capital of \$100,000 to manufacture chemicals and chemical byproducts. The incorporators are J. T. Rep-ton, N. Handler and W. H. Birken, I. Berson, 16 Court St., represents the company.

THE WINAMAC CEMENT PRODUCTS Co., Winamac, Ind., has been incorporated with a capital of \$25,000 to manufacture cement specialties. The incorporators are Chris Hansen, John Kruzick and George Kurzick, Winamac.

THE FLEXIBLE CORK Co., Jersey City, N. J., has been incorporated with a capital of 7,400 shares of stock, no par value, to manufacture cork products. The incorporators are H. A. Black, Alfred F. McCabe and John R. Turner, 15 Exchange Pl.

THE EDWARD R. BULE CHEMICAL CORP., New York, N. Y., has been incorporated with a capital of \$30,000 to manufacture soaps, cleaning preparations and other chemical products. The incorporators are Edward R. Bule, C. F. Newinger and V. Mast. The company is represented by Lee, Aron & Wise, 7 Dey St.

THE KANE OIL REFINING Co., Brooklyn, N. Y., has been incorporated with a capital of \$25,000 to manufacture refined oil products. The incorporators are W. A. Kane, Sr. and Jr., and H. S. Cook, 38 Park Row.

THE OIL & SUPPLY Co. OF ILLINOIS, 116 South Michigan Ave., Chicago, Ill., has been incorporated with a capital of \$20,000 to manufacture refined oils. The incorporators are H. O. Nottingham, Frank B. Page and James E. Hauronic.

THE C. M. CARROLL PAPER Co., New Bedford, Mass., has been incorporated with a capital of \$25,000 to manufacture paper products. Charles M. Carroll, 50 Page St., is president and treasurer; G. E. and Milton E. Carroll are directors.

THE STAR OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are W. A. and E. M. Mathias, and R. E. Burbank, Los Angeles.

THE PURE AIR CORPORATION, New York, N. Y., has been incorporated with a capital of \$100,000 to manufacture chemicals and chemical byproducts. The incorporators are S. G. Geler and J. S. Friedman, 277 B'way.

THE ROBERT WYSLEY Co., 91 River St., Hoboken, N. J., has been organized to manufacture chemicals and affiliated products. Nicholas Noggi heads the company.

THE UNIVERSAL CHEMICAL Co., Richmond, Va., has been incorporated with a capital of \$100,000 to manufacture chemicals and chemical byproducts. The incorporators are H. L. Jones, Norfolk, Va.; and J. McD. Woolford, Richmond.

THE DROWN SPECIALTY Co., Worcester, Mass., has been incorporated with a capital of \$10,000 to manufacture paper products. William L. Drown is president; and Oscar L. Drown, 6 Field Way, treasurer.

THE UNIVERSAL SHALE PRODUCTS Co., Buffalo, N. Y., has been incorporated with a capital of \$500,000 to manufacture refined mineral oil products. The incorporators are A. Adamozak and J. Janowski. Falk, Phillips & Schlenker, Morgan Bldg., represent the company.

THE LIBERTY PAINT Co., 1400 First National Bank Bldg., Chicago, Ill., has been incorporated with a capital of \$20,000 to manufacture paints, oils, etc. The incorporators are Frank B. Page and associates. Winston, Strawn & Shaw, address noted, represent the company.

THE CROWN DIE CASTING Co., Detroit, Mich., has been incorporated with a capital of \$25,000 to manufacture die castings and kindred metal products. The incorporators are R. Frank Ward, Mt. Morris, Mich.; John F. Goude and V. E. Thompson, Flint, Mich.

THE PEEL CHEMICAL CORP., New York, N. Y., has been incorporated with a capital of \$200,000 to manufacture chemicals and chemical byproducts. The incorporators are A. B. Johnson, R. P. Dicks and A. David, Platt & Field, 120 B'way, represent the company.

THE MODERN LUBRICATING Co., Minneapolis, Minn., has been incorporated with a capital of \$100,000 to manufacture lubricating oils and kindred products. The incorporators are A. N. and D. Peever, and George H. Clarke, Minneapolis.

THE HIDE & LEATHER Co., Boston, Mass., has been incorporated with a capital of \$200,000 to manufacture leather products. Ralph W. Dunbar is president, and Harrison M. Davis, 75 Ames Bldg., treasurer.

THE PECOS VALLEY REFINING Co., Los Angeles, Cal., has been incorporated with a capital of \$100,000 to manufacture refined oils. The incorporators are L. K. Adams, John C. Gillkam and George W. Davis, Los Angeles.

THE BOHEMIA BRICK & TILE Co., Houston, Tex., has been incorporated with a capital of \$125,000 to manufacture brick, tile and other burned clay products. The incorporators are A. T. Eddington, Otto Jetal and James Pokorny.

THE AMERICAN CELUTEX CORP., New York, N. Y., has been incorporated with a capital of \$200,000 to manufacture celluloid and other composition products. The incorporators are A. Burke, I. L. Goldberg and C. S. Aronstan, 100 B'way.

THE MERLE SEARS PAPER BOX Co., 740-42 Main St., Danville, Ill., has been incorporated with a capital of \$60,000 to manufacture paper cartons, containers, etc. The incorporators are H. N. and Merle Sears, and George D. Johnson.

THE PRODUCERS' PETROLEUM Co., Duncan, Okla., has been incorporated with a capital of \$250,000 to manufacture petroleum products. The incorporators are John O'Donahue, W. M. McGregor and C. E. McCutchen.

THE BELCO DRUG & EXTRACT Co., 790 Broad St., Newark, N. J., has been incorporated with a capital of \$25,000 to manufacture chemicals, drugs, etc. The incorporators are Samuel M. Hollander, S. Kneip, Newark; and E. Fairhurst, Kearny, N. J.

THE HUNTINGTON-PACIFIC OIL & REFINING Co., Los Angeles, Cal., has been incorporated with a capital of \$250,000 to manufacture petroleum products. The incorporators are J. J. Eiseman, J. H. Roth and George E. Benson.

THE LOWRY MFG. Co., Winchester, Ky., has been incorporated with a capital of \$10,000 to manufacture chemicals, washing powder and kindred products. The incorporators are E. A. and S. M. Lowry, and Edward C. Epperson, Winchester.

THE CHIEF CHEMICAL LABORATORIES, INC., Brooklyn, N. Y., has been incorporated with a capital of \$6,000 to manufacture chemical specialties. The incorporators are S. Krasner and H. Shorenstein. Caldwell & Polhemus, 50 Church St., New York, represent the company.

THE STANDARD CLAY Co., Brazil, Ind.,

has been incorporated with a capital of \$300,000 to manufacture bricks, tile and other burned clay products. The incorporators are Albert F. Price and Edwin T. Norris, Brazil; and John H. Wright, Indianapolis, Ind.

THE RELIABLE GLASS Co., 1816 West Division St., Chicago, Ill., has been incorporated with a capital of \$6,000, to manufacture glassware. The incorporators are Harry Resnick, Samuel Sless and Jacob Schulemsohn.

THE FAIRMONT-SOMERSET OIL Co., Fairmont, W. Va., has been incorporated with a capital of \$200,000 to manufacture petroleum products. The incorporators are Osman E. Swartz, A. J. Colburn and W. R. Dougan, Fairmont.

THE GREENPORT BRICK CORP., Greenport, N. Y., has been incorporated with a capital of \$300,000 to manufacture brick and other burned clay products. The incorporators are J. Briskman, S. Bitterman and E. R. Greenstein. Bitterman & Hecht, 305 B'way, New York, represent the company.

Coming Meetings and Events

AMERICAN ASSOCIATION OF ENGINEERS will hold its seventh annual convention at the Hotel Lafayette, Buffalo, N. Y., on May 9, 10 and 11.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17. Headquarters will be at the Congress Hotel.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

AMERICAN ZINC INSTITUTE will hold its annual meeting in St. Louis May 9 and 10.

COLORADO SCIENTIFIC SOCIETY, Denver, Col., will hold its 343d regular meeting May 7, 1921, in the Colorado State Museum Bldg., Denver. Arthur J. Hoskins will address the meeting. His subject is "Colorado's Oil-Shale Industry."

BRITISH IRON AND STEEL INSTITUTE will hold its spring meeting May 5 and 6, at the Institution of Civil Engineers, Great George St., S. W. 1, London, England.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-eighth annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., the week beginning June 20.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month; except June, July, August and September.

TANNERS' COUNCIL OF THE UNITED STATES will hold its annual spring convention at the Hotel Traymore, Atlantic City, May 5 and 6.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: May 6, American Chemical Society, Nichols Medal award; May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

CHEMICAL & METALLURGICAL ENGINEERING

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ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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New York, May 11, 1921

Number 19

Meetings of Chemists And Electrochemists

THE spring meetings of the American Electrochemical and American Chemical societies, which are reported in this issue, afforded the usual opportunity for discussing technical subjects, exchanging opinions and renewing acquaintances. The electrochemists, being smaller in number and more flexible in organization, adapted themselves to their surroundings at Atlantic City and indulged in competitive sports and recreation for two afternoons. Apparently this admixture of pleasure to the technical sessions was regarded as a successful experiment, because the directors voted to hold the fall meeting at Lake Placid, N. Y., September 29 and 30 and October 1. The technical feature of the Atlantic City meeting was a Symposium on Corrosion, which is fully reported elsewhere. While no new or startling facts were brought out, additional data and observations were recorded to verify or refute some of the unsettled theories which have been advanced to account for the varied phenomena of corrosion. An important action of the directors was a decision to hold a Symposium on Electrothermics annually at the spring meeting. With this topic definitely scheduled thus far in advance, it should be possible to prepare excellent programs embodying not only the results of operation but also of experiment and research. The election of ACHESON SMITH to the presidency of the society will insure a lively interest in the first symposium on this subject next spring.

The chemists met at Rochester and it is worth recording at this point that the meeting was marked by freedom from confusion and excellent arrangements on the part of the local committees. If we were to emphasize the most distinctive general feature of the convention, we should mark the presidency of Dr. EDGAR FAHS SMITH and the enlivened recognition of the need of fundamental research. Dr. SMITH is an unusual presiding officer. He speaks with such rare grace, with such sanity and good nature, that the audience hardly recognizes how closely it is held in leash. If it starts to run away from a subject, or to give way to useless discussion, he brings it back with some droll comment that does the work desired under a ripple of laughter. He adds also a quality of dignity to that of affability which is reflected in the tone of the whole meeting. The other noteworthy feature is the apparent earnest resolution of the members to declare the need of fundamental research. It presses in many places where even laboratory work in one field or another is at an *impasse* because certain facts, which should be known are not available and the smaller laboratories have not the facilities to determine them. That incompetent and underdone chemists should be seeking and finding other occupations is in the nature of things and generally approved, but the disposition of short-sighted men in

industry to dismantle established research laboratories in the interest of false economy is regarded as a menace to national progress.

We have no sympathy with camp-meeting designations for serious assemblies, but if we must have a tag for the occasion at Rochester we should be disposed to call it the Sober Second Thought Meeting. It was more of a scientific colloquium than a traders' assembly, and yet it would have been more illuminating to traders who have "bought into" chemical industry than any number of Chamber of Commerce festivals of speech. The necessity of real chemical scholarship in industry as well as in academic life was repeatedly emphasized, and to miss this point would have required a mind either unusually dull or supersaturated with arrogant vanity.

The general meetings were unusually constructive and informing. Senator WADSWORTH and Congressman LONGWORTH, who spoke, have a vision of the function of chemistry in national life. We cannot recall any time when such a direct, frank and confidential communication from a lawmaking body was made to the society as was presented by both these gentlemen. Certainly no political constituency could have asked or received a more direct pledge from its leader than was given to the society by Congressman LONGWORTH when he reiterated the assurance that the dye and chemical industry would be given adequate protection in the forthcoming tariff schedule.

An interesting criticism was made by Dr. ALSBERG in one of the meetings to the effect that there is too much tacit agreement at gatherings. Papers are not attacked enough. If a member gives his records and these seem wrong, somebody is likely to get up and ask the speaker how he has reached his conclusions, and the answer is not likely to contain much more information than that these were concluded from preponderance of evidence. The questioner sits down unconvinced, and the speaker is not called on to make a proper defence of his work. This has the defect of inadequate censorship, and tends to permit defective information and shallow reasoning to go on record. He intimated that we are too tender with one another, and that it is better to cause a little pain and to hurt the feelings of those who persevere in error than to permit an error to endure. We think he is right. In this respect the chemists can learn a lesson from the electrochemists, with whom the frankest criticism is the prevailing custom. Debatable and controversial questions are not handled with gloves in that organization.

We are glad to report an action by several of the sections and divisions that will have a tendency to make future meetings more interesting and profitable. It is plainly recognized that the program as now constituted is appalling rather than attractive on account of the large number of papers scheduled for presentation and the difficulty experienced by the average attendant in

discriminating between good, bad and mediocre offerings. Under the spur of Mr. HOWE's keen criticism the Division of Industrial and Engineering Chemistry voted to appoint a committee to pass on all papers before they are accepted for the program. Papers must be in the hands of the committee at least two weeks before the meeting and they will be accepted, rejected or liberally blue-penciled according to their merits. In addition to this the chairman will decide whether papers shall be read in abstract or *in extenso* and will have power to limit discussion on subjects in which only a few are interested. Similar tendencies are noted in the Division of Physical and Inorganic Chemistry and the new Petroleum Section, both of which will issue to their members in advance of the meeting a full set of abstracts of papers admitted to the program. These are hopeful, if somewhat sporadic, signs of improvement—experiments out of which the parent society will doubtless evolve a unified plan for all sections and divisions.

A Suggestion To Authors

THIS is in the nature of a personal chat with those excellent and estimable persons who read papers at scientific society meetings. Without their zeal and enthusiasm we would have no formal technical programs, and but for their personal interest in science we would not have nearly so wide a dissemination of technical knowledge. Curiously enough, however, they frequently lack the quality of salesmanship which would greatly enhance their value to their audience. They do not know how to present the ideas which they have carefully recorded after painstaking thought, research and investigation. About twice a year following the spring and fall seasons of scientific and technical conventions, we have been tempted to express our feelings on this subject, not in unkind criticism, but by way of friendly advice and suggestion. Probably this is because it falls to the lot of editors not only to attend but also to report a great many meetings, and consequently their feelings on this subject are more intense than are those of the average attendant.

In the first place there are few technical papers that will bear reading verbatim to an audience. The literary style in which they are couched is far better adapted to quiet perusal in printed form. What the audience is most interested in may be phrased expressively, if inelegantly, by the query, "What's it all about?" In other words, there is, or should be, an important feature, result or conclusion which summarizes the author's contribution and which can be told in simple language in conversational style. It is not expecting too much of an author to ask that he shall be sufficiently familiar with his subject to be able to review and summarize his paper extemporaneously and relieve his audience of the impossible task of following him through a formal reading. This is particularly true when chemical equations, mathematical formulæ or tabulated data are to be presented. A few lantern slides and a five-minute explanatory talk will frequently tell the whole story better than a twenty-minute formal reading which leaves the audience confused. It is a matter of simple observation that the author who best transmits his ideas to his audience does so through these simple expedients; and it may be worth noting that our convictions in the matter are shared and openly expressed by those thoughtful persons trying to get the most out of their attendance on conventions.

Army's Nitrogen Policy Determined

WE NOTE with gratification that Secretary WEEKS has finally determined the nitrogen policy of the War Department and that his ruling is practically in accordance with the editorial suggestions made in CHEMICAL & METALLURGICAL ENGINEERING, April 27, 1921. The Fixed Nitrogen Research Laboratory, in American University in Washington, is to be continued, and Nitrate Plants Nos. 1 and 2, at Sheffield and Muscle Shoals, Ala., respectively, will be retained under Army control in the most economical stand-by condition. The Secretary's decision is eminently satisfactory from all points of view—fundamental scientific research, industrial development and military preparedness.

More Business In Chemistry

A YOUNG chemist who is a real one and whom we like as a companion lately criticized us technical journals for accepting the advertisement of a business institute. "Why," he asked, "do you want me to study business and salesmanship and commercial law and such things when my subject is chemistry? Being engaged in technology, I have to address myself to business problems at the expense of my information in chemistry. My proper subject for my spare time should be and is the fundamentals in science; the philosophy of the subject, the general principles, the work of THEODORE RICHARDS, or IRVING LANGMUIR, of SVEDBERG, and of the men who look ahead. Chemistry is not a dinky little thing that one studies and then *has*. No chemist is a chemist when he graduates; or at least very few are. Why should I study book-keeping when I don't want to keep books, or salesmanship when I don't want to sell? I have more important work in my own field. Chemistry is too big and too deep to make jacks of all trades of those who follow it."

Now all knowledge is not for all men nor is every advertisement in a magazine intended for every reader thereof. The place for our friend whom we quote is in the laboratory rather than in the works, and we hope to see him some day an honored professor of chemistry in an institution of learning. He has a leaning toward research in pure science, and that is where he should be engaged. But in technology we need more and better business understanding. Thorough training in and familiarity with the principles of science is the first requirement, but in technology there is an equal need of good, sound, business sense. Indeed, we can't get along without it.

The fact is we must have sense about business just as we must have sense about chemistry. When over a score of years ago the Yale Corporation promoted the greatest teacher of physiological chemistry that this country has known to be director or dean of the Sheffield Scientific School, we had a fit of indignation that has lasted until this day. Teaching is the greatest of all the arts; it is paid less, but is, in point of fact, more important than administration. The loss to medicine and biology by the withdrawal of Prof. CHITTENDEN from teaching was too great to be forgiven, even in so distinguished a body as the Corporation of Yale University. Their fault was a lack of business sense; they wanted a good administrator, Dr. CHITTENDEN was the only one they could find easily, and according to the iron-bound Yale traditions it was the only way they could provide him with the proper compensation.

Business sense means a sense of co-ordination; the ability to put the right people in the right places; the capacity to plan ahead so that the desired purpose may be achieved. It means economy in planning just as applied chemistry means economy in technology. They go together. There's every reason in the world why our chemists should have that vision of human reactions that we call business. It will help more than anything else to put an end to fake chemistry and establish chemists in the eyes of business leaders and the public.

Development Possibilities Are Unlimited

WHAT is the most hopeful fact in this period of industrial depression? Undoubtedly it is that the usual obsession has not spread that "the country is overdeveloped." That has been a dominant thought in every previous industrial depression. Each business man, reasoning from the phenomena in his own industry, has concluded that he had too many competitors. There were too many miles of railroad, and too many factories making this thing or that. Machinery had been built to do all the work and all the machine shops could hope for was employment in keeping up the machinery already supplied. That is not the common thought today.

They say human nature does not change, and that may be true in a sense, but the style of thought and the viewpoint do change. Somewhat over a century ago the crowd jeered at ROBERT FULTON because his new steamboat broke down. Today a typical American crowd would be sorry. The female of the species has been offered more in the small electric motor than the male, as an individual. She has her electric-driven vacuum machine, washing machine, wringer and ironer. The male has his electric fan in the office, and that is about all. The male's lawn mower is food-propelled, depending on weight for traction, with the coefficient of traction varying inversely with the cutability of the grass. If a lawn mower with an electric-driven cutter is put on the market the first users will not be jeered by their neighbors. The neighbors will ask, "Where do you get those things?"

Repeatedly it has been proved that the country cannot be overdeveloped and at last men have learned the lesson, partly at least, supplied by recorded history. At a given time there may be too much of a material offered, or too many of a given device, for the people to buy, but that is because they have not been working hard enough or have not utilized other economical materials or devices to enable them to save the necessary money. That is what men do in every industrial depression or in its latter part.

The obsession that "the country is overdeveloped" did not make its appearance with recent industrial depressions, but has been chronic for three-quarters of a century, or since the introduction of farm machinery released a large percentage of the population from agriculture to engage in manufacturing. Each time, when the depression ended, it was seen that the country was not developed too much, but that instead it had fresh possibilities. What occurred was that prices and costs went too high and people became disinclined to buy. As the people curtailed their purchases they produced a condition that enlarged the prospect of prices and costs going lower and thus the tendency to abstain from buying was encouraged, the influence

being cumulative, until the shake-out became sufficient to justify making a fresh start.

To-day one does not hear the cry, to any extent, that "the country is overdeveloped." Instead, people are simply saying prices are too high, wages are too high, costs are too high, and when they find their proper level business will go forward. Public thought has not, as a millstone around its neck, the notion that everything worth doing has already been done and there is little left for the future to do.

Men will be quite ready to take hold when the readjustment in prices, wages, costs, has been completed. They are anxious to take hold. They are not afraid that the work has already been done. Anyone can see ample prospects of work and development. Under proper financial and industrial conditions we can profitably electrify our railroads, stop the consumption of over 90 per cent of our bituminous coal without recovery of byproducts and the movement of hundreds of millions of tons of coal a year over railroads (when the high-tension electric line is a vastly greater improvement in transportation than was the oil pipe line of nearly half a century ago), reduce the air, noise and heat leaks in our dwelling places and do a thousand other things, not forgetting to provide the electric-driven grass cutter already mentioned. The public has sensed the situation rightly. The country is not overdeveloped; it merely needs to readjust some things.

Interim Protection For the Dye Industry

IT HAS BEEN a matter of some speculation and no small degree of anxiety to foresee how the dumping of dyes in this country could be prevented in the interim between the declaration of peace with Germany and the passage of tariff legislation. The first proposal was to attach an amendment to the Knox peace resolution, extending the powers of the War Trade Board Section of the Department of State, which now regulates imports of dyes from Germany. This possibility, however, was eliminated when all amendments to the Knox resolution were rejected.

A much more hopeful prospect for quick and effective action, however, is seen in the proposal to handle this matter in the emergency tariff legislation. The Senate Committee on Finance is now considering an amendment to H.R. 2435, excluding from importation into the United States for a period of six months from the enactment of the legislation, sodium nitrite, coal-tar products and synthetic organic drugs and chemicals, unless the Secretary of the Treasury shall determine that such articles or satisfactory substitutes are not obtainable in the United States in sufficient quantities and on reasonable terms. In this event the prohibited articles may be admitted for consumption by an actual consumer in the United States within six months after receipt of the merchandise. The amendment further provides for the transfer of the personnel, records and activities of the War Trade Board Section of the Department of State to the Department of the Treasury.

Emergency tariff legislation is not regarded seriously in many quarters, being looked upon as a political sop to agricultural interests. Apparently, however, it may become the most handy medium for accomplishing interim protection to the dye industry. It's an ill wind that blows nobody good.

British Chemical Industries

FROM OUR LONDON CORRESPONDENT

LONDON, April 14, 1921.

THE industrial and political situation completely dominates markets at the time of writing and even if, as is confidently predicted, the threatened railway and transport strike should be canceled, the recent revival has already been stopped and a considerable period will be required for recovery.

REPARATION ACT FAILS TO BENEFIT PURCHASERS OF CHEMICALS

The reparations bill has apparently not yet produced any "reparations" as far as the chemical trade is concerned. As foreshadowed in my last article, German exporters are demanding either payment in full, leaving the British importer to pay an equal amount in duty, or alternatively simply doubling their prices. In either case the consumer ultimately has to pay the tax, and it is becoming a question of whether the loss of trade will be sufficient to force Germany to make fresh proposals. Meanwhile the stocks of German chemicals imported or under contract prior to March 8 are fairly heavy, and some weeks must elapse before any appreciable rise in prices is to be expected.

FINE CHEMICALS INCLUDED IN PROTECTIVE MEASURE FOR KEY INDUSTRIES

In addition to optical and chemical glassware, tungsten, thorium, cerium, etc., the new "ways and means resolutions" to be discussed before inclusion in the finance act include "all synthetic organic chemicals (other than the dyes, etc., protected under the dyestuffs bill), analytical reagents, all other fine chemicals and chemicals manufactured by fermentation processes." Protection is to be given in the form of 33½ per cent customs duty for five years, and there is to be a similar duty in respect of "dumped" goods or those which are, owing to depreciated currency, offered at prices below the cost of profitable manufacture in the United Kingdom. The introduction of this legislation was unavoidably postponed by the industrial crisis, but already claims for the protection of other industries and goods and protests against the inclusion of others are being pressed on the government and on members of Parliament. It is understood that among others metallic magnesium is likely to be included, and that the fiercest controversy will develop in regard to the alleged inadequacy of the protection afforded. Meanwhile the fine chemical industry remains stagnant, many works being closed down or working on half time, while others are finding difficulty in raising further capital.

BRITISH DYESTUFFS CORPORATION DISMISSES ITS MANAGING DIRECTORS

Something of a sensation was caused by the announcement made at the annual meeting of the British Dyestuffs Corporation that the board of directors had decided to terminate the agreements with Sir Joseph Turner, who controlled the Huddersfield Works, and Dr. Herbert Levinstein. Although rumor had been rife in regard to Dr. Levinstein's retirement and in regard to lack of harmony and co-operation, the drastic steps now taken were quite unexpected. The board announced that pending unification of control under a single managing director a committee of three directors would form the executive, but it remains to be

seen whether a suitable "superman" will be forthcoming. Sir Harry McGowan, of Nobel Industries, retired from the board earlier in the year and the new directors appointed are Field Marshal Sir William Robertson, Sir William Alexander (formerly of Charles Tennant & Co.) and Vernon Clay, chairman of the Color Users Association. There is likely to be further controversy before the affairs of the corporation recover from what is considered to be an unnecessary muddle. Meanwhile the dyestuffs position remains practically unchanged and Sir H. V. Kilvert, a prominent member of the Manchester Chamber of Commerce, has been appointed chairman of the advisory committee under the dyestuffs act. There has been further delay in the appointment of the development committee.

BRUNNER, MOND TO INCREASE CAPITAL

It is announced that in addition to making suitable alterations in the articles of association of Brunner, Mond & Co. \$10,000,000 of additional 7½ per cent preference shares are to be issued in the near future. Work at Billingham synthetic ammonia factory is making good progress and part of the capital issue is no doubt required for that purpose. On the other hand Magadi soda shipments have begun, so that details of the prospectus are awaited with great interest. Wages of chemical workers are being reduced by many works, notably by Lever Bros. and the United Alkali Co., and owing to the depressed state of markets and the fall in the cost of living this tendency is likely to continue.

GENERAL NOTES

The report of the commission under General Hartley which visited German chemical factories last year is to be published at an early date and, unlike the corresponding report of the mission fathered by the Association of British Chemical Manufacturers, will be available to the general public. Like the report of the nitrogen committee, publication has been delayed so long that much of the matter will be out of date. Further details of the visit to Canada and the United States of the Society of Chemical Industry will shortly be available. It was felt that if possible the whole party should travel together on a "one-class" boat and fortunately the cancellation of the sailing of the *Megantic* will probably enable the president to sail with the rest of the party on the *Melita* on Aug. 12 for Montreal. It was hoped that the larger firms would send special representatives, but so far the response from this quarter has been very feeble, though it is perhaps too soon to judge of the final result. It now seems unlikely that the party will number more than sixty. Circulars have just been sent to all members of the engineering profession with regard to the proposed formation of an engineers' club with headquarters in St. James' St. It is stated that over 1,000 engineers have signified their intention of joining the new club, the subscription for which has been fixed provisionally at \$40 for town members. The promoters are seeking to include chemical engineers and others connected with the chemical industry, but it is felt that on account of the relatively high subscription the club will not be truly representative and is not likely to include the junior members of the profession. Sir William Pope is to address the members of the Chemical Industry Club next month and will probably deal with the further development of the scheme for central premises promoted by the Federal Council of Pure and Applied Chemistry.



Meeting of the American Electrochemical Society

Report of the Spring Meeting, April 21-23, 1921, at Atlantic City, N. J.—Business Session—Presidential Address—Summaries of the Technical Papers Presented, With Discussion of These Papers—Social Features

THE thirty-ninth General Meeting of the American Electrochemical Society took place at the Hotel Chalfonte, Atlantic City, April 21 to 23. The meeting was exceptionally well attended and was conceded by all to have been one of the most interesting and enjoyable held by the society. There were a number of papers that drew forth much heated discussion. The social functions, favored by ideal weather, afforded the members a splendid opportunity to renew old friendships and increase their acquaintanceship. Much of the success of the meeting is due to the able guidance of the committee of Philadelphia members.

Business Sessions of the Society

At the meeting of the board of directors, Thursday evening, various matters of importance were discussed. The place of meeting in the fall was definitely fixed as Lake Placid, N. Y., Sept. 28 to Oct. 1 inclusive. An invitation was read to meet in Buffalo in the spring of 1922, but no final action was taken. The board sanctioned the formation of a Division on Electrothermics which will include all those members interested in electric furnaces, electric steel, electric brass, etc., electrodes, refractories, regulators, heat-treating apparatus, etc. Acheson Smith is chairman of the new division. President Landis appointed a committee of three, William Blum, George B. Hogaboom and H. S. Lukens, to canvass the membership of the society and ascertain whether a division on electrodeposition would meet with the necessary support and encouragement. The division, as proposed, is to cover the subjects of electrolytic refining, electroplating, electrotyping and electro etching.

At the annual business meeting on Friday morning the following new officers were elected: President, Acheson Smith; vice-presidents, Charles F. Burgess, C. G. Schluederberg and E. L. Crosby; managers, Carl Hering, J. V. N. Dorr, F. A. J. FitzGerald; treasurer, P. G. Salom; secretary, Joseph W. Richards. The treasurer's report for the term 1920-21 showed total assets, \$13,100; total receipts, \$24,000, and total expenditures \$28,134, of which \$19,730 covered the publication of four volumes of the *Transactions*.

In the absence of Dr. Baekeland Mr. Hamilton, examiner of the U. S. Patent Office, reported briefly on the present status of the patent bills before Congress. He emphasized that the Patent Office was flooded with applications and that work was proceeding very slowly and inefficiently, due to lack of proper financial support and encouragement for the employees to remain in office. Mr. Hamilton also urged the members present to exert their influence in encouraging the teaching of electrochemistry in schools and colleges.

The publication committee's report was presented by Dr. Fink. It was decided to hold a session on Non-Ferrous Electrometallurgy and another session on Electrodeposition at the coming fall meeting of the society at Lake Placid. At the spring meeting, 1922, there will be a session devoted to Electric Furnace Cast Iron. For future meetings, Dr. C. W. Moore suggested a symposium on "Electromotive Force" and E. O. Benjamin suggested a symposium on the production and utilization of "Electrolytic Gases" such as hydrogen, oxygen and chlorine.

At the conclusion of the business meeting a number of amendments to the constitution were voted. According to one of these amendments a quorum of the society shall henceforth consist of fifty members instead of 10 per cent of the membership, now totaling 2,300. Another amendment authorizes the board to appoint an assistant secretary who shall relieve the secretary of all clerical work. A new section was added to the constitution providing for a nominating committee.

At the conclusion of the business meeting the retiring president, Dr. W. S. Landis, delivered a highly interesting and instructive address entitled "Our Inventory."

Presidential Address—Our Inventory

BY W. S. LANDIS

At long and irregular intervals it was the habit of the proprietor of the crossroads general store to walk slowly through his place of business, glance to the right and to the left, and up and down, and make mental notes on the status of his stocks. So long as this crude method of determining his inventory was satisfactory to himself he remained the country storekeeper or fell by the

wayside. If through accident he developed to the stage of actually "taking stock," he abandoned the country store, moved to the nearest town and opened up a larger and more elaborate, though frequently more specialized, place of business.

There is a wide difference between the primitive stock-taking of the crossroads merchant and the continuous inventory carried by our modern corporation, and we of the newer school are still theorizing as to the ways and means which keep some of the old timers in the field. At the same time when we look into our own branch of industrial activity, I think we will find its system of inventory is in much the same condition as that of the crossroads store. Are we carrying such a form of inventory as to enable the quick determination of the quantity and quality of stocks on our shelves? Is this stock suited to our markets? Will we be able to meet our competitors on their own terms? How much do we know of the future prospects of our business? Remember, I am speaking here of the industry as a whole and not of any specific branch or unit.

MAGNITUDE OF THE ELECTROCHEMICAL INDUSTRY

The industry with which we as members of this Society are associated—that one utilizing the chemical and thermic effects of the electric current—represents, on the North American continent, an invested capital of something over six hundred million dollars. As a matter of fact this may actually be upward of a billion dollars, but our antiquated crossroads system of keeping our inventory does not permit us any great degree of precise determination of such factors. The lesser figure does not include, so far as it has been possible to segregate the same, those portions of plants not exclusively a part of the electrochemical process, nor does it include generating stations where they are operated as separate corporations. The great difficulty, however, has been to determine where the line should be drawn in those industries which use the same equipment for products derived from electrochemical or electrothermic sources, and from other sources independent of the electric current. It is this indefiniteness that represents the difference between the six hundred million dollars and the billion dollars mentioned above.

The casting of a balance sheet of an industrial group the size of ours is a somewhat different task from merely keeping up the inventory of an individual unit making a part of the whole. We are dealing with factors here as fundamental items which are usually only considered from the unit standpoint as intangibles.

My attempt at compilation will fall far short of the desired completeness we all desire, but matters of this sort and in this place can always be passed on to one's successors.

LOCATION

Our first item of consideration is the value of the location we have chosen to establish our industry. It is not unusual to hear, for example, that Norway is the logical home of the electrochemical industry, or that Germany will stifle all future competition in our line. Are we to consider, on the basis of such broad and unsupported statements, that our choice of location has been an unfortunate one—that we are located on a side-street in a poor neighborhood—that America is a liability to us instead of an asset? Personally I have no time for such propaganda—I am not even disturbed by the fact that a prominent American corporation has

established a Norwegian branch factory. The mere fact that Norway seems to have an abundance of undeveloped water power will not make it the Mecca of the electrochemist, for it takes more than undeveloped water power to build up an industry such as ours, and when one considers that Norway possesses no local markets, must import every pound of coal and coke, is short of skilled labor and uncertain as to temperament of the little unskilled labor available, I am not ready to write off very much on our choice of location.

In appraising the value of location, one must consider many factors, for example: The liberal form of government under which we live for a time showed a decided tendency toward an unfortunate socialistic attitude to industry. This now appears to have been only an incident of the war and prospects ahead of us are that we shall soon be clear and free to develop in proper competitive and individualistic manner. Laws governing proper combinations for meeting foreign competition are becoming more constructive and helpful. Outside of England I do not believe a single European nation can today compare in as liberal prospective legislative helpfulness.

TRANSPORTATION

As to transportation, the war left us a great fleet of merchant ships capable of taking adequate care of our export business. Unfortunately operation of this fleet is handicapped by marine laws framed by prairie sailors. Some day our scheme of government may advance to that state of development where political expediency makes way for skill and experience in the proper planning of specialized activities. Improvement of inland navigation in many cases goes hand in hand with hydro-electric development, all of which will help to unload our railroad systems. The electrochemical industries should be the preferred customers of such inland water transportation systems because of their location.

Our railroad system is the best in the world, even in spite of the universal domestic criticism. Just ask any returning foreign traveler. But development is at a standstill, rates are impossible; in fact in this case "best in the world" really means everything is pretty poor. The railroads are in for a complete reorganization—new management, new policy, greater efficiency from fewer and better employees—and they had better start pretty soon and get it over with or industry will again be on their heels.

WATER POWER

The recent water-power legislation will certainly lead to several important new hydro-electric developments and the possible establishment of new electrochemical centers. When prices of construction materials and labor drop to a point when the fixed charges imposed on the power cost are not too burdensome, work will begin on the many long-delayed projects. Our industry is bound to profit through these undertakings.

FUEL

Someone has said that electricity in electrochemistry is merely an excuse for burning coal. When one looks over the fuel requirements of the heavier electrothermic industries, the statement is not a great exaggeration. Nowhere outside of the United States is there already developed the abundance of high-grade fuel that we have near our electrochemical centers. Continental

fuels are of inferior grade and higher in price. Even English coals are going to be expensive in the future. Of the materials for making electrodes, we have in plenty and of such quality that today our large carbons command first place throughout the world.

RAW MATERIALS

It is no doubt true there are a few raw materials used in this industry with which we are not abundantly supplied. During the war emergency special efforts were made to develop the production of these miscellaneous materials, and the efforts were crowned with some success. If a fraction of the great sums of money spent on war plants which were of absolutely no use whatever toward the winning of the war—and I am not including here many plants founded upon perfectly sound engineering judgment and certain of performance but not completed before the signing of the armistice—had been spent on the search and development of some of our less plentiful raw materials, I might have a different story to tell with respect to these less abundant materials.

I believe after due consideration of the few facts just stated that we can write our choice of location down on the asset side of our balance sheet and give it a very high value. On the other hand there is no doubt that we must place against this large asset a small liability for shortage of a few rare materials and a larger liability for the disorganized state of our transportation systems. But so far the assets greatly exceed the liabilities, which foreign propagandists will please note.

The chemical industry of this country is comparatively new. We did not possess the background of alchemists that Europe had, but we seem to be fast making them. Our schools of chemistry have only in the last few years taken on a semblance of Americanization, for most of our older teachers were educated abroad and equipped their laboratories almost exclusively with foreign apparatus. This has not been altogether satisfactory, for our industry is primarily an American one using American processes worked in American apparatus, and supervised by American engineers. Aluminum, carbide, graphite, metallic sodium and a host of other products are primarily of American origin. The caustic soda and chlorine industries use almost exclusively American cells. As a matter of fact I do not know of anything in the industry of any great importance that has been brought over from Europe and held to its original European form for any length of time, and I know of only one considerable development in Europe that seems not to

have been brought here at all. With these facts in mind, we must agree that the American engineer is superior to the European in all electrochemical and electrothermic development, in spite of his semi-European chemical training. It is our duty to impress these facts upon the direction of our schools of higher education and render all the assistance we can to Americanize their methods and equipment.

Our industry with six hundred million to one billion dollars of capital investment looks for a profit of from one hundred to two hundred million dollars annually to meet capital charges and provide for reasonable growth and development. This return must come from the direct efforts of those charged with the conduct of the business—the executives, superintendents, engineers, etc. In other words men largely technically

trained are responsible for the earning of this enormous sum of money, and the universities and technical schools must in turn supply these men. Looking at this from a "gross" standpoint, the electrochemical industries must return approximately five hundred million dollars per annum, largely via university products.

Only a few technical schools make direct attempts at turning out electrochemists. Some others merely provide auxiliary courses in electrochemistry, and a still larger number merely group the subject with physical chemistry. There are practically no schools capable of properly handling post-graduate students in electrochemistry, because they do not have the necessary equipment.

In our schools of civil engineering we give our men regular drafting equipment. They work with standard levels and transits, and do not use small-scale model

testing machines in their study of materials. In our schools of mechanical engineering we provide our men with regular boiler plants and operating steam engines, not models. The students are not forced to work with miniature automobiles or internal combustion engines in any laboratories with which I am familiar. Why, therefore, should we expect in the training of our electrochemists that they should do their work in the laboratory entirely with glass beakers or similar small-scale equipment?

Why should the only representative electric furnace with which they ever come in contact during undergraduate days be either a picture or a small model, or in a few particularly fortunate cases exist in some nearby industrial plant that is open to their general inspection? If we are going to really educate electrochemists, we must provide in the university as a part of the daily working equipment, not models, but actual



ACHESON SMITH

Newly Elected President of the American Electrochemical Society

industrial installations, and operate these before and with the student through the assistance of practical electrochemists, supplementary to the theoretical instruction and lecture work.

I very much doubt if the universities of this country have available and are spending \$100,000 per year for the direct teaching of electrochemistry. I do not know of a single school laboratory that has a thousand kilowatts available for electric furnace work, or more than a model plating or refining equipment. If the industry is going to expect the graduates of institutions operating under such handicaps to return to it a gross of some five hundred million dollars per year and a net of from one hundred to two hundred million dollars, it will have to do something for our educational institutions along electrochemical lines, otherwise the German threat may not be all propaganda.

This Society holds two meetings a year, and averages nearly a thousand pages of publications annually. Our system of keeping inventory does not permit us to determine just what net returns the industry obtains from the communications, meetings and other services rendered by the American Electrochemical Society. It is my opinion that it adds directly a good many thousand dollars per year toward the net of the corporations. I am certain that if we include the dues of members paid by the corporations, the corporations will not have contributed \$2,500 per year to the support of the Society, an extremely small percentage of the net return they derive from the existence of just such a body at this.

The Society is doing the best it can and to the extent of its available means to advance the interests of electrochemistry. With larger means it could do a great deal more. The officers of the Society believe that it would be unwise to attempt to raise additional funds by increase of dues. There is, therefore, only one way to obtain the greatly needed additional income which the Society could profitably use and that is through some working arrangement with industry whereby additional funds could be secured on something other than a charity basis. Since I am merely casting up an inventory which is presumed to be a record of facts and not of opinions, I merely wish to leave this idea with my successors with the hope that they can work something out of it.

LABOR

As to the ordinary labor in our plants, I am not prepared to say that it is of as high quality as might be found in other countries, but at the same time I will not class it lower. On the other hand, we use only a fraction of the quantity in this country that is used abroad. We use automatic devices much more freely. We build larger units and operate them at higher capacities. In consequence while our common labor may not be quite so steady and is not so cheap per man-hour, when we consider the quantity used I do not believe that labor places an extremely serious handicap on the development of the American industry.

There are many labor abuses which will have to be corrected. The demoralization incident to the war is already being eliminated and it will probably not be long until our labor cost will not be the determining factor in foreign competition.

Reviewing our item of personnel, I think we can list the engineering ability, inventiveness and efficiency of the American engineer and the American workman as

an asset of particularly high value. I cannot place the technical school and the Society on the other side of the balance sheet, because that would put them in the false light of being liabilities, when as a matter of fact we know they are not, and have been rendering wonderful service under existing handicaps, but at the same time I think we must all admit that they are not up to the standard we are desirous of setting for such institutions and that our first endeavor in rectifying this inventory should be directed to improving those two items.

I could continue in this manner to discuss many additional items, such as our research and technical organizations, periodicals, our prospective future developments, and a host of others; they all call for attention which time forbids my yielding. I am certain all will fall in with our assets.

CONCLUSIONS

Close scrutiny of our balance sheet shows our industry to be in excellent condition. Every such report I have ever seen of a going concern always has a liability side and we are no exception. General business conditions at this time are not good. Low exchange values of foreign coins, coupled with questionable economic practices in some of the European countries, are causes of temporary but immediate concern. Bad habits acquired by our legislative bodies during the war and not yet broken will trouble us for some time. The relationship of our schools and this Society to the industry can be improved. All must be properly weighed and considered.

On the other hand, the wonderful opportunities America affords for the development of our industry, the skill, activity and courage of our engineers, all against the historical background set up by Acheson, Castner, Cowles, Hall and a host of other early workers, can mean only the most successful future. Let us take full advantage of the opportunity.

Technical Sessions

There were three technical sessions, one on "Arc Welding and Electric Furnaces," another on "Electrolytic Products and Cells" and a third on "Corrosion." In addition to these there was a public address by Dr. R. B. Moore on "Helium." Brief accounts of the papers presented at the various sessions, together with the discussions, are given below. The Symposium on Corrosion is treated collectively in a separate article. Corrosion is a topic of ever-increasing importance and many of the authorities on the subject attended the symposium.

HELIUM AND OTHER RARE GASES

A most enjoyable and instructive lecture on his experience and research with the rare gases of the atmosphere was delivered before the members of the Society Thursday evening by Dr. R. B. Moore of the U. S. Bureau of Mines. With the aid of numerous lantern slides and practical demonstrations Dr. Moore sketched the history of the rare inert gases, referring to the work of Cavendish, Lord Rayleigh, Sir William Ramsay and others. He described the three important processes for separating helium from other gases: The Claude, the Linde and the Jefferies-Norton. The capacity of the new plant at Fort Worth, Tex., is 35,000 to 40,000 cu.ft. of helium per day. The lifting power of helium is 92 per cent of hydrogen. The cost of helium

by the Jefferies-Norton process is about \$30 per 1,000 cu.ft.

ARC WELDING AND ELECTRIC FURNACES

O. H. Escholz, research engineer of the Westinghouse Co., East Pittsburgh, presented a study of the Phenomena of Arc Welding. Vaporization and condensation of electrode material cannot account for all the metal transfer, since the energy input is insufficient to vaporize metal at the rate it is consumed. In fact 60 per cent of the energy is probably absorbed in liquefying 90 per cent of the wire electrode, 25 per cent in vaporizing the remainder, leaving 15 per cent for radiation losses. Expansion of gases occluded in the welding wire undoubtedly occurs, but this is not the cause of extensive transfer of metal, because "gassy" wires do not deposit at high rates; in fact quite the opposite. Escholz therefore holds that the electrode metal is transported when gravitational force exceeds the sum of surface tension and cohesion in a globule of liquid, or when physical contact is made with a wetted surface (plate metal liquefied by anode energy).

In the discussion of Mr. Escholz' paper C. J. Holslag, of Newark, did not believe that magnetic effects were very pronounced in arc welding. It was his experience that the metal passes from the electrode to the work as a vapor. The heat generated at any instant in a particle of metal at the tip of the electrode is transferred in the next instant to the work. This accounts for the high temperature of the work. Henry Hess, of Philadelphia, suggested that it would be interesting to determine the speed of metal deposition by the arc.

ELECTRIC FURNACES FOR NON-FERROUS METALS

H. W. Gillett of the U. S. Bureau of Mines gave the next paper, on "Electric Furnaces for Non-Ferrous Metals." This paper contains many details on the electric furnaces in operation in the United States melting non-ferrous metals. Makes and capacities are summarized in Table I, and the applicability of various types of furnaces to common alloys is noted in Table II.

Non-ferrous electrometallurgy has made wonderful

TABLE I. SUMMARY OF ELECTRIC FURNACES

Make	Total Capacity per Heat, Tons	Total Kw.	Number Furnaces	Number Users
Ajax-Wyatt.....	45	4,635	93	25
Detroit Rocking.....	53	15,900	57	28
Baily.....	48	6,890	76	51
Booth.....	13	5,345	40	35
13 other furnaces.....	34	9,580	52	30
Total in use.....	193	42,350	318	169
Ajax-Wyatt, planned for prompt installation.....	(35)	(4,200)	(70)	25 duplicates
Total, including Ajax-Wyatts planned.....	228	46,550	388	144 separate users

strides within the last five years and the electric furnace has been firmly established in the brass and bronze industries. At the coming Lake Placid meeting a whole session will be devoted to the subject.

ELECTRODYNAMIC FORCES IN ELECTRIC FURNACES

Dr. Carl Hering of Philadelphia, in his paper on "The Electrodynamic Forces in Electric Furnaces," described in detail the various "effects" met with in the operation of electric furnaces. Conductors carrying large currents are surrounded by a magnetic field exerting a strong force perpendicular to the surface. If the conductor is a liquid—as in some channeled electric furnaces—the current and its accompanying radial compression may cause the conductor to part; the phenomenon has been long known as the pinch effect. A complementary force is the so-called "stretch" effect, which tends to lengthen a conductor and causes a liquid conductor to move along its axis or heap up on the outside of a turn. Furthermore, strong eddy currents are set up in a liquid conductor on the outside of a square corner; "corner" or "motor" effect. All these circuits tend to produce motion which sets up a counter e.m.f., an observation thought to have the generality of a law.

G. H. Clamer of the Ajax Metal Co. took exception to a number of the statements made by Dr. Hering. He referred to the early work of Schneider, president

TABLE II. APPLICABILITY OF VARIOUS TYPES OF ELECTRIC FURNACE TO VARIOUS ALLOYS

Alloy Analysis									Types of Furnaces						
Fe	Cr	Ni	Cu	Sn	Pb	Zn	Ag	Al	Direct Arc	Stationary Indirect Arc	Moving Indirect Arc	Reflected Heat	Contact Resistance (Bennett)	Vertical Ring Induction	High Frequency
5	15	85	28	..	..	..	..	..	O.K.	O.K.	O.K.?	? ¹	?	?	O.K.?
..	..	67	..	..	..	..	..	..	O.K.	O.K.	O.K.	? ¹	?	?	O.K.?
		{ 25	75	..	..	..	..	..	? ²	O.K.	O.K.	O.K.	O.K.?	?	O.K.?
		5	95	..	..	..	..	..	? ²	O.K.	O.K.	O.K.	O.K.	No ³	O.K.
			100	..	..	..	..	..							
			{ 90	10	..	..	..	..	O.K.	O.K.	O.K.	O.K.	O.K.?	? ³	O.K.
			88	10	2	..	..	..							
			{ 80	10	10	..	..	..	O.K. ⁵	O.K.	O.K.	O.K.	O.K.?	No ⁴	O.K.
			76	3	18	3	..	..							
			68	4	26	2	..	..							
			85	5	5	5	..	..	No ⁵	O.K.	O.K.	O.K.	O.K.	O.K.	O.K.
			{ 74	4	5	17	..	..							
			80	..	..	20	..	..							
			70	..	..	30	..	..							
			{ 67	..	3	30	..	..	No ⁵	No ⁵	O.K.	O.K.	O.K.	O.K.	O.K.
			61	1	..	38	..	..							
			65	..	1	34	..	..							
			60	..	..	40	..	..							
	18		58	..	..	24	..	..	No ⁵	No ⁵	O.K.	O.K.	?	O.K.	O.K.
			{ 3	..	..	15	..	85	No ⁵	? ⁵	O.K.	O.K.	?	? ³	O.K.
			2	..	..	30	..	68							
			8	..	..	..	..	92	?	O.K.?	O.K.	O.K.	?	? ³	O.K.
			10	..	..	..	90	..	?	O.K.	O.K.?	O.K.?	?	? ³	O.K.
			10	..	..	85	..	5	No	No ⁵	O.K.?	O.K.	?	?	O.K.?

O.K. = Furnace metallurgically satisfactory for this alloy.
? = No data on hand.
O.K.? = Probably satisfactory, but no record of trial.
No = Furnace not satisfactory for this alloy.
¹ Temperatures probably rather high for good refractory life.

² Question of copper poisoning by fume from direct arc not yet settled.
³ Induction furnace on this alloy would require resistor tube of special design.
⁴ Lead too high for good life of usual lining of induction furnace.
⁵ Furnace causes loss of volatile metal from this alloy.

of the Creusot Steel Works, France, and to his furnace with a liquid resistor outside the bath. In the Ajax-Wyatt furnace the pinch effect is not the sole factor. Its successful operation is based upon a combination of the pinch effect and the motor effect. The motor effect is caused "by the repulsive action of two conductors carrying unlike currents, thus causing the particles of metal in the conductors to be repulsed as far away from each other as possible."

RECENT PROGRESS IN HIGH-FREQUENCY INDUCTIVE HEATING

"Recent Progress in High-Frequency Inductive Heating" was the title of Dr. E. F. Northrup's paper, a sequel to that presented before the Society in April, 1919. His new paper was received with great applause and very favorably commented upon. It will be published in full in a future issue. In discussing his own paper Dr. Northrup pointed out that so far only the "star" connection was found to be practical when using this style of furnace on a commercial three-phase circuit; the "delta" connection does not work properly. He recently melted a fairly large quantity of a very high melting alloy composed of tungsten, osmium and a little nickel; he has also melted a sample of pure tungsten in his furnace. Dr. Northrup described in detail the building up of the inner lining of his carbon or graphite crucible. This lining will withstand a temperature of 2,000 deg. C. and is practically impervious to gases at this temperature.

Dr. Northrup said that he had found lampblack to be the best heat insulator at high temperatures. Graphitization of carbon is carried out so readily in the high-frequency furnaces it is probable that this may become one of the main uses for the furnaces. By imbedding a compressed piece of carbon in lampblack the graphitization can be carried out very easily. Similarly, a pure rod of cobalt can be produced by introducing into the Northrup furnace a compressed rod of cobalt powder packed into very finely divided and loosely packed cobalt powder. The metal rod so made will be practically free from carbon.

Mr. FitzGerald of Niagara Falls referred to some of his experiments years ago on the graphitization of carbon, stating that he had encountered all kinds of difficulties in keeping large pieces of carbon from cracking. Would this difficulty be easily surmounted when graphitizing in the Northrup furnace? Dr. Fink pointed out that the success of a crucible lining such as Dr. Northrup described was largely a matter of grading the layers so as to pass, step by step, from a low coefficient of expansion to a higher one. This same principle is successfully applied in fusing special low-expansion glass to ordinary high-expansion glass. L. E. Saunders of Worcester suggested that Dr. Northrup try magnesium oxide linings, which also can be made very impervious.

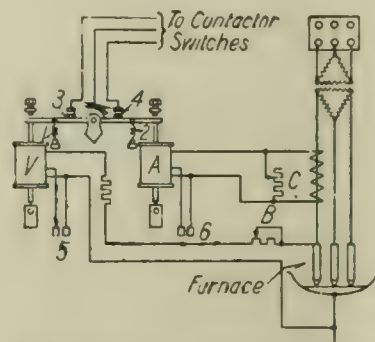
REGULATION OF ELECTRIC STEEL ARC FURNACES USING MOVABLE ELECTRODES

W. G. Mylius of the Westinghouse Co. then presented his paper on "The Regulation of Electric Steel Arc Furnaces Using Movable Electrodes," describing a new regulator designed to give rapid and close regulation of heavy electrodes without "hunting." Assume a cold furnace. When the main circuit breaker is closed voltage coil *V* (see illustration) is energized, closing contact 3 and operating electrode motor continuously

and at full speed until it comes in contact with the bath, when *V* will be de-energized instantly, opening the motor circuit. As no alternating current can exist in any electrode until two or more are in contact with the bath, current coil *A* will not be energized until that time, when contact 4 will be closed, causing the motor to raise the electrode and drawing the arc. When the pull of coil *V* builds up to that of coil *A*, the lever becomes horizontal and the motor stops. Current can be adjusted within a 20 per cent range by rheostat *C*.

Auxiliary contacts 5 and 6 respectively operate simultaneously with the "lower" or "raise" contactors on the motor control circuit and shunt part of coils *A* and *V*. When the induced change in pull by change in current and change in turns is sufficient to restore

the lever to horizontal the motor will stop. A vibrating condition exists between control element and contactor whenever the current per phase is less than 15 per cent on either side of normal value, and the motors are subject to a series of impulses, the average length of which, being a function of the amount of furnace current, deviates at any instant. This also allows



SCHEMATIC DIAGRAM OF CONTROL ELEMENT CIRCUIT

the motor to operate at high speed until the current has been brought to within 15 per cent of normal, when the speed is gradually reduced to zero, thus preventing "overshooting" and allowing automatic regulation on a cold charge. It is also impossible for an electrode to run down into the bath when current fails. One electrode can be withdrawn without disturbing automatic equilibrium in the two others. If voltage drops to zero, control levers balance and all motors stop.

A lively discussion followed. Mr. Bennett inquired about the power factor of the new regulator. According to his experience there was considerable lag in the reversing switches and hunting or overshooting is hard to eliminate. But even at an electrode feed of 24 in. per minute he has obtained regulation within ± 2 per cent. Mr. Kellerher of Canada has found the Thury regulator to operate within ± 1.5 per cent under normal conditions. E. L. Crosby, Detroit, pointed out that as far as the central station was concerned the interest in the regulator was not confined to "normal conditions." According to his experience ± 10 per cent was nearer correct. Mr. Seede of the General Electric Co. said that up to 1913 or 1914 the step-by-step regulator had the field for itself. But in many a case it did not seem altogether satisfactory, and accordingly the continuous movement regulator was developed, which proved in many respects an improvement over the Thury. President Landis found that the mechanical feature of the regulating equipment and the quick response of the motors was most important in carbide furnaces with electrodes weighing 10 tons each. Mr. Seede reported that even with 10-ton electrodes the regulation could be kept within $\pm \frac{1}{2}$ per cent, using the continuous movement regulator.

A NEW PHOTO-ELECTRIC CELL

B. S. Cushman of Auburn, N. Y., presented a highly interesting paper by T. W. Case on a photo-electric effect in audion bulbs of the oxide coated filament type.

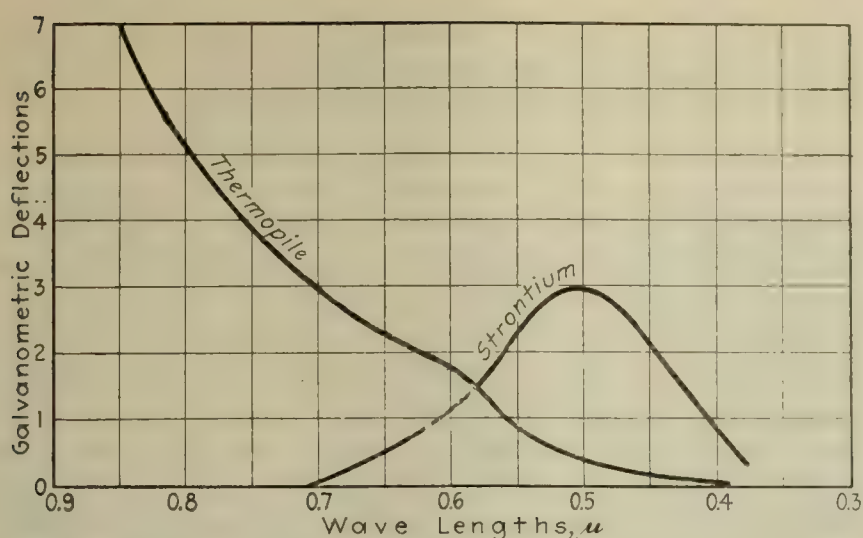


CHART SHOWING SENSITIVITY OF STRONTIUM CELLS TO LIGHT

Mr. Case reported that he has been able continuously to record daylight intensity for the past several months. The photo-electric effect on barium and strontium filaments in audion bulbs furnishes a current of 100 to 150 micro-amperes which actuates an automatic recorder.

Mr. Cushman showed two strontium cells and reproduced on the screen a number of daylight records which had been automatically registered by a Leeds & Northrup potentiometer. One of the cells had almost the same sensitivity as that of the human eye to light. The barium cells are sensitive to the longer rays, the strontium cells to the shorter rays. The sensitivity of the latter is shown in the illustration. In the discussion Dr. Richards suggested that the addition of a small amount of Sr to the Ba as a stabilizer might be similar in its effect to the addition of Ce to Th in the Welsbach mantle.

ELECTROLYTIC PRODUCTS AND CELLS

The apparent irreversibility of the calomel electrode was investigated by A. W. Laubengayer of Cornell University. Some years ago Paschen had pointed out that a mercury anode polarizes much more strongly in hydrochloric acid than in sulphuric. Mr. Laubengayer finds that the apparent irreversibility of the electrode is not real, but is due to the formation on the surface of the mercury anode of a strongly adsorbed film of mercurous chloride, which offers a high resistance to the passage of the current. Why mercurous chloride should behave so differently from mercurous sulphate could not be established. The paper was briefly discussed by Dr. Fink, who suggested a microscopic study of the films.

ELECTROCHEMICAL ASPECTS OF PHOTOGRAPHIC DEVELOPMENT

"The Electrochemical Aspects of Photographic Development" was the title of the next paper, by Dr. S. E. Sheppard of the Eastman Kodak Co. In it he discussed previous work and added information being developed at the research laboratory of the Eastman Kodak Co. He discussed the physical chemistry of the development reactions, and pointed out the present unsatisfactory value of the measurements by electrical methods, which are entirely relative to the particular experimental conditions.

ELECTROLYTIC MANUFACTURE OF PARAMINOPHENOL

Another contribution by the Eastman research laboratories was presented by A. S. McDaniel. It dealt

with a war-emergency investigation on the electrolytic manufacture of paraminophenol. The research was carried out jointly by Messrs. McDaniel, Schneider and Ballard.

ELECTROLYTIC NICKEL

Two papers on electrolytic nickel gave rise to a very animated and lengthy discussion in which both practical and theoretically inclined members participated. The first, by William Blum, electrochemist of the Bureau of Standards, was on "The Use of Fluorides in Solutions for Nickel Deposition."

Charles P. Madsen was the author of the second paper, "Ductile Electrolytic Nickel." These two papers will be published in full in a subsequent issue.

A NEW HIGH-CAPACITY STORAGE BATTERY

C. W. Hazelett gave a description of a thin plate storage battery recently designed by him. The performance of this battery based on the amount of lead and active material varies from 50 to 200 per cent above that of the standard types. The higher percentages prevail at exceedingly high rates and at very low temperatures. It is machine made and a large decrease in cost of production has resulted. It is not subject to the mechanical defects and the variability experienced with present standard types.

It has been found practical to ship charged elements, wrapped in paper, to service stations for rebuilding batteries where the container is in good condition. This is due to the fact that the separators which hold the electrolyte like a lamp wick do not allow the plates to dry out any more than when immersed in electrolyte. By this system a complete battery may be rebuilt in less than an hour at approximately one-half the regular cost. This unusual principle is made use of where a non-spill battery is required by simply pouring out the excess acid when the battery is in use and replacing it while recharging. There is practically no decrease in capacity when this is done.

Since the life of a battery is practically always destroyed by buckling plates and short-circuiting or by the washing-off of the active material and since neither of these conditions is possible with the Hazelett storage battery, very long life would be expected. Conservatively speaking, their life is averaging from two to three times that of the standard types.

Walter E. Holland, of the Philadelphia Storage Battery Co., referring to Hazelett's battery, reported upon comparative tests carried out at his research laboratory. He felt that a number of the claims made by Mr. Hazelett—e.g., those in regard to voltage performance and capacity—were somewhat exaggerated.

MARSH CHLORINE-CAUSTIC SODA CELL

The final paper on the program was entitled "The Marsh Electrolytic Cell Batteries for Chlorine, Caustic Soda and Hydrogen," by C. W. Marsh.

Mr. Marsh gave a brief description of a high-capacity cell for electrolysis of brine, containing graphite anodes, corrugated sheet steel cathodes, with asbestos paper diaphragms clamped tightly to the edges of the cathodes. Arrangements are made for collecting both chlorine and hydrogen. Single cells are made to take up to 2,500 amp. The ampere efficiencies over long periods amount to 90 per cent; the power efficiencies 50 to 65 per cent.

The cell consists of three parts: a structural top with downward extended ends, anodes suspended from the

top, and a cathode clamped to the top and ends, forming the electrolyte compartment. The cell is supported from the top in a box or on insulated beams or suspended from the top through insulated bolts inserted in the top. A hoist operating from an overhead trolley beam or any similar overhead device is used for assembling the cell and to raise and lower the cell into position.

The structural top is like an inverted trough with downward extended narrow ends. The material may be stoneware, re-inforced concrete or other suitable material. Openings are provided in the top for brine inlet and automatic brine control device, brine level indicator, brine gage glass, chlorine outlet, cleaning holes and openings through which extend the top of the anodes.

The graphite anode consists of four, six, ten or any reasonable number of 1.75-in. (4.4-cm.) diameter graphite rods 24 in. (60 cm.) long arranged one above the other with spaces between and pinned to a rectangular section of graphite acting both as a support and a leading-in post. Pairs of these anodes are suspended from the top through clamps on the upper ends of the graphite posts.

The cathode consists of perforated sheet steel horizontally corrugated to conform to the surface of the horizontal graphite rods. The asbestos paper diaphragms are laid on the cathodes conforming to corrugations. The cathode is then clamped along the bottom edges of the top and against the ends with the diaphragm acting as a gasket. The cathode and the ends and top thus form the electrolyte compartment. The chlorine gas collects in the top above the brine. The caustic liquor forms on the cathode and is collected in the supporting box or by other trough-like receivers. The hydrogen gas may be recovered for use by confining the cathode in an inclosure, if the cell is suspended, or within the supporting box. The connections for electric

current and for other purposes are made in the usual way. Connections are made along the top of the cell.

Social Features of the Meeting

The afternoons of Thursday and Friday were given over to sports and recreation. The golf tournament attracted a large number of enthusiasts. The course of the Sea View Golf Club was in exceptionally fine condition and the weather was ideal. Through the courtesy of Frank Hodson the members enjoyed the hospitality of the club, and so many were the attractions and inducements of the club that a goodly number of the electrochemists forgot entirely about the technical sessions "the morning after." In order to make the golf tournament doubly interesting the committee, with Arthur E. Gibbs as chairman, had arranged for a large number of attractive and practical prizes, generously contributed by the Westinghouse Co., Stellite Co. and Monel Co. The prizes were awarded on Friday evening at a gathering of the entire Society in the large auditorium of the Chalfonte. The occasion was a most impressive one. L. E. Saunders made the presentations with appropriate comments on the skill and veracity of the individual contestants. The first prize went to John A. Seede, who, due to his characteristic "continuously regulated" strokes, netted the lowest score. Then there were second, third and fourth prizes. Also prizes for special distinction: C. G. Schluederberg received a prize for covering the largest area of the course; H. C. Parmelee received a very fitting little prize, a pocket adding machine. Mr. Parmelee's distinction was the largest number of strokes. When asked for his score, the committee had mistaken his score for his telephone number. As to the "indoor sports," first prize in billiards went to Dr. J. W. Richards.

For Symposium on Corrosion of Metals and Alloys see page 841 of this issue.

Properties of Various Metals and Alloys

Some of the important properties of various metals and alloys have been summarized in the attached table by R. W. Woodward of the Metallurgy Division, Bureau of Standards. These values are typical, but should not

be used for design purposes as of precise significance, especially if details of the special alloy in question are available. However, they form a most convenient reference table for data not commonly summarized, and are suitable for nearly all estimates.

Material	Tensile Strength, Lb. per Sq. In.	Elongation in 2 In., per Cent	Modulus of Elasticity (Lb. per Sq. In.)	Compressive Strength, Lb. per Sq. In.	Brinell Hardness Numeral	Density, Lb. per Cu. Ft.	Melting Point, Deg. F.	Coef. of Linear Expansion per Deg. F.	Resistance Ohms per Circular Mil- Ft.	Temp. Coef. of Resistance per Deg. F.
Cast iron	30,000	None	15,000,000	100,000	100	450	2,000	0.0000068		
Wrought iron	50,000	35	25,000,000	30,000	125	480	2,760	0.0000066	60	0.00322
Low-carbon steel, annealed	60,000	35	30,000,000	40,000		490				
Low-carbon steel, cold-rolled	50,000	20	30,000,000	60,000		490			95	0.00183
Med.-carbon steel, annealed	80,000	28	30,000,000	50,000	135	490				
Med.-carbon steel, heat-treated	125,000	13	30,000,000	100,000	360	490				
High-carbon steel, annealed	86,000	33	30,000,000		156	490	2,500	0.0000067		
High-carbon steel, heat-treated	200,000	10	30,000,000		375	490				
Alloy steel, heat-treated	225,000	10	30,000,000	200,000	410	490				
Copper	35,000	50	17,000,000		42	555	1,981	0.0000095	10.37	0.00220
Cast red brass	30,000	22	13,000,000	30,000	40	535		0.0000105	39.5	0.00055
Cast gun metal or govt. bronze	38,000	25	13,000,000		64	545				
Manganese bronze, rolled	75,000	25	16,000,000		100	525				
Zinc	12,000		11,000,000	25,000	48	445	786	0.0000163	36.5	0.00210
Aluminum	13,000	25	10,000,000	67,000	25	165	1,218	0.0000130	16.98	0.00216
No. 12 aluminum cast alloy	20,000	3	10,000,000		55	176				
Duralumin, rolled and heat-treated	55,000	25	10,000,000			175	1,200		28.3	
Tin	4,000	35	4,000,000	6,400	14	455	450	0.0000126	67.9	0.00240
Lead	2,000		700,000			710	621	0.0000164	125.0	0.00217
Genuine babbitt				15,000	25	460	460			
Platinum	35,000	50	23,000,000			1,340	3,191	0.0000050	66.0	0.00204
Gold	30,000	25				1,200	1,945	0.0000081	14.5	0.00206
Silver	45,000		9,000,000			650	1,765	0.0000108	9.9	0.00222
Nickel	40,000	10	29,000,000		76	570	2,646	0.0000071	64.0	0.00230
Nichrome	150,000					517	2,800	0.0000091	657.0	0.00024
Manganin									260.0	0.000006
Constantan	120,000					554	2,300	0.0000080	293.0	0.00001

Rochester Meeting, American Chemical Society

Report of the Sixty-first Meeting April 25-29, 1921—Council Meeting—Addresses at the General Meeting—Papers Presented at the Industrial and Engineering Chemistry, Dye, Rubber and Physical and Inorganic Chemistry Divisions, and at the Cellulose and Petroleum Sections

THE sixty-first meeting of the American Chemical Society was held at Rochester during the week beginning Monday, April 25. There were about 1,400 registrants, although the attendance was probably larger than this.

In view of the constantly growing burden of expense which the Society's meetings impose on their hosts, it was resolved at the previous meeting that greater simplicity of entertainment should be observed. To this general rule the Rochester Section conformed, but it made up for luxuries by perfect arrangements and order. Everyone was looked after, and every requirement was met without delay or inconvenience. It was a good meeting.

The Council Meeting

The Council meeting was called to order at 4:05 p.m. at the Rochester Club, President Edgar F. Smith in the chair.

Memorial resolutions were adopted in regard to the deaths of Dr. Albert C. Hale, formerly secretary of the Society, and Dr. I. D. Hines, for many years a member of the Council. Dr. George F. Rosengarten was re-elected to membership on the committee on national policy, succeeding himself. An invitation was presented from the Alabama Section to hold the spring meeting of 1922 at Birmingham, which was accepted.

Drs. Charles F. Chandler and William H. Nichols were elected to honorary membership. Under requirement of the constitution the names were acted on again by the members of the Society at its general meeting.

It was resolved that the Council express to the directors the hope that they absolve the printer of the Society's periodicals from any forfeit if he fails to deliver the journals regularly during the threatened strike of the printing trades for a 44-hour week. The conclusion was reached only after the increase in the cost of the periodicals which would follow the 44-hour week demanded in the printing trades was considered, and after a comparison was made of the rates of pay to journeymen before the war, now, and under the demanded advance. It was not from jealousy that the instructor in chemistry who receives less was unwilling to grant this request to his brother the compositor who receives more, but rather because he can't pay any more for his journals the while he must have them.

The proposal for a new section of the Society to be known as the Arkansas Section was adopted.

The appeal to Congress passed at the general meeting to safeguard the dye industry was passed by the Council.

It was determined that in future, if reports of committees are presented between meetings of the Council, these may be accepted and adopted by the advisory committee in the place of such action by the Council itself. This step was taken because sometimes it is necessary that preliminary reports be acted on to provide for further progress.

The committee on metric system offered resolutions

urging chemists and manufacturers to use metric units in specifications, and it was resolved that authors be requested to use them in their papers and that the editors request them to do so.

Dr. Charles Baskerville reported for the committee appointed to meet the American Mining Congress. The purpose of this was to conserve the mineral resources of the United States, and progress was noted. On behalf of the Holmes memorial committee he did likewise. The report on occupational diseases in the chemical trades was an illuminating discourse even in the abridged form in which it was presented. Some of its features will be discussed on another occasion in this journal.

The advisory committee presented for action a resolution recommending to the Commissioner of Patents that a trained chemist be appointed as chief examiner. This was carried, as was also a resolution that the secretary of each division be authorized to demand the submission of any paper offered for presentation at any general meeting, and that the chairman and secretary of each division have the power to decline any such paper, if, in their judgment, it is unavailable.

The number of members at the end of 1920 was 15,582.

Dr. Herty reported encouraging progress in regard to the proposed Institute of Chemo-Medical Research which was formerly referred to as the Institute of Drug Research. The committee has lately been in conference with the Chemical Foundation. A very favorable report was also received from the committee appointed to co-operate with the Chemical Warfare Service. A meeting lately held at Edgewood Arsenal shows that this immensely important property of the U. S. War Department is now being conserved and held ready against the time of need for it. In the light of the report a resolution was adopted complimentary to Brigadier General A. A. Fries and his associates for their splendid work in this connection.

A number of other committees reported, and in conclusion the Council declared itself in favor of the principles contained in the Nolan bill, which died in Congress, and opposed to the so-called Federal Trade Commission rider, which provided for the disposal by the Federal Trade Commission of patents taken out by Government employees.

During a recess the committees were the guests of the Rochester Section at dinner at the Rochester Club.

The General Meeting

The General Meeting was called to order at the Chamber of Commerce by Frank H. Lovejoy, chairman of the Rochester Section, who introduced J. Ernest Woodland, chairman of the executive committee, and Mr. Woodland made an address of welcome. He then introduced J. Bernard Haggerty, secretary to Mayor Edgerton, who gave the freedom of the city to everybody there. Next E. J. Miner, president of the

Pfaudler Co. of Rochester, after a felicitous introduction, made an earnest appeal for the encouragement of research. He deplored the tendency, frequently observed of late, to discontinue efforts in this direction because of hard times. He declared that intelligent research is not an expense, but rather an investment in insurance for the future. He indicated also a danger that scientific men, instead of addressing themselves too much to theory, are likely to become too utilitarian, and thus, by neglect of pure science, to render themselves unfit to meet with clear vision the greater problems that come before them. He made an earnest plea to magnify the importance of pure science, for in the men of science of today rests the hope for the future. It was an address that might well be printed and used as a tract to circulate among the business men of the country.

President Smith then took the chair, and responded on behalf of the Society to the words of welcome in his own delightful and engaging manner. The act of the Council was confirmed by the unanimous election of Drs. Charles F. Chandler and William H. Nichols to honorary membership.

Prof. Bingham of Lafayette College in a short address made a plea for the practice of dealing and trading in units of the metric system. Much more can be done in favor of bringing it into use by acting than by talking. He urged that wherever and whenever possible supplies and materials be bought in metric units.

Dr. Raymond F. Bacon of the Mellon Institute in a short address urged upon members to bear in mind how in 1914 many industries were closed down for lack of a few pounds of some needed product, and advised that in most of the forty-two legislatures now in session there are bills pending designed to enforce prohibition of alcohol as a beverage that include provisions which, if passed, will do no less than wipe out several legitimate and important industries. These are in no wise related to the drink evil. Many of the proposed statutes are drawn with the best intentions, but their provisions are fraught with serious danger. The Volstead act was designed, according to its caption, to provide for the prohibition of alcoholic beverages and to promote the chemical and industrial uses of alcohol, but the latter feature is being wholly forgotten in the legislation which threatens.

Captain G. B. Hide made an appeal for the Near East relief, and H. C. Howe announced that the fourth table of chemical and physical constants will be out by July.

SENATOR WADSWORTH FOR CHEMICAL PREPAREDNESS

Senator James W. Wadsworth, Jr., made no pretensions to chemical scholarship, but said that in the Congress of the United States he was far from being alone in the lack of it. He has only lately recognized the utter dependence of industry upon chemistry, and he has been made alive to the fact that if this science does not go forward with us we cannot progress as a nation. He would not undertake to instruct the audience before him in the relation of their own profession to national defense, but he had lately spent a day at Edgewood Arsenal, and wished that others might go there and see what it means to the people of the United States and to future generations. It is of staggering size. The people of this country, regardless of their politics or their opinions as to foreign or domestic affairs, should count themselves fortunate in having this great plant for their protection, held

in readiness and administered by so able and competent an authority as General Fries.

He had participated in considerable discussion in relation to the Chemical Warfare Service, more particularly in the Committee on Military Affairs, and this discussion had at times been rather lively.

The head of the department himself and the Chief of Staff had contended against a separate Chemical Warfare Service, and had wanted it merged, or, rather, submerged, in the Engineers Corps. The members of the committee had a very slight understanding of the subject, but when they learned that 30 per cent of the casualties were due to gas, they had the wit to see that the service was not negligible, and legislation to keep it as an integral part of the army was finally enacted. In its last session Congress also appropriated money to make at Edgewood 120,000 masks and 120,000 extra canisters, which are the best masks that have been made anywhere, although even they do not protect against all known gases. He believes, however, that if we are compelled to go to war again, and the enemy uses gas, we shall have made good provision against it, and not be utterly unprotected in that respect as we were before. He believed it safe to say that Congress will not permit this service to perish.

There are, he said, conflicting views current as to the proper size for the United States regular army. Personally he does not favor a standing army that is too large, but rather believes in the proper training of citizens who in case of war have to do most of the fighting after all. But it is possible to make the regular army, which must serve as a nucleus in time of war, too small. With an army of 280,000 men, which is the maximum figure considered, the number of officers in the C.W.S. will be 100 out of a total of 17,800, and 1,200 enlisted men out of 280,000. But if the total number be reduced in the measure proposed by some earnest legislators, the enlisted men in the C.W.S. will be reduced to four officers and 400 enlisted men. This would be almost fatally inadequate.

Another point of information that was being learned is that high explosives depend on nitrates, and that if we do not produce them by chemical means we must send 10,000 miles away for them. He had never read in history of a people able to defend themselves unless they were self-reliant and independent. Now the best measure for national defense is that the means for defense be made by the people themselves. A government alone cannot provide for it in days of peace. Such preparation must be included in the peaceful occupations of the people. No government is competent enough or pure enough to do this thing of itself. For this reason he has opposed proposals to launch the United States Government in great industrial enterprises whereby it would invade the domains of business to prepare itself against the day of war. He repeated that since the people must fight the wars it is they who should prepare for them—and they should make nitrates as a legitimate business industry.

He would like to think that war will never overtake us again, but he can't be sure; and if we are not sure we are not warranted in neglect. In conclusion he rejoiced that a great organization like this, which builds for the future, gives its thoughtful consideration to the security of the country, and he looked upon it as a happy augury that if, in future, danger again threatens us, we shall have such a large body of skilled men on whom we can call.

ROCHESTER MEETING OF THE AMERICAN CHEMICAL SOCIETY

April 26-29



HANS T. CLARKE
VICE-CHAIRMAN



FRANK W. LOVEJOY
HONORARY CHAIRMAN



J. ERNEST WOODLAND
CHAIRMAN



ERLE M. BILLINGS
SECRETARY TREASURER



CHARLES F. CHANDLER



GILBERT N. LEWIS



HARRY L. B. GRAY
HOTEL COMMITTEE



FLORUS R. BAXTER
EXECUTIVE COMMITTEE



BENJAMIN V. BUSH
PUBLICITY COMM.



NICHOLAS LONGWORTH



EDGAR FAHS SMITH
PRESIDENT AMERICAN CHEMICAL SOCIETY



JAMES W. WADSWORTH



HARRY A. CARPENTER
CHAIRMAN REGISTRATION



IRVING LANGMUIR



C. E. K. MEES



HERBERT EISENHART
FINANCE COMMITTEE



CHARLES F. HUTCHISON
CHAIRMAN ENTERTAINMENT COMM.



CHAS. W. MARKUS
TRANSPORTATION



O. I. CHORMAN
ENTERTAINMENT COMMITTEE



ROBERT E. WILSON



RAYMOND F. BACON



WILDER D. BANCROFT



IVAR N. HULTMAN
COLLEGE & FRATERNITY DINNER COMM.

President Smith asked all to rise, and while the audience was standing, he expressed in a few eloquent words the sincere thanks of the Society to Senator Wadsworth for his splendid message.

CONGRESSMAN LONGWORTH ON TARIFF SCHEDULES

Congressman Nicholas Longworth followed. He said he had lately called at the most distinguished residence in the country, and that its occupant, who is the most powerful man in the country at this time, had said to him: "I hear you are going to address the American Chemical Society. That is good; but what the chemists of America most need is not talk, but protection."

The speaker said he was now chairman of that subcommittee of Congress which is framing the chemical schedule, and he admitted that it was a difficult job. Nobody can tell the cost of products, either here or abroad. It is a great field of guess-work. Therefore it is idle to pretend to follow the old slogan and declare that a proposed tariff bill will equalize the difference in costs, if they can't find out what these are! The market prices are by no means trustworthy guides, because of fluctuations. Even well-known chemicals have varied in price in thousands of per cent. One product widely used has had a range in the last few years of from 10c. to \$4 a pound. As far as possible, he hopes that we may go back to specific duties. But even these are often unreliable and a specific duty that might be a proper one today might, in some cases, be wholly out of proportion three or four months hence. On the other hand, as soon as we consider ad valorem duties we face the problem of foreign exchange, and that is another source of trouble. The only way to meet the situation is to have a valuation of foreign imports based on the wholesale values of the same products in this country, when it becomes necessary to fix an ad valorem duty.

Another great difficulty is that we have changed from a debtor to a creditor nation. How then can Europe pay its debt to us if we bar Europe from our markets? Again, how can we meet the low labor costs that prevail, for instance, in Japan?

The speaker believed that the true solution consists in maintaining a bargaining counter, and in having three rates of duty to apply:

1. As a regular rate.
2. A maximum rate to those who do not treat us as favorably as they do other countries.
3. A minimum rate to be applied only by order of the President and to be used in exchange; as, for instance, to silks from France against outgoing chemicals from the United States to France.

There is one class of merchandise for which no rate of duty even to a thousand per cent will suffice, and that is coal-tar dyes and other coal-tar products. We must not only put duties on some, but keep others out altogether. In the bill he introduced into the last Congress he proposed a licensing system, but the plan met the objection that Americans do not like to apply for licenses to carry on their business. What he hopes to bring about will be to divide dyes listed by the Tariff Commission into three groups, viz.:

1. Those that are not imported at all because they are made here in abundance and sold at reasonable prices.
2. Those occasionally importable because they are not made here in sufficient quantity to care for the industries that need them.

3. Those that are not made here at all and which may be imported freely.

Mr. Longworth is convinced that Germany is awaiting the day when she may flood this country with coal-tar products in such a manner as to kill the domestic industry. The German factories are running full time; they have not been injured, and their labor and chemical forces have not been called on to fight in the army. If we want to save this industry for the United States, with all that it means, we must put a flat embargo upon certain German products, and he believes that this time it will be done.

Another difficult matter is that the bill will hardly be ready for the President to sign after its passage through both houses before November or December, whereas the War Trade Board goes out of existence by July 1, or possibly sooner. To make provision against such dumping of German goods into this country some unusual legislative steps will have to be taken, but he has hopes of this also. In short, Mr. Longworth believes that the members of both houses have finally come to realize that our preparedness for defense lies in our chemical industries.

In conclusion he repeated Senator Wadsworth's observation in regard to the immense advantages to the country in having the American Chemical Society to which it can turn when under threat of war.

President Smith again asked the audience to rise and in the name of the Society he thanked Representative Longworth for his happy and heartening address.

MEASUREMENT OF COLOR

Dr. E. K. Mees of Rochester gave an illustrated talk on "The Measurement of Color." The development of the colorimeter has proved that the subject is of interest to manufacturers as well as to physicists and chemists; the range of industries calling for color measurement including makers of soaps and makers of soups. We can measure the stimulus that produces the sensation of color, and we can measure the sensation itself. Thus the stimulus is found in the cause of the sodium flame, whereas the sensation is produced directly by a dandelion. While to us the color of both is alike, they are wholly different in the spectrum. To examine the stimulus we must use analytical methods, while to measure the sensation our methods must be synthetic.

BLUE EYES AND BLUE FEATHERS

Prof. Wilder D. Bancroft, in talking on "Blue Eyes and Blue Feathers," said there is no pigment in blue eyes, but that the sensation of blue is explained by the presence of a thin layer of minute particles between which the long red waves pass without touching them, whereas the short blue waves are sure to strike them so as to be deflected, or at all events so scattered that they produce the sensation of blue. Gray, green and brown eyes are due to more of these particles against which the impact of longer waves makes itself manifest. He followed with an explanation of the color of blue feathers.

The chameleon and the flounder produce different effects of color by the arrangement of particles in their skins. Slides were shown of a patient flounder which took protective coloring from a large number of bottoms over which it was placed, and it showed amazing attempts at conformity to the surfaces beneath it. Over sand and over granite rock and over a considerable number of various bottoms it became almost

invisible, whereas when such an unusual surface as a chessboard or other regular figured bottom was provided, the poor fish did its best, but couldn't quite meet the requirement. A test that seemed unfair was to place it so that the head was over a black surface, and the rest of it over white. The fish saw only the black, and turned as dark as it could all over. It turned as near white as it could with the conditions reversed. The protective coloring is due to a volitional change in the particles under the surface of the skin, and copies more or less closely what the fish or chameleon sees. It is not due to pigmentation of the skin.

SURFACE FILMS AS PLASTIC SOLIDS

Robert E. Wilson, director of the Research Laboratory of Applied Chemistry, Massachusetts Institute of Technology, gave a general address on the structure of surface films. By a variety of new and ingenious methods it was demonstrated that the stability of most, if not all, stable bubbles is due, not to the mere lowering of surface tension, but to the formation of *plastic solid*, rather than *liquid*, films at the liquid-gas interface. These films are probably gel-like in structure, and owe their formation to the concentration of the bubble-forming material (such as soap) at the interface. The same essential conclusions were also shown to apply to the interfacial films between oil and water, which are formed by the ordinary emulsifying agents. Here again the presence of a plastic solid, rather than a liquid film, is the main factor in preventing coalescence of the drops. Plastic solid films also appear to play an important part in lubrication.

Prof. Wilson also showed that the presence of these solid films, at all except the lowest concentrations of materials such as sodium stearate and saponin, caused erroneously high results in the ordinary (Du Nuoy or drop weight) methods of measuring surface tension between solutions and air or oil, etc. The measurements in such cases really represent the sum of the surface tension plus the frictional resistance to rupturing the film. While it has not yet been found possible definitely to separate the two effects, they are at least of the same order of magnitude, and in many cases the frictional forces are larger than the surface tension forces, as witnessed by the grotesque deformed and pointed, and yet stable, drops, of which pictures were shown.

Indeed, the results may account for the hitherto unexplained fact that certain concentrated soap solutions will spontaneously emulsify oil, which would appear to indicate a *negative* interfacial surface tension, and yet oil dropped into the solution gives a reasonably definite drop weight which calculates over to *positive* value for the interfacial surface tension.

RELATION BETWEEN THE STABILITY AND THE STRUCTURE OF MOLECULES

Irving Langmuir amplified his previous presentations of the octet theory by showing the part played by electrons held in common between the positive fields of two atomic nuclei forming a molecule. The fundamental hypothesis states that stability is attained when the negative shell has its full quota of electrons as based on the structure of the inert helium series. An outer shell is not stable until it contains eight electrons; thus a stable molecule differs from the inert elements mainly in having more than one positive nucleus and holding one or more electrons in common. Double bonds exist

where two electrons are held in common by two nuclei and triple bonds exist where three are shared.

IONIZATION OF ELECTROLYTES

The activity of the ions or ionic strength of an electrolyte forms the basis of theoretical work with solutions. Prof. Gilbert N. Lewis has recently calculated tables from laboratory determinations which will form a very valuable addition to the present store of constants. It is predicted that mixed salt concentrations at saturation can be calculated and of course all work on electrolysis will be greatly benefited. The paper will be published in the current issue of the *Journal of the American Chemical Society*.

The Chamber of Commerce Luncheon

At the luncheon in the Chamber of Commerce there were over 1,000 present, and Dr. Arthur D. Little of Boston gave a popular talk. Business men, he said, deal in dollars. They go out after them and they have accountants to keep record of them, and they discuss them constantly. But dollars are only symbols of things, while things are materials and labor; and labor creates value only as it works on things. Now the nature and control of materials is the province of chemistry. Therefore chemistry is a partner in the manufacturer's business; a closer partner than the Federal Reserve Bank or the labor union. We have lawyers to look after man-made laws, but chemistry deals with its own laws, and a chemist is a counselor of chemical laws. Men who have to do with materials need chemical service, and since we have but one chemist to every 7,000 of our population, it is time that live men began to look around for good ones. One ounce of whiskey in 55 gal. of water makes a dilute drink, and that is the ratio of our mixture of chemists to people in this country; of men who study the ways of materials.

He cited a great number of instances in which the chemist had saved situations and added to the wealth of the nation, and explained in an illuminating manner the chemical foundation of production. He showed it should be the controlling consideration in regard to raw materials, how it finds suitable substitutes for materials needed that are too costly or too rare, and how it finds new outlets for products. He explained the value of scientific control of production, as well as how the chemist finds new uses for existing plants. The audit and sheet balance is a record of past performances. The research laboratory provides for and aids in future performances.

Petroleum Section

The question of organizing a Petroleum Section of the American Chemical Society was first taken up and discussed seriously in February of this year; the approval of the national officers was obtained early in March and the work of enrolling members and preparing a program was begun at once. Encouraging comment was received and about fifty persons indicated their intention of joining the Section; but the real prospect of success could not be judged until the test of holding a meeting had been applied. However, at no time after Wednesday morning, April 27, when the Section first met, was the fate of the project in any doubt.

In the field of petroleum so much of the research work and the information available are in the hands of the representatives of the industry that their support and co-operation are absolutely essential to success. That

such support and co-operation were being given was indicated by the presence of the chief chemists and technical directors of many large oil companies, a number of whom had traveled long distances to be present. These and an adequate representation from the universities and research institutions filled to overflowing the small room first assigned for the meetings of the section and two movings were necessary before adequate quarters were found.

The time of the Section was divided between the business of organization and a short but very interesting program of papers. In arranging for the meeting, the Council, through the national officers, had appointed Dr. T. G. Delbridge, of Philadelphia, chairman and Dr. W. A. Gruse, of Pittsburgh, secretary. The organization, as voted by the meeting, provides in addition for a vice-chairman and an executive committee of five members, who are to conduct the business of the Section; the payments of dues were decided upon, and in order to facilitate and stimulate intelligent discussion of papers it was voted to circulate, prior to a meeting, abstracts of all papers to be presented; the circulation of written discussion was also considered. Standing committees on papers and on membership were provided for.

PETROLEUM HYDROCARBONS THAT CANNOT BE DISTILLED

The first paper on the program which followed the preliminary organization was one by Dr. Charles F. Mabery, of the Case School of Applied Science, Cleveland, by seniority and by merit dean of investigators in the field of petroleum chemistry in this country. Dr. Mabery's paper was on "A Method for the Separation of Petroleum Hydrocarbons That Cannot Be Distilled." The principle employed was that of fractional solubility in hot ether-alcohol; by repeated treatments the author has separated individual hydrocarbons from the residue of petroleum oils non-volatile *in vacuo* above 300 deg.; the hydrocarbons were identified by specific gravity and molecular weight determinations and by elementary analysis and were found to belong to the series C_nH_{2n-8} to C_nH_{2n-12} . The composition of the heavy fractions of petroleum oils have long remained *terra incognita*, and Dr. Mabery has given many younger investigators a splendid example of patience and courage in undertaking such difficult and time-consuming work.

SOME CHEMICAL CONSIDERATIONS OF PETROLEUM REFINING

Dr. B. T. Brooks, in a paper on "Some Chemical Considerations of Petroleum Refining," made a plea for a closer connection between pure organic chemistry and petroleum technology, and for better dissemination of information now in the files of private organizations. Dr. Brooks pointed out some influences tending to make the oil industry more like what a good industry should be, chief of which is the growing scarcity of crude oil. He characterized present-day practice in oil refining as highly unscientific, and in an interesting review of recent work explained some of the possibilities for technical improvements. Dr. Brooks voiced the opinion of many present when he called attention to the need in this country of a journal resembling the *Journal of the Institution of Petroleum Technologists*, where persons engaged in petroleum work could find both an adequate record of all reliable work and could also be assured of a medium which would bring their researches

to the attention of all those interested. This paper will be published in full in a subsequent issue.

EXPERIMENTS WITH OILS AND OIL MIXTURES

Dr. R. E. Wilson, director of the Research Laboratory of Applied Chemistry at M. I. T., presented two interesting papers. In the first, read by himself, Dr. Wilson explained a very accurate but simple method of determining the initial and various partial condensation temperatures of kerosene- or gasoline-air mixtures. A Socony kerosene mixed with air in the proportion of 14.5 to 1 gave a dew-point of 232 deg. F. at one atmosphere total pressure, and a Socony gasoline under identical conditions gave 97 deg. F. The data were presented for a wide range of conditions. Of great interest were the data which the work supplied on the total heat of kerosene and kerosene-air mixtures. The second paper, jointly with L. W. Parsons and read by Dr. Parsons, described work carried out co-operatively with the Vacuum Oil Co. on a method for measuring the true color of oils, using the Dubosq instrument and giving results on a scale directly related to the Lovibond. The unknown oil was measured in a thin film of known thickness, and compared with varying thicknesses of an oil solution of standard color. The method permits the determination of batch colors from effluent colors during filtration, provided the weight of oil is known.

OTHER PAPERS PRESENTED

Dr. F. H. Garner read a paper written jointly with Dr. W. F. Faragher on "Removal of Hydrogen Chloride From Chlorohydrocarbons." The effect of temperature and various catalysts on this reaction, so important in the preparation of unsaturated compounds, was studied, and a method was presented for the preparation of olefines.

C. J. Rodman presented a new and very accurate method for determining very small percentages of water in transformer oils, depending on evaporation *in vacuo* and absorption by phosphorus pentoxide.

Dr. E. W. Dean and F. W. Lane, of the Bureau of Mines, reported, in a paper read by Dr. Lane, on a study of the variation with temperature of the viscosity of some typical American oils and their fractions. The authors found that their curves could be represented by a general equation, and pointed out that there was no reliable method for calculating viscosities for oils for which less than three values have been determined at different temperatures.

Dr. W. A. Gruse read a paper by W. F. Faragher, F. H. Garner and himself, in which a résumé was given of a study of the measurement of unsaturation in cracked gasolines and unsaturated hydrocarbons by the determination of the iodine number; particular attention was paid to the variation of the iodine number with time and quantity of material.

Dr. W. F. Parish, in a paper presented in his absence by W. F. Faragher, reported on the interesting topic of reclaiming used motor oils; he brought out the fact that the reclaimed oils (mixed with soda ash and blown with steam) were better than new oils, after the removal of absorbed heavy ends of motor fuel, because the high temperatures in the explosion chamber served to decompose the lighter constituents. Dr. Parish brought out the desirability of perfecting a standardized form of reclaiming apparatus which could be used by persons without technical training, and emphasized the

fact that the oil drawn from a motor after a thousand miles' running is not a waste product, but can easily be reclaimed.

Dr. C. E. Waters reported on a continuation of his well-known work on the oxidation of lubricating oils. The paper was read by Dr. F. R. Baxter, and was a study of the catalytic influence of various metals on the oxidation of oils being tested in the Waters apparatus. The influence of copper was so marked that the author closed with a suggestion that transformers be made of zinc or aluminum and that bearing metals should contain no copper.

Division of Industrial and Engineering Chemistry

The meeting of this division, which has always been looked forward to in preceding years with anticipation as a source of profitable information for chemical engineers, was a distinct disappointment to the members who heard the papers presented. While there were several of extreme high merit as scientific presentations outlined in the following paragraphs, the very poor average called forth some caustic comments from the members at the close of the session.

RATE OF DRYING OF SOLID MATERIALS

Those who expected the drying symposium to be worth while were not disappointed in the excellent scientific address delivered by W. K. Lewis on "The Rate of Drying Solid Materials." This paper was the result of seven or eight years' scientific investigation at the Massachusetts Institute of Technology and dealt with the mechanism of evaporation of water from the surface of solids.

All solids hold water adsorbed on their surfaces in moist air. Solids can never be dried below the equilibrium point, which depends on the humidity and the temperature. The only water which will evaporate is the free water. This adsorbed water behaves as though its equilibrium moisture were the same as that of the solids.

For the simplest mathematical example sheet materials were chosen to prove out the process involved.

The accompanying diagram shows a sheet of material under consideration. The distance MN represents the space on this sheet under test. Let this sheet be divided by the center line as shown, then the space included between the lines to the left of the center line represents the original moisture content of the sheet. The line AB represents the average concentration of moisture, or the differential gradient throughout the sheet. It is not really a straight line, but will do for practical industrial approximation.

The moisture within the body of this material must be permitted to get to the surface. Evaporation at the surface and diffusion of moisture from the material are the two processes involved in getting rid of this moisture. Both are really a problem of diffusion, since the moisture must be diffused through the air. There is a difference

in the operation of the process of removing the moisture at low temperatures and high temperatures when figured mathematically. Let w equal the surface concentration of water. Then

$$\frac{dw}{dt} = bx$$

where b is a constant depending upon the drying conditions and x is the moisture content of the surface.

$$\frac{dw}{dt} = \frac{8abw}{(2a + bL)L}$$

When diffusion is rapid as in the case of wood pulp, then

$$\frac{dw}{dt} = \frac{2bw}{L}$$

When the evaporation is slow,

$$\frac{dw}{dt} = \frac{4aw}{L^2}$$

Experimental data were presented to prove this in the form of numerous curves. In the first case time in minutes was plotted against per cent of moisture to show when the moisture content of the solid reached the equilibrium of that of the air. Another curve was presented to show the rate of twine drying.

Most sheet materials shrink when they dry, and allowance must be quantitatively made in the equation when these curves are plotted. Other slides showed the adiabatic air-drying of heel board corrected for shrinkage. The rate of diffusion is proportional to the difference between partial pressure of moisture on the surface and partial pressure of the drying air.

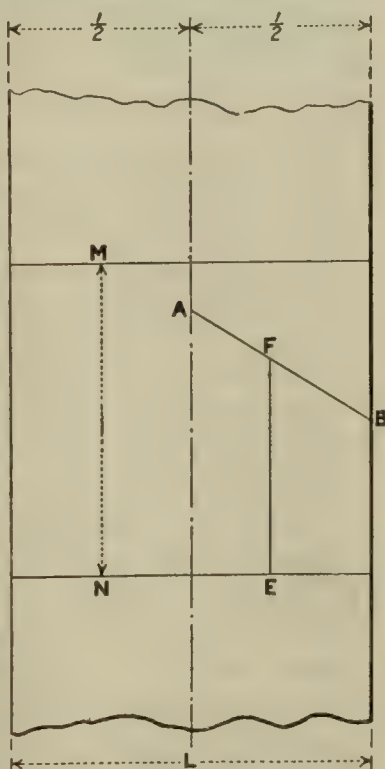
Further curves were presented to show that the rate of drying is inversely proportional to the thickness of the material and that the drying is constant at constant air velocity. The rate of drying then varies with the air velocity.

It was found during these investigations that the ratio of water taken out of the substance to the heat put into the drying operation exactly equals the specific heat of the substance. Materials in which diffusion is slow as in the case of tightly twisted twine, for instance, dried at a rate inversely proportional to the square of the thickness. In the case of soap, where the diffusion is extremely slow, the moisture recedes into the center of the cake, slowing up the drying process. There is no relation between diffusion and the rate as occurs in swift drying shown by the formulæ, which datum confirms the theory given in the first paragraphs. Removal of an organic solvent by drying from fibrous material operates just like drying out of water.

In summarizing, the conditions surrounding the process of drying are: (1) Care so as not to injure material dried; (2) adequate air supply; (3) adequate heat supply; (4) adequate time to complete the process. The first three items are taken care of in industrial drying today, but the fourth is now empirical and the author believes that the time factor may be quantitatively worked out so as to permit the drying of industrial materials on a definite scientific basis.

THEORY OF ATMOSPHERIC EVAPORATION

W. H. Carrier's paper on the theory of atmospheric drying involved the development of numerous drying formulæ, as well as the treatment of the subject from a physical and thermodynamic viewpoint. The work was carried out with particular reference to compartment drying, although the data may be applied to other types.



Since this work involved so many calculations, it would have been better published than read before the members, since it only consumed time. It was impossible to follow the rapid reading of so many calculations.

THE COMPARTMENT DRIER

A. E. Stacey, in collaboration with W. H. Carrier, presented a paper on the compartment drier, treating the subject from a chemical and physical viewpoint. The work contained the operations involved in the process of compartment drying and also covered the method of drying by silica gels. Numerous slides were presented showing all types of compartment driers now installed in the industry.

DIRECT-HEAT ROTARY DRYING APPARATUS

Like the preceding paper, the one given by R. G. Merz, on the direct-heat rotary drying apparatus, covered little material that is not already known to the users of driers. It was an exposition of the different mechanical developments of rotary driers and discussion of the industries where they may be applied. The rotary drier was first developed for the drying of ores in the mining and metallurgical industries and is now finding a wide application in the chemically-controlled industries. It is adapted to installations where large quantities of materials must be dried at low temperatures, when such material will not be injured by continued abrasion in the revolving barrel.

TUNNEL DRIERS

G. B. Ridley spoke from an engineering viewpoint on the installation and operation of tunnel driers as applied to the dehydrating fruit plants on the Pacific Coast. These driers are similar in construction to the well-known tunnel kiln used in the ceramic industries, and may be operated by the application of steam, hot air or direct heat, steam being the most easily regulated where low temperature can be used. Trays of the material are loaded on rack cars, which are in turn wheeled through the long tunnels and submitted to the drying air. Excellent engineering data were presented to show methods of scientific control by charts and diagrams. The tunnel drier is cheap and convenient, will handle any material, can be accurately controlled, etc. It is better to enter the cars at the hot end of the tunnel where the material will stand the high initial heat, because more rapid drying prevents case-hardening or leathery consistency being given the material; and in the case of fruit, maintains the flavor. This drier operates more economically with large air circulation to control humidity. Efficiencies of furnaces or driers range from 92 to 98.5 per cent. Direct heat is the most efficient way if correctly applied.

THE SPRAY PROCESS

R. S. Fleming, of the Merrill-Soule Co., Syracuse, N. Y., talked on the spray process of drying as originally invented in Germany in 1901, for the drying of milk, blood, albumen, etc. The manufacture of powdered milk by this process was started in the United States in 1905. It was later modified to provide for the condensation of the liquid before it enters the driers.

The apparatus needed consists first of an air scrubber to clean the air before introducing to the spray room. The air may be water-washed or better yet filtered through cotton wool layers. Blowers provide the air pressure and in some cases an exhaustor is used on the

finishing end of the system. Steam pipe is placed over which the drying air may be passed and finally a set of sprays operate in the drying chamber where the hot air hits the fine material. This chamber usually consists of a large rectangular room with the liquid sprayed into the air from the ceiling. The atomizer proper may be air-sprays, operated by compressed air or by introducing the liquid under hydraulic pressure. Finally, a dust collector may be installed to operate in conjunction with a filter at the end of the system to save the fine dusts.

In actual operation very intimate mixture of air and particles is secured, causing an intense evaporation on the surface of each droplet. This occurs so rapidly that the droplet is kept cool. It is an especially efficient way to obviate injury by heat where some organic substances are handled. The greatest danger for such substances is when the mass is in the stage between a sirupy and dry condition. This state is passed instantly in the spray-drying process. The expense of drying by this method is too high for inexpensive substances, but where milk, sugar and other organic liquids, including blood and albumen, are to be dried, the efficiency more than overcomes the high cost.

Where concentrated liquid is fed into the sprays larger particles are produced, so that there is less bulk and greater solubility when the substances are to be redissolved in water when used. Among other types of substances glucose has been successfully dried. This paper holds interest for many people who have special problems in drying difficult liquids.

VACUUM DRYING

B. J. Van Marle discussed the subject of vacuum drying and the various equipment used, including rotary, shelf and drum driers. There are no universal driers for any material and the fields overlap. The quantity of product and cost are considerations in deciding which equipment will best handle same. The cost of vacuum driers is high because strength to resist pressure is needed. They are not suitable for large quantities, particularly the shelf type. This paper was a good exposition of the manufacturers' line of equipment in various fields where it is employed.

TESTS OF COUNTER-CURRENT KELP DRIERS

E. C. Spencer described the test on small counter-current kelp driers which showed that the thermal efficiency of the counter-current drier was 78 per cent on a 4-ton drier as compared with 88 per cent on a uni-directional drier.

DISCUSSION ON DRYING SYMPOSIUM

The informal discussion after the presentation of these papers developed the fact that in the spray process of drying usually about one-third of the total solids obtained is collected in the dust collector at the end of the process; also that the particles dry in a spherical condition. Preconcentration affects size of particle more than any variations in the pressure on the spray. Sugar has not been successfully dried by the spray process because the particles land on the floor in a molten condition and therefore form a sticky mass. Glucose, however, behaves admirably.

A. V. H. Mory further brought out that it is better to cause the liquids to boil in vacuum drying. He further developed that in compartment drying in an original design, the air was introduced at the top of the

tunnel at one end and drifted through the material to the bottom of the tunnel at the other. In putting a blower counter-current to the current of drying air an equal distribution of air was obtained through the entire mass or space of the drier. Mr. Stacey attributed this result to the additional amount of air entering the drier, but Dr. W. K. Lewis showed that it was due to the high velocity causing a turbulent motion which brought more of the same air in contact with the material. In other words, when the velocity of air is slow it simply drifts through, drying the nearest edges of the pieces in question, while in the case of a rapid velocity of air it becomes turbulent and presents continually unsaturated portions of air to the wet mass to be dried. The critical velocity from the straight line to the turbulent motion is greater in the case of air than water. Turbulent motion in a drier is exceedingly important.

Crosby Field, of the Allied Chemical Corporation, criticized the types of papers presented in that the manufacturers did not go into mechanical details. In general they design driers by hanging metal around the drying idea, and this metal is not distributed to the best mechanical advantage. Mr. Gertz, of C. O. Bartlett & Snow Co., laid the responsibility for this condition on the purchasers of driers, who buy on cost rather than quality of design. The manufacturers are therefore forced to skin the design down to meet the competition. It was very evident on the whole that the members were not satisfied with this symposium.

Other Papers

METHOD OF TESTING FILTER CAKE OBTAINED IN REFINING VEGETABLE AND ANIMAL OILS

Charles Baskerville presented samples and described the methods for treating filter cake obtained in refining vegetable and animal oils. Crude linters are introduced into the filter cake to act much in the same manner as hair in plaster. When the cake is removed it is treated with sulphuric acid solution and the linters are separated in centrifugals. More than 93 per cent of the 5½ per cent free fatty acid found in the cake coconut oil was recovered. There is a considerable overall saving of free fatty acid, say about 1 per cent, and the process has been installed in six plants which obtain a saving of 6,000 tons per annum. The samples presented showed very excellent recoveries of cottonseed oil, soya-bean oil, peanut oil, coconut oils, etc.

APPLICATION OF THE COTTRELL PRECIPITATOR TO THE WOOD-DISTILLATION PROCESS

L. F. Hawley, of the Forest Products Laboratory, described research carried on in the use of the Cottrell precipitator to recover mists in the wood-distillation process. The so-called dissolved tar which is removed from the pyroligneous acid by distilling off the acids is not a tar like the coal tar consisting of oils and pitch, but is really a pitch containing very small proportions of oil and soluble in the pyroligneous acids on account of the presence of acetic acid and methanol. Such contaminating pitch is carried over in the form of a fog or mist consisting of very fine drops of liquid pitch.

It is found that since the Cottrell precipitator is able to precipitate fine particles of liquid or solids when carried in a stream of gas, it should be introduced into this process, and was therefore connected between the retort and condenser of the small wood-distillation ap-

paratus. During the first run the precipitator was heated so that the vapors at the outlets from the precipitators had a temperature of about 160 deg. C. On examining the inside of the precipitator it was found that a deposit of hard pitch had been built up from the inside surface of the tubes. The temperature of the precipitator was then run near 100 deg. C. to collect the small amount of liquid with the hard pitch. This tar was not very thick even at ordinary temperature and was sufficiently liquid to drain from the tubes without any difficulty.

Although the small-scale experiments have not removed the last traces of pitch and although a satisfactory acetate of lime could not be made from the directly neutralized pyroligneous acid, yet they have shown that the general idea of precipitating tar from hot vapor is a possibility and that in a commercial-scale apparatus the formation of secondary tar may be more complete before the vapors leave the retort, and therefore a purer pyroligneous acid can be obtained by this method. The complete equipment will be described in a future number of CHEMICAL & METALLURGICAL ENGINEERING.

ALCOHOL AND CHEMICAL INDUSTRIES

J. M. Doran, in discussing the use of alcohol in the chemical industries, showed how the present and future development, notably the dye industry, is intimately bound up with the alcohol industry.

The Eighteenth Amendment to the Constitution and the Volstead act affect this key industry far more vitally than the average chemist is aware. Title III of the national prohibition act accords special treatment under the law to industrial alcohol, but overshadowing all are the prohibition features of Title II of the same act, wherein alcohol is defined as intoxicating liquor and made subject to the restrictions surrounding intoxicating liquors. In order to free the alcohol industry and dependent and allied chemical industries from the strangling rules surrounding liquor under which no industry can prosper, it is of utmost importance that alcohol be divested of its beverage character. The handling and use of pure alcohol in any industry is now a liability rather than an asset.

Under the denaturing provisions of the national prohibition act it is possible both to enforce prohibition and to assure the healthy development of industrial alcohol. This may be done by using for denaturant some of the chemicals that subsequently follow in a process where the industrial alcohol is to be used. In other words, select the denaturant for each particular user and introduce it ahead of time, thus preventing the use of the solution for a beverage. This would place the alcohol on a non-beverage basis, thus making the technique more efficient in the disposal of the liquor phase. The educational and research institutions should take this matter up if we are to have a healthy chemical industry.

VALUATION OF OIL-BEARING SEEDS BY FREE FATTY ACID OF THE OIL

Lehman Johnson, in a paper on the valuation of oil-bearing seeds by free fatty acid of the oil concludes that since below 2 per cent free fatty acid a well-settled crude cotton oil is normally prime, making the required color and 9 per cent refining loss, and since above 2 per cent free fatty acid the refining loss on settling oil admits very fairly of a factor, the method presented of the value of the oil-bearing seeds by the percentage of

oil obtained through extraction of the thoroughly dried seed with petrolic ether and determining the free fatty acids from this same extract is quite accurate and fair enough for commercial purposes, and should eventually be substituted for the "cut and count" of damaged seed as now provided by the Interstate Cottonseed Crushers' Association, which says, Rule 2, Section 4: "The percentage of damage shall be determined by counting the damaged and immature seeds." The same method is probably applicable to other oil-bearing seeds where the oil is refined by the alkaline method.

DETECTION OF CARBON MONOXIDE

C. R. Hoover presented a method for the detection of carbon monoxide with apparatus designed for accomplishing same. The importance of the detection of quantities of carbon monoxide physiologically harmful is shown by the large number of deaths each year due to asphyxiation, practically all of which are caused by the presence of this gas. An increasing number of workers in the industries, as well as operators of automobiles and other motor vehicles and users of gaseous fuels, are exposed to this peril. Carbon monoxide is an insidious danger, since it is colorless and odorless, giving no warning of its presence through the unaided senses. In spite of numerous ingenious chemical and thermometric detectors, the effect of the gas upon small animals has been practically the only method successfully employed.

The newly developed apparatus consists of a rubber aspirator bulb attached to a nickelplated brass tube about 6 in. long. A few squeezes of the bulb draws a sample of the air being tested through the brass tube, which contains activated charcoal to remove gases likely to interfere with the test for carbon monoxide, and forces it out through a small glass tube containing a mixture of fuming sulphuric and iodine pentoxide. If carbon monoxide is present, this white solid turns varying shades of green, increasing in depth as the amount of carbon monoxide increases. By comparison with a permanent scale attached to the apparatus the amount of gas present is readily determined. The whole determination requires but a few seconds and after a few minutes the color disappears from the glass tube and the test can be repeated.

More recently an improved device has been constructed. A piston and cylinder with positively operated valve replaces the aspirator bulb. This insures a definite volume of gas for each test and a shorter time for the taking of a sample. The material acted on by the carbon monoxide, which is prepared from iodine pentoxide, fuming sulphuric acid and granular pumice stone, has been rendered more sensitive so that quantities of gas as small as 0.03 per cent can be definitely shown and fairly accurate analyses of amounts up to 2 per cent quickly made. The detector is designed for use in coal and metal mines, industrial plants using or producing gases containing carbon monoxide, garages, telephones or telegraph conduit tunnels, holds and stoke rooms of ships, boiler rooms, etc. In most of these the simple form of detector has already been successfully used. In comparing the results of this detector with chemical analyses, the following results were obtained:

Bulb Method	Piston Method	Laboratory Analysis
0.5	0.6	0.583
.5	.4	.431
.3	.2	.161
.2	.125	.127

MICROSCOPE ILLUMINATION WITH REFERENCE TO BROWNIAN MOVEMENT AND COMBINATION LIGHTING

A. Silverman showed some experiments with the microscope illumination with reference to Brownian movement and combination lighting, the first part of this paper dealing with the Brownian movement. The slide with a hollow-ground depression in which the colloidal solution was placed had dipped into it the lens of the microscope, which in turn was surrounded on the edge of the depression by a circular lamp. On examination it was found that the particles displayed Brownian movement much more distinct than ever before observed.

The second part of the paper dealt with combination lighting to show in proper detail a fossil insect imbedded in amber. In the contrast illumination of this with white background beneath the slide the fossil appeared only as a dark outline with no detail. Placing a black background below the slide some detail was shown, but it mainly appeared as a white outline on the black. The third slide, showing light background with reflected light thrown on the top of the fossil, gave an exceedingly fine illumination of perfect detail brought out by the illumination.

RELATION OF STRUCTURE TO FREE ALKALI IN SODIUM SILICATE SOLUTIONS

William Stericker, of the Mellon Institute, in discussing the relation of structure to free alkali in sodium silicate solutions, stated that the literature was full of contradictions on this subject, and that the textbooks were erroneous. The alkali silica ratio in sodium silicate solution varies from 1:1 to 1:4. It has not been conclusively proved that sodium silicate solutions are independent of the free alkali content. Concentrated solutions are non-hydrolized. When a layer of water was placed on a layer of silicate, fine hair lines were seen to wriggle up through the water, showing there was some substance present which went quickly into solution in the water, and if left to lie long enough, an intermediate layer was formed between the water and the silicate solution. In studying a solution of silicate the sodium hydroxide exists in higher concentration at the interphase than elsewhere. Basic dyes were adsorbed on the surface of the particles, while acid dyes were not adsorbed by colloidal particles. When a basic dyestuff is used as an indicator, it gives the concentration at the interphase. In testing with hydrogen ion concentration apparatus it was found that the alkali is not hydrolized even in dilute solution. It was further found in testing by this method that the concentration of the dilute portions away from the colloidal particles was really determined in the two-phase system.

Colloidal particles may contain electric current, and this current may account for the discrepancy discovered. Heating of the solution affects the degree of hydrolysis.

It is then difficult to determine the amount of free alkali in sodium silicate solution. No general method can be devised. Attention is called to these facts so that any attempt to determine free alkali must be made under the same concentration as that under which the material is to be employed in industrial use—that is, dilute or concentrated—and the temperature of the solution must be kept the same as that in the condition under

which it is going to be used. The Mellon Institute is continuing on this research.

COMPRESSION EVAPORIZATION

Gustav Carlsson gave an illustrated talk on the new method of concentrating liquids developed in Europe recently. This compression evaporation is effected by heating the liquid in containers to boiling point and compressing the evolved vapors, thus raising the temperature.

For complete description of this process see Mr. Carlsson's article in *CHEMICAL & METALLURGICAL ENGINEERING*, vol. 24, page 645, April 13, 1921.

ACTION OF LIME ON GREENSAND

R. Norris Shreve, in discussing the action of lime on greensand, delivered the most complete engineering paper of the session. Greensand or glauconite, found in large deposits along the coast of New Jersey, is treated with lime for the recovery of potash salts. Analyses of this greensand show 3.4 per cent potash, 0.4 per cent soda and 49.8 per cent silica. The Eastern Potash Corporation is building a plant at New Brunswick, N. J., for the recovery of potash and the manufacture of brick from the residue. This plant will treat 1,000 tons of sand per day with about 900 tons of lime to produce 65 tons of potash or an equivalent amount of other potash salts. Ten rotary kilns will be installed with a capacity of 1,800 tons of lime per day and will be equipped with revolving coolers. The lime is added to the greensand in digesters in the presence of water at high temperature and pressure. Caustic soda will be obtained as a byproduct. The liquors from the digestors are run into four large quadruple-effect evaporators for treating the weak caustic solution. These evaporators are 18 ft. in diameter and 55 ft. high. Investigation has been made as to the various methods of handling this greensand and the result of grinding has shown that the best digestion is obtained where 90 per cent passes 200 mesh.

Digestion of the greensand is best carried on under high temperatures. The effect of ratio of water used shows that digestion increases with the amount of water, but it does not pay to handle the water beyond the ratio of one part of lime, one part of greensand to five parts of water. The effect of substituting caustic potash solutions in the ratio of one to one to five of greensand, lime and liquid, shows that the action is retarded somewhat, but nevertheless it is economical to re-use the wash liquors. Five thousand tons of water is handled in the plant daily. The plant is so arranged that the weak liquors treat the fresh greensand and lime and the water from the filter presses is re-used.

Testing variations in the lime ratio at different digestion periods, all tests being made at a high temperature of 470 to 483 deg. F., proved that the ratio can be brought down to 0.85 part of CaO without interfering with the reaction. Investigation was further made with accelerating solutions of various salts such as calcium chloride, sodium nitrate and potassium nitrate.

The plant has a capacity of about 20,000 tons of potash per year, and as the market is somewhat limited other potassium compounds will be produced, particularly potassium nitrate and potassium sulphate. If either one of these latter salts is added to the primary charge, it acts as a catalyzer, or accelerator, and increases the potash yield from 61 to 81 per cent.

It is concluded that for best recovery it is necessary

to grind the glauconite to pass 200 mesh, to maintain the digestion temperature at about 470 deg. F. for one hour, and to use a ratio of greensand, lime and water of 1 to 0.9 to 5. Sodium nitrate was found to be the best accelerator. The product as it comes from the plant is an exceedingly pure one, being equal to the c.p. product of commerce.

WATER RESISTANCE OF TREATED CANVAS DURING CONTINUOUS EXPOSURE TO WEATHER

F. T. Veitch, in discussing the water resistance of treated canvas during continuous exposure to weather, showed that three formulæ gave 100 per cent results. These formulæ involve the use of petroleum, wool grease, beeswax, lead oleate and asphalt. All these increase the resistance of canvas to water as well as to wear in a marked degree.

BUSINESS MEETING

Because of the mass of papers of indifferent value that are being presented before the Industrial and Engineering Chemistry Division it was moved by A. Silverman that the division appoint a committee to pass on all papers before they are accepted for delivery before the division. The chair is to appoint this committee, which will require that the papers be submitted at least two weeks in advance of the meeting. This committee shall have the right to reject any or all papers, and to "bluepencil" such sections of the paper as are deemed of no immediate interest; furthermore, the chair is to have the power to limit the discussion on papers so that in cases where only a few of the members are interested the discussion can be carried on outside of the meeting. The chair shall also have the power to decide whether the papers be read in abstract or in full. The motion was carried.

This action will eliminate the long historical and bibliographical papers that have tired out the members of the division until they left the meetings and missed the points of real scientific and engineering interest.

Dye Division

The meeting was well attended, and the discussion sincere and lively. Most of the papers were of interest only to the dye chemist, although a wider interest attached to some of them. Generally speaking, but with notable exceptions, they lacked that informative value for the development of which the division was established. American manufacturers have not yet got to the point where they dare let very much be said.

The first paper was "A Contribution to the Estimation of H Acid," by Henry R. Lee.

A NEW PROCESS FOR ALIZARINE

The next was "A New Process for Alizarine," by Charles W. Schaffer. This was a preliminary report of laboratory development of a process for producing alizarine with benzene as the raw material. The general interest consists in the fact that it is one of several processes that seem to be coming along to produce alizarine from some material other than anthracene. When anthracene is removed from coal tar according to current practice, the pitch is made unavailable for roofing and road making. Now these uses for pitch are fundamental to the coal-tar industry in the United States, while alizarine is, in effect, the key to the vat dye industry. It is, therefore, of leading importance that a source of alizarine outside of anthracene

be discovered. With abundant alizarine we should not worry about vat dyes in large quantities.

BLEACHING DYED COTTON FABRICS

Dr. J. Merritt Matthews of New York presented a paper on "Bleaching Dyed Cotton Fabrics." This of itself was technical, but the discussion brought out some interesting points. It was generally agreed, as Dr. Matthews said, that the dye industry has been one-sided in its development in this country, with major attention to the making of intermediates and dyes, but inadequate attention to their application. Dr. Derrick of Buffalo confirmed this point, and expressed the wish that the color laboratory at Washington would take up some of the fundamental problems. We are far from adequately informed of the science of dyeing, and we do not know what the actual processes are that take place when a dye attaches itself to a fiber. An immense amount of research in the abstract problem and in the physical chemistry of dyeing is urgently needed, and yet single manufacturers cannot well undertake it. (Our own impression is that unfortunately they do not undertake it.) There are many old dyes that are made in abundance that could be made far more fast and stable and even—in short that could be made far better than they are—by fundamental study, by the exercise of reasonable invention, and by greater care in the dyeing. With this Dr. Matthews was in hearty agreement, and said that the fast colors of antiquity were not due to better dyes, but that the ancient methods of dyeing were more careful, more laborious, and better than ours. Advances have been made in economy at the expense of quality in the art. At this point a gentleman familiar with the textile industry observed that the methods of the dye-houses in mills are deteriorating rather than improving for two specific reasons: The price of coal is such that every process is shortened to the minimum in order to save coal, and the requirements of organized labor are such that the time of men engaged in the work is also made as short as possible.

INDUSTRIAL NEEDS OF CHEMISTRY IN AMERICA

Dr. William J. Hale spoke on "The Industrial Needs of Chemistry in America," and these immediate needs are real chemists. It would have been a godsend to industry if some smart Aleck manufacturers who "have no use for physical chemistry" and who have been scrapping organized research laboratories on the ground that fundamental research is "deadwood" had heard and digested this paper. In some cases, however, it would require a crowbar to aid their mental digestion. Dr. Hale commented with favor on Dr. Derrick's suggestion of co-operation with the color laboratory and other available facilities for fundamental research, and at the Thursday morning session the subject was taken up again.

The chairman, Dr. Davis, recognized that a competent committee to co-operate with the Government laboratories would probably contain men engaged with manufacturing concerns and that it might involve suspicion or misunderstanding of their purposes, despite the best intentions.

Dr. Derrick wasn't worried about that. He said we are inviting ourselves to confer with the Washington authorities, and that the very purposes that the division had in mind were of interest to all manufacturers and users of dyes.

Dr. Alsberg, chief of the Bureau of Chemistry, said that color laboratories were established to render public service, and that the makers and users of colors were its particular public. This public did not have to invite itself; it was already invited.

In regard to the character of research it is almost impossible to get appropriations for that of a fundamental character without giving the specific results that are expected to ensue from it. To impress the mind of Congress any work must be presented to it in terms of money value. It must be translated into dollars. This is always difficult, and sometimes impossible, and yet we can hardly blame Congress for it. It is our business to inform the public of the need of these things, and then Congress will learn from the public. Most of the money appropriated for the Bureau of Chemistry goes to the enforcement of the pure food and drugs act. In order to demonstrate the need of work in pure science for the benefit of legislators Dr. Alsberg had tried to segregate the work in pure science that is being done in order to solve very practical and definite questions, but he found it impossible to make the separation that he desired. The bureau has no appropriation for any theoretical work of which the immediate practical value is not self-evident. He believes that fundamental research is especially the province of the Government laboratories and those of universities and research foundations, while that in applied science is more particularly the province of industries—always, of course, within reason. Another point is that many problems call for years of work; they cannot be solved in an hour; and only the Government is rich enough or long-lived enough to carry them through. We know how pressing is the need of such fundamental knowledge, but the public does not. As soon as we can tell the public of it so that it can understand, then Congress will also understand, and will act. Some industries such as farming, and certain branches dealing in food products, must be helped in a practical way, but in an industry which calls for such meticulous chemical control as that of dyes the information needed is the nature and behavior of reactions, vapor pressure, eutectic points, and fundamental studies within the domain of physical chemistry. Dr. Alsberg said that he, and he believed his successor, whoever this may be, would be glad to give the members of such a committee an official, advisory status, and he believed the Secretary of Agriculture would take the same attitude.

IMPORTANCE OF THE DYE INDUSTRY

Dr. Derrick again referred to the lopsided nature of the industry of which Dr. Matthews spoke because the underlying principles of the uses of dyes are not known. The Germans are working along this line and we are not. There are a great number of scientific problems, fundamental problems that are not understood either here or in Germany or anywhere else. To solve them requires so many different kinds of scholarship that no industrial organization can afford to make the necessary appropriations. And yet the men of just such varieties of scholarship are available in Washington. He was delighted at the broad-minded way in which Dr. Alsberg had presented the attitude of the Bureau of Chemistry. Here is a way to get many of the problems solved. The people interested are the whole public rather than individual manufacturers. Dyes are merely raw materials; the thing desired is good textiles, etc., at once cheap, and dyed, not only

properly, or even in the best way known; they should be dyed in the best way possible, which is an entirely different thing.

COMMITTEE APPOINTED TO SECURE CO-OPERATION WITH THE GOVERNMENT

A great deal of enthusiastic discussion followed for which we have not space, but the general agreement was the need of fundamental research. A motion was passed to create a committee of three, of which Dr. Derrick should be one, to confer with the Bureau of Chemistry at Washington and other available establishments, with the view to planning for co-operation, under all necessary formalities, and under the approval of the governing body of the American Chemical Society. It seems probable that this committee will have the opportunity to succeed in this important work.

Dr. C. R. de Long of the Tariff Commission sent a record of the dyes imported in 1920, which we print elsewhere.

Cellulose Section

This was the first meeting of the section and the crowded attendance, together with the high standard of the papers presented, indicated a widespread interest in the subject. The topic which attracted greatest attention was that of the symposium relating to "Our Future Supply of Liquid Fuel," and the ensuing discussion indicated a lively appreciation of the gravity of the subject. The communication by T. A. Boyd of the General Motors Co. showed that the number of automobiles and trucks in use in the United States has increased from about 1,000,000 in 1912 to about 9,000,000 in 1920, or an average increase of over 1,000,000 a year. Crude oil, the principal source of motor fuel for motor vehicles, has shown an increase in domestic production from around 220,000,000 to 440,000,000 bbl. per year, so that while the number of motor vehicles in use has multiplied about ninefold, the output of domestic crude oil products has only doubled.

The production of crude oil has increased since 1909 about 140 per cent, that of gasoline about 800 per cent, but the number of automobiles registered has risen 2,570 per cent. The consequent enormous demand for gasoline has been met, partly by increasing the boiling point range, partly by extracting liquid hydrocarbons and partly by cracking. According to the U. S. Geological Survey the unmined supply of petroleum is roughly 6,000,000,000 bbl., which, if the present rate of production is maintained, will be exhausted in about thirteen years. From these figures it is apparent that some other source of liquid fuel must be found, and cellulose in the form of plant life appears to offer interesting possibilities.

POSSIBILITIES OF THE TROPICS TO FURNISH MATERIALS FOR CELLULOSE AND CARBOHYDRATES

It was shown by H. N. Whitford, professor of tropical forestry, Yale University, that a possible solution is to be found in the utilization of the solar heat of the tropics for the growth of cellulose materials such as cassava, nipa palm and especially bamboo. Thus an area in the Philippines of about 63,000 square miles, if planted with selected species of bamboo, might be expected to yield cellulose material from which an amount of alcohol equivalent to the present annual consumption of gasoline could be obtained. Other interesting data relative to cassava and the nipa palm were

given, as for instance that the present annual product of "nipa alcohol" from quite a small area in the Philippines amounts to 3,000,000 gal.

POSSIBILITIES OF A FUTURE FUEL SUPPLY FROM OUR FORESTS

R. C. Hawley, also of Yale University, pointed out that the forest resources of the United States are capable of supplying waste wood annually to the amount of 11,000,000,000 cu.ft., equivalent to 2,475,000,000 gal. of a colloidal fuel to be obtained by peptization of a entirely neglected.

In view of the important results recently obtained by F. B. LaForge of the Bureau of Chemistry on the production of furfuraldehyde from corn cobs, it was of interest to learn that if the total waste cellulose material represented by the corn stalks and cobs could be utilized for the production of furfuraldehyde, it would yield approximately 3,900,000,000 gal., or sufficient to replace our present supply of gasoline. The material has been tried out as a motor fuel and has the great disadvantage of causing pre-ignition in the motor, but it is confidently believed that this could be overcome.

In the subsequent discussion of the papers and of the part to be played by the chemist attention was drawn to the possibility of two solutions of the fuel problem: (a) the joint production of furfuraldehyde and alcohol from some suitable available raw material, and (b) the use of a colloidal fuel to be obtained by peptization of a material such as cellobiose by means of alcohol, the former to be obtained by the bacterial decomposition of wood. In view of the necessity which would arise, in attempting to use such a colloidal fuel, of altering the entire design of the engine to the Diesel type, earnest consideration should be given to the cheapest sources of supply of alcohol and furfuraldehyde. In the first place it is not practicable to use domestic cereals, as this would interfere too seriously with the nation's food supply, but the utilization of cornstalks and cobs, waste wood and, further, of the growth in the tropics of something in the nature of a cross between a cereal and a tree species in order to obtain (as stated by one member) "a kind of bamboo filled with starch" is what is required as a source of raw material. The problem is a fascinating one for the cellulose chemist and offers abundant opportunity for research work and the exercise of the imagination.

EFFECT OF ADDING VARIOUS CHEMICALS TO WOOD, PREVIOUS TO DISTILLATION

The paper of L. F. Hawley on the effect of adding various chemicals to wood, previous to distillation, showed that an increase in the yield of products could be obtained by subjecting the wood to a previous treatment with 0.5 per cent of sodium carbonate. Curiously enough, the sodium remains combined as carbonate at the end of the operation.

In the discussions relating to the manufacture and commercial application of nitrocellulose it developed that there is no recognized standard method for determining the viscosity of such solutions and a committee is to be appointed of those interested, with G. E. Esselen as chairman and E. Bingham as consultant, to work out the details of a standardized, acceptable procedure.

The value of the work being carried out at the Forest Products Laboratory on cellulose materials has been recently recognized, on the one hand by the increased

Government grant of \$100,000 and on the other by the contribution of the American Paper and Pulp Association. It is considered highly desirable that the chemists should have time available for the compilation of monographs and special theoretical papers and the following resolution was adopted by the section and ordered forwarded to the director of the Forest Products Laboratory:

"The Cellulose Section of the American Chemical Society, in session at Rochester, N. Y., congratulates the director on the increased Government grant and looks forward to increased activity in the matter of the acquisition and publication of fundamental scientific data and monographs."

The chemical changes involved during the infection and decay of wood pulp, by Bray and Staidl, also of the Forest Products Laboratory, brought out the immense financial loss caused by this factor and threw light on the nature of the changes occurring. It is this phase of the subject which is being financed by the A.P.P.A.

THE MICROSTRUCTURE OF WOOD

One of the interesting contributions was that by Allen Abrams on "The Microstructure of Wood," this work having been financed by the Meade Paper and Pulp interests and carried out at Massachusetts Institute of Technology. It represents a new technique by means of which chemical changes in the cell structure taking place under the influence of chemical and other reagents can be readily followed from a study of microscopic sections stained or otherwise treated.

EUROPEAN PRACTICE IN CELLULOSE ACETATE AND DOPES DURING THE WAR

It was brought out in the communication on "European Practice in Cellulose Acetate and Dopes During the War," by Philip Drinker, that there exists a mass of valuable information accumulated by E. C. Worden and himself during 1914-19 in a special Government report which they presented on the subject. A resolution was passed unanimously by the section urging the Government to publish such information in the report as is not regarded as confidential, since it is considered that this would be of great value to the industry.

ACTION OF HYDROBROMIC ACID ON CELLULOSE AND RELATED DERIVATIVES

In the paper dealing with "The Action of Hydrobromic Acid on Cellulose and Related Derivatives," by Harold Hibbert and Harold S. Hill, higher yields of bromomethyl furfuraldehyde were recorded than obtained by Fenton. The fact that dextrose gives a yield of 10 to 15 per cent of the same crystalline derivative destroys the value of this reaction as an argument for the ketonic structure of cellulose.

A PROPOSAL FOR A STANDARD CELLULOSE TO BE AVAILABLE FOR RESEARCH

A paper by B. Johnsen, of the Hammermill Paper Co., on "A Proposal for a Standard Cellulose to Be Available for Research" gave rise to an animated discussion. The author suggests the advisability of having the section arrange for the manufacture of a considerable amount of an especially pure cellulose to be available for the cellulose chemist and by the general use of which for research purposes strictly comparable results would be obtained. It was stated that the Atlas Powder Co. had expressed its willingness to manufacture the material.

A committee was appointed, consisting of B. Johnsen, a representative of the Atlas Powder Co. and the chairman of the Section (with power to add to their number), to draft a tentative scheme of purification, the chairman agreeing to bring this to the attention of interested parties for their criticism and comment and to have the matter referred to the Section for final action at the September meeting in New York.

Rubber Division

When one considers the great depression which has existed in the rubber industry for the past six months the Rubber Division was very fortunate in having any spring meeting at all. Only two papers were presented from manufacturers' laboratories. All the others came from the universities, the Bureau of Standards or makers of materials. However, the sessions were well attended by about fifty interested men and women. Evidence of constructive thinking and fair mindedness was manifested in the discussion which followed each paper.

TENTATIVE PROCEDURE FOR THE ANALYSIS OF RUBBER GOODS

Tentative methods of analysis, compiled by W. W. Evans from the methods of the joint rubber insulation committee, the Bureau of Standards and the underwriters' laboratories, had been mailed to all members of the Division previous to the meeting. The discussion took the form of outlining various profitable changes in the methods as presented. These changes were referred to the analytical committee, which is composed of the following men: Messrs. Collier (Bureau of Standards), Dugan (Goodyear), Wiegand (Ames Holden MacCready), Simmons (Akron University) and Evans (Goodrich). Very briefly the methods adopted are as follows:

Acetone Extract—Use underwriters' apparatus and method except dry to constant weight at 70 deg. C.

Unsaponifiable Material in Acetone Extract—The committee is to determine once and for all whether alcoholic soda or potash is preferable. Otherwise the method is similar to that of the joint rubber insulation committee. Calbeck proposed treating the alcoholic soda solution with a small amount of silver nitrate to decompose any aldehydes. His solution keeps longer without discoloring. In all such determinations running a blank is strongly recommended.

Free Sulphur—Name changed to "Soluble sulphur." Regular bromine oxidation method recommended.

Chloroform Extract—Usual procedure.

Alcoholic Potash Extract—Usual procedure, but comments under "Saponifiable matter" apply here.

Total Sulphur—Bureau of Standards method. Caution: use only the bromine saturated nitric acid solution and allow no free bromine to come in contact with the sample.

Ash, Sulphur in Ash, Barytes—As per underwriters' practice.

THERMAL CONDUCTIVITY OF SOME RUBBER COMPOUNDS

A paper on "Thermal Conductivity of Some Rubber Compounds" was read by A. A. Somerville. A series of thin sheets of rubber with thermocouple junctions between were placed on a steam chest kept at 100 deg. C. On top of this pile a vessel containing melting ice maintained a temperature of 0 deg. C. By comparing the time necessary for the center thermocouple to reach

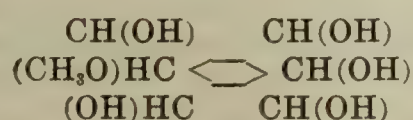
maximum temperature for various stocks a measure of their relative heat conductivity was obtained. The conductivities of stocks containing 3 and 10 per cent sulphur on the rubber and 10 per cent sulphur with 2 per cent accelerator were found the same. This value was taken as unity. The following table contains the values obtained with 10 per cent sulphur, 2 per cent accelerator and 150 per cent zinc oxide or its equivalent volume of other filler based on 100 parts of rubber:

Base stock	1.00
Zinc oxide (150 per cent)	1.65
Glue	.87
Asbestine	.91
Lampblack	1.02
Gas black	1.14
Crimson antimony	1.15
Whiting	1.23
Lithopone	1.33
Magnesium carbonate	1.45
Soapstone	1.45
Clay	1.67
Litharge	1.78
Red oxide	1.86
Fossil flour	1.90
Barytes (ground)	2.28
Barytes (precipitated barium dust)	2.65
Frictioned fabric	1.07

The state of cure of the various stocks was found to have no effect on the conductivity.

CONTRIBUTION TO THE KNOWLEDGE OF THE RESINS OF HEVEA RUBBER

G. Stafford Whitby and J. Dolid presented a paper entitled "Contribution to the Knowledge of the Resins of Hevea Rubber." By the use of glacial acetic acid certain crystalloids have been isolated from the acetone soluble portion of hevea rubber. Constituent A gives an acetate soluble in chloroform melting at 80 deg. C. The insoluble portion melts at 169 deg. C. Constituent B melts at 62 deg. C. and C melts at 128 deg. C. Its formula is $C_{27}H_{44}O$. Dr. Whitby has definitely established the presence of a rare sugar, quebracheetol, which is related to inosite, and has the following structural formula:



SOLUBILITY OF GASES IN RUBBER AS AFFECTING THEIR PERMEABILITY

"The Solubility of Gases in Rubber as Affecting Their Permeability" was treated in a paper by C. S. Venable and Tyler Fuwa. Many years ago Graham proposed that the permeability of a gas through a membrane depended on, (a) the concentration and (b) the rate of motion of the molecules. In other words, that $P = K \times C \times D$, K being a constant. Transposed to our present terminology this means that the permeability P equals the pressure p times the square root of the molecular weight divided by the solubility S .

N_2 , CO , O_2 and CO_2 give fairly good constants. But hydrogen, methane and ammonia are badly out of line. This has led the authors to propose that an additional factor depending on the size of the molecules of the respective gases should be incorporated in Graham's formula.

Summarizing: 1. Rubber holds gas by true solution.

2. The solubility is directly proportional to the pressure.

3. Solubility decreases with increase in temperature.

4. The solubility is independent of the degree of vulcanization.

5. There is a relation between solubility and permeability, of which size of the molecules is probably a factor.

ANALYSIS OF RUBBER GOODS CONTAINING ANTIMONY SULPHIDE

S. Collier and M. Levin described a method of analysis of rubber goods containing antimony sulphide. The method involves separation of fillers by means of cymene, and solution in acid. Antimony is separated by means of H_2S and determined in the regular way.

THE DIRECT DETERMINATION OF SULPHUR OF VULCANIZATION

S. Collier and M. Levin presented a paper on "The Direct Determination of Sulphur of Vulcanization." Sample is acetone extracted, then dissolved in cymene. Fillers are removed by centrifuging and filtration. The soluble portion is evaporated to dryness and sulphur is determined in the usual way with nitric acid and bromine.

It is somewhat doubtful if this method gives in all cases the true sulphur of vulcanization. The sulphur combined with MR and substitutes apparently would be included. The method doubtless has applications in pure gum stocks or cases where the composition is known.

VOLUME INCREASE OF COMPOUNDED RUBBER UNDER STRAIN

At the Philadelphia meeting a year and a half ago H. F. Schippel pointed out that compounded rubber increases in volume when strained. He demonstrated this fact by indirect methods. Henry Green has been able to observe and photograph, by means of the microscope, the actual changes which take place. Working with rather coarse barytes, he obtained cavities at either end of the barytes crystals. He noted that some particles developed cavities when the piece containing them was stretched, but some did not. In seeking an explanation of this he advanced the theory that many of the particles were surrounded with an adsorbed film of air. In such cases the rubber did not adhere to the crystal. In other cases when this film was absent there was adhesion between the rubber and crystals and no cavities were obtained.

Speaking of zinc oxide Mr. Green stated that in a stock containing 100 volumes of zinc oxide to 100 volumes of rubber no agglomerates were discernible under the microscope.

INFLUENCE OF PIPERIDINE-PIPERIDYL-DITHIOCARBAMATE ON VULCANIZATION

G. Stafford Whitby and O. J. Walker described experiments on the influence of piperidine-piperidyl-dithiocarbamate on vulcanization. The experiments were performed in the absence of zinc oxide. In a high sulphur stock (10 per cent sulphur on the rubber) piperidine-piperidyl-dithiocarbamate becomes a mild accelerator with excellent aging properties. With zinc oxide it is very powerful.

A RAPID BOMB METHOD FOR DETERMINING SULPHUR IN RUBBER COMPOUNDS

Experiments using a bomb made by the Standard Calorimeter Co. of Moline, Ill. (the manufacturer of the

REPORTS OF COMMITTEES

Abstracts—Arrangements have been made with the trade papers to carry any articles the division wishes published.

Accelerators—About fifteen accelerators are now on the books of the secretary and the members of the Rubber Division can secure the composition of these by writing him.

Physical Testing—The old committee was discharged and the following men appointed on a new committee: Messrs. North (Goodyear), Wiegand (Ames Holden MacCready), Collier (Bureau of Standards), Grafton (Quaker City) and Simmons (Akron University).

Division of Physical and Inorganic Chemistry

The schedule of this division was too ambitious, having almost three times as many papers as the average group at the meeting and dividing the time for presentation and assimilation into insufficient periods. At least forty of the sixty-five papers should have been read only by title, giving the important contributions time for detailed consideration.

The fifteen papers in the Symposium on Contact Catalysis in themselves brought out nothing extraordinary in the way of ideas and were exceeded in value by the discussions of Messrs. Langmuir, Taylor, Forbes, Fink, Weiss and Bancroft. Dr. Langmuir introduced the idea that the boundary between the two phases of the catalyst probably located the zone where the reaction takes place. In the equilibrium between the metallic and oxide phases of copper or nickel ideal conditions from the point of view of the oscillation theory are to be had for catalysis. Without this boundary phase, no appreciable reaction takes place, so that this conception promises at least to augment if not entirely supersede the long-honored adsorption theory. However, the experimental work of the investigator is made even more difficult by this conception, especially if he attempts to make quantitative measurements on anything other than the velocity of his catalyzed reaction. A survey of phase boundaries doesn't seem to be even a remote possibility and even if it were, there is no reason to believe that the activity would be equally distributed over the more or less accessible areas between the two phases. The removal of water of crystallization from salts in a desiccator is not usually thought of as a catalytical phenomenon, but it has been proved to be such, the presence of both the hydrous and anhydrous phases being essential before the water goes off under normal conditions. Superheat or a scratch will induce the latter phase. The same phenomenon takes place in the calcination of limestone. Copper oxide is not reduced by hydrogen until metallic copper is formed and the reaction takes place at the location of the contact between the metal and oxide.

HIGH-TEMPERATURE NICKEL INACTIVE

When nickel catalyst is heated above 600 deg. C. it gradually falls off in hydrogen adsorption, becoming inactive at 1,000 deg. C. R. M. Burns and H. S. Taylor presented curves showing measurements made at Princeton. In studying copper it was found that the hydrogen adsorption was very low. A physical study of all the hydrogen catalyzers is being made in their laboratory and detailed attention is being given to the phase systems and catalyst surfaces.

In the discussion Irving Langmuir pointed out that

the electron may be an important factor, present theory of valence and chemical combination indicating that molecules are held together by electronic forces. John Morris Weiss drew attention to the lack of knowledge of what temperatures exist at the surface of the catalysts and suggestions were made that they be calculated from reaction heats or measured by fine platinum resistance wire. It is rather doubtful if any useful result can be obtained by such methods.

INFLUENCE OF AGITATION ON REACTION VELOCITY

R.p.m.'s as a catalyst formed an interesting contribution by C. H. Milligan and E. Emmet Reid. Whether every influence that increases the velocity of a reaction is to be taken as catalytical phenomenon is a disputed question. Most chemists prefer to class mass, temperature, concentration and agitation in a category by themselves. The authors observed that with agitation at 1,000 r.p.m. benzene absorbed 80 c.c. of ethylene per minute, forming ethyl benzene and at 13,000 r.p.m., 1,790 c.c., the same conditions of saturation being taken for comparison. Final saturation produced hexa-ethylbenzene.

CATALYTIC COMBINATION OF HYDROGEN AND OXYGEN

R. N. Pease and H. S. Taylor reported their study of the influence of reduced copper oxide catalyst on the reaction of hydrogen and oxygen mixtures below combustion temperatures. The stability of copper oxide in hydrogen at 150 deg. C. was found to be very great, no reduced copper appearing until after four days, when a small spot appeared. The presence of 2 per cent water or oxygen prevents the formation of any reduced copper. In the catalytical reaction between the hydrogen and oxygen, the boundary phase between the oxide and metal is accepted as the location of the catalytical effect, giving a fluctuating equilibrium.

In the production of hydrogen from water-gas considerable trouble is had in obtaining a product free from carbon monoxide. N. A. Neville and H. S. Taylor have worked on a reaction using potassium carbonate as a catalyst, whereby carbon dioxide is obtained at temperatures around 500 deg. C. An explanation of the phenomenon cannot be had by simply assuming that the salt absorbs carbon dioxide and thus induces its formation. Perhaps its effect on the carbon itself in maintaining temperature and surface uniformity induces the reduction of the gaseous water by the carbon monoxide.

OXIDATION AND REDUCTION IN COPPER CELLS

In refining copper in electrolytic cells a large part of the current is ordinarily spent in oxidation at the graphite anode and reduction at the cathode, if iron sulphate is present in the electrolyte. Colin G. Fink reports that if ferrosilicon anodes are used, the phenomenon ceases, indicating that there is some inherent property in graphite, perhaps oxy-graphite, that catalyzes the oxidation phenomenon and prevents oxygen being given off at the anode.

LOW-TEMPERATURE BRIN'S REACTIONS

James Kendall and F. J. Fuche have recently found that mixed oxides of silver, mercury and barium yield their peroxides at very much lower temperatures. Sufficient work has not been done to tell if the effect were partial or complete and if the reaction will be valuable in making a modified Brin's process for the separation of oxygen from air.

STRUCTURE OF THE ICE MOLECULE

Dennison has recently shown by X-ray crystal analysis that ice consists of two water mols with the electrons arranged in a hexagonal packing. A structure was proposed by Irving Langmuir in which the nuclei of the four hydrogen atoms hold by their fields of force the two oxygen cube atoms, the hydrogen electrons filling the shell of the oxygen atom and the nuclei being sandwiched in between.

PURIFICATION OF HELIUM

When helium becomes loaded with air after it has been in use through diffusion of the latter through the balloon fabric, it can be purified by a process recently developed by Leo Finkelstein and C. B. Seibel. The mixture is cooled below the critical temperature of nitrogen and filtered through adsorption carbon, which takes up both the oxygen and nitrogen. The refining plant is mounted on two railroad car trucks and can be moved to the various aviation fields.

INFLUENCE OF GELATIN ON TRANSFERENCE NUMBER OF H_2SO_4

Alfred L. Ferguson reported a correction in the transference number of sulphuric acid, now in the literature as 0.177, the new determination being 0.1868 at 25 deg. C. In studying the influence of gelatin, it was found that the gelatin formed a true salt with the anion and changed the transference due to the low velocity of this complex cation. The concentration cell method was used with the formula:

$$E = \frac{2 - 3n_a}{2} \frac{RT}{F} \ln \frac{c_1}{c_2}$$

THE ALKALINITY OF SEARLES LAKE BRINE

The alkalinity of the brine at Searles Lake is due to the weak acid soda salts: the carbonates, bicarbonates, borates and metaborates. The total CO_2 content averages around 1.84 per cent and the B_2O_3 1.04 per cent. In order to determine the salt composition, the p_H curve of each salt was determined, from which it was possible to calculate the composition from the hydrogen ion concentration of the raw brine.

THE VAPOR DENSITY OF TECHNICAL PHOSGENE

Phosgene constants were reported by F. O. Germann and Vernon Jersey, the boiling point being 8 deg. C., vapor pressure at zero 552 mm. and the vapor density 4.5263 g. per liter. It was observed that the rate of hydrolysis was proportional to the wet surface area. When the phosgene was passed over wet glass beads, the hydrolysis was instantaneous, while if water was poured into the liquid phosgene, the reaction proceeded only at the interfilm.

CHROMATIC EMULSIONS

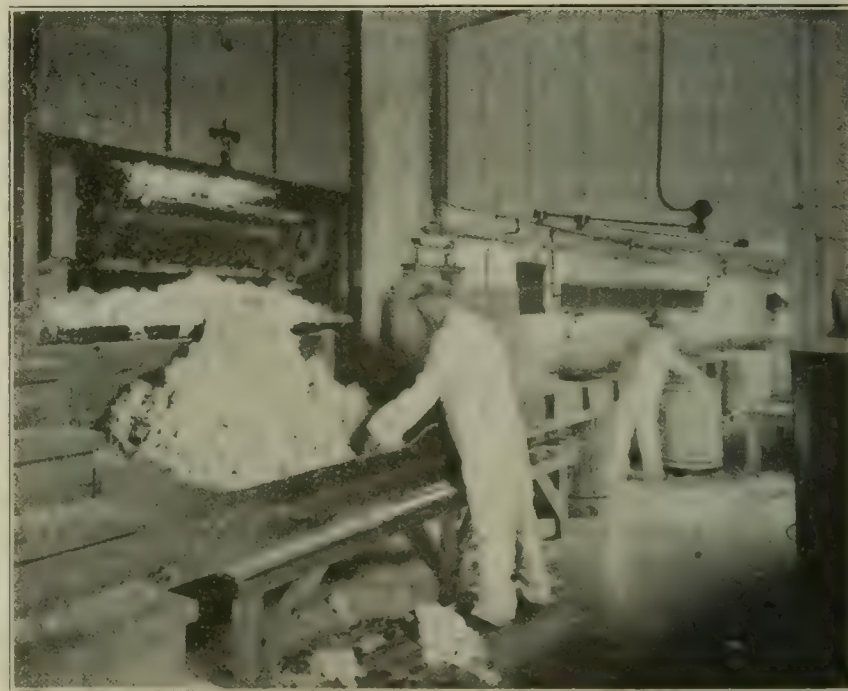
Chairman Harry N. Holmes entertained the division with experiments on the dispersion of light into its color elements by transmission through globules formed by digesting glycerine, water, amylacetate, benzene and pyroxylin into an emulsion. The size of the particles did not appear to be a factor, but the glycerine concentration was important. The pyroxylin stabilized the emulsion, forming a strong film surface around the globules. In daylight the dispersion effect is lost due to the mixing of the rays, but with light from a single source the phenomenon is very beautiful.

Kodak Park Works

Kodak Park, the largest of the five Rochester establishments of the Eastman Kodak Co., is a park of 225 acres situated just within the northerly limits of the city. Eighteen of these acres are laid out in trees, shrubs and lawn. Its principal products are photographic film and papers, dry plates, chemicals and developers. Factories are also maintained for the manufacture of raw paper, gelatine and acids (nitric and sulphuric) for nitrating purposes, also for the manufacture of wood, paper and fiber boxes, cartons, tin containers, film spools and wood parts for cameras. Steel and concrete buildings to the number of 114, representing an additional floor space of over 80 acres, have already been erected for the manufacture of these various products.

FILM CAPACITY

Some conception of the extent of Kodak Park and the various ramifications of the photographic industry it contains may be gathered from the fact that the output in motion picture film alone for last year was over 50,000,000 ft. per month or, roughly, 125,000 miles for



COTTON DRIER

the year. Into the manufacture of this and other film goes nearly 3,000,000 lb. of cotton per year, and into the sensitizing of Eastman products over three tons of pure silver bullion every week, or one-twelfth of all the silver mined in the United States.

POWER AND LIGHT

Power and light are furnished by two turbine and four engine-driven electric generators, with a total capacity of 4,500 kw., or 6,000 hp. Another 2,400 hp. is furnished by the Rochester Railway & Light Co.'s plant; 2,250 motors are required to operate the machinery in the buildings. The power house contains twenty-two boilers with a total (rated) boiler capacity of 7,800 hp.

Above the boilers are the coal bunkers, with a capacity of 3,200 tons. From these the coal drops through chutes to mechanical stokers at the rate of upward of 400 tons per day. Waste gases from the furnaces pass through fuel economizers and ashes are removed by a mechanical conveyor.

Two chimneys, which tower above the power house and dominate the landscape for miles around, have a



NITRATING SILVER

combined capacity equal to 20,000 boiler horse-power. Each is 366 ft. high; one measures 28 ft. at the base and 11 ft. at the top, and the other 31 ft. at the base and 15½ ft. at the top. These chimneys were built high to carry off any possible fumes from nitration.

REFRIGERATION PLANT

As moisture or variation of temperature would be fatal to uniform film quality, the great rooms in which film is sensitized and handled are kept at even temperature by a constant supply of cold air. Refrigeration for this purpose is maintained by six ammonia compression machines of 2,650 tons capacity, and twelve ammonia absorption machines of 1,700 tons capacity, a total of 4,350 tons—sufficient for a city of 200,000 people. A fire department is maintained with 150 trained men under the direction of a chief and two deputy chiefs. They live in close proximity and are available at all hours. The fire equipment includes a White motor truck, chemical engine, three hose carts, hook and ladder truck, salvage and tool wagons, pulmotors, smoke helmets, diving suits and all the minor paraphernalia attaching to such equipment. In addition to this, twenty-seven hose houses are located over hydrants outside various buildings, each equipped with 250 ft. of 2½-in. hose.

WATER SUPPLY

The works have an inexhaustible private water supply system connected directly with Lake Ontario, six miles away. A pumping station on the lake shore, with a capacity of 16,000,000 gal., pumps the water through a 24-in. main to a 5,000,000-gal. reservoir in the park. The pumping station there, with a capacity of 12,000,000 gal.—sufficient to supply a city of 150,000 population—maintains a pressure of approximately 100 lb. throughout the park. A steel tank with a capacity of 150,000 gal., built 150 ft. above the reservoir, and two auxiliary fire pumps with a capacity of 1,000 gal. each, are additional fire precautionary measures. Sixty-eight hydrants and four miles of 6, 8, 10, 12 and 16-in. mains gridiron the works.

WELFARE WORK

The attitude of the company toward its many thousand employees is reflected in the numerous provisions for their comfort and physical well-being. These begin with park surroundings; they include lunch facilities, recreation grounds, medical service, dental service,

reading and rest rooms, and all the other welfare features of a modern industrial plant.

RESEARCH LABORATORY

Picture making has been made the simple pastime it is only because the results of careful investigation into the behavior of photographic products have been transferred with equally scientific exactness to the sensitive materials employed. The right arm of the photographic industry is consequently the laboratory, and the company maintains one of the most completely equipped and best staffed industrial laboratories in the world.

The laboratory building itself is 80 ft. square, three stories in height, and employs a staff of one hundred and twenty. In addition to testing laboratories, X-ray rooms and studios, the building is equipped with an independent plant for the manufacture of photographic material on such a scale that the results can be practically applied in the manufacturing departments. Here also are made the photographic materials required for scientific work, for which, of course, there is little or no commercial demand. There is no attempt to limit laboratory investigation to purely practical ends, and the results obtained are available for publication in the same way as university and government laboratories publish theirs.

PHOTOGRAPHIC LIBRARY

A large photographic library, in charge of a trained librarian, is maintained in connection with the laboratory. Practically every important photographic work in English as well as in foreign languages may be found among the 6,500 volumes on its shelves. A large number of books and magazines on kindred subjects are also included.

FILM MAKING

The first process in film making consists in thoroughly washing cotton with caustic soda to remove vegetable gum and other impurities. This is done in large rotary vats. To eliminate moisture the cleansed cotton is then passed through huge driers. It is then "treated" with a mixture of nitric and sulphuric acid to produce cellulose nitrate. Nitrating centrifugals are used for this process. These machines consist of "perforated baskets" rotating inside a vat. The cleansed cotton is fed into the basket and acids are let into the vat until the cotton is immersed. The acids are then immediately drawn off and the basket is rotated at high speed for draining.



SILVER BULLION (KODAK PARK USES ONE-TWELFTH OF ALL THE BAR SILVER PRODUCED IN THE U. S.)



NITRATING COTTON

To remove every trace of acid, the nitrated cotton is then put into huge washing machines, which are a combination of washing machine and wringer. The construction is similar in principle to the nitrating centrifuga's. The nitrated cotton contained in perforated baskets is immersed in vats of water, and the water drained off after each rinsing. The wringing is done by rotating the baskets at high speed. These washings are repeated for several weeks.

FILM "DOPE"

Washing and drying completed, the nitrated cotton is ready for the solvents. These solvents are run into "mixers" and the cotton is fed into them through chutes. In the mixers—sometimes called dough machines—large paddles churn the cotton and solvent together thoroughly. When thoroughly mixed, the solution is a viscous liquid called "dope."

This "dope" is piped to large air tight tanks, where it is kept ready to be converted into sheets. This is done on what are known as coating machines. An elaborate system of filters spreads the mixture evenly on highly polished wheels, where it forms a sheet 3½ ft. wide, 2,000 ft. long and 0.005 in. thick.

This sheet, when dry, becomes the familiar transparent film backing or base on which the sensitized coating is spread. The accuracy of these machines is



DOPE TANKS

such that the variation in thickness of a sheet from end to end, when coated, is not more than the $\frac{1}{2,000}$ part of an inch.

SILVER NITRATE

Silver is the active element in the light sensitized material with which film is coated. Pure silver bullion is first dissolved in diluted nitric acid to form silver nitrate. When evaporated, this is reduced to white crystals, which are carefully washed and redissolved until all trace of impurities is removed. The pure silver nitrate crystals are then placed in trays, a thousand ounces to a tray, and stored in aluminum drying closets.

The compound sensitive to light, known as silver bromide, is formed by mixing these nitrate crystals with potassium bromide and gelatine, dissolved in hot water. This gelatine solution, known as the "emulsion," is spread on the film in emulsion coating machines. This coating is, of course, a dark-room operation, as is the mixing of the "emulsion" itself.

From the slitting machines the film goes to the spooling room, where it is wound on cartridges. Motion picture film is reeled in 200 and 400 ft. lengths, and when so spooled and packed is ready for shipment.

Excursions were made to other plants, including the Taylor Instrument Cos., Pfaudler Co., Bausch & Lomb Optical Co., Rochester Gas & Electric Corporation, Bastian Bros., Vacuum Oil, Bartholomay Co. and the municipal disposal plants.

Exhibits at Mechanics Institute

One of the pleasing sidelights of the meeting was the number of exhibits of local manufacturers shown in the hallways at Mechanics Institute, where the convention divisional meetings were held. The R. J. Strasenburgh Co. showed a case of standardized pharmaceuticals. The Pfaudler Co. exhibited special pieces of glass-lined apparatus including condenser, enameled steel agitator, enameled kettles, reducing ell and observation glass for viewing the interior of a tank containing liquid.

Grahame Chemical Co., of Rochester and Liverpool, England, showed a complete set of apparatus for hydrogen ion determination together with a series of indicators to be used. The Taylor Instrument Co. of Rochester had a large glass showcase in which were displayed the Tycos line, including thermometers, hydrometers, recording instruments, compasses and the cyclo-stormograph.

By far the largest exhibit was a very complete layout of scientific apparatus handled by the Will Corporation, with headquarters in Rochester. This included the complete line of the products of the Torsion Balance Co., in charge of A. T. Millroy; a glass-blowing exhibit in charge of Frederick Kraissl, of the Corning Glass Works. Numerous pieces of pyrex glass were formed by the blowers. Christian Becker, Inc., had a section displaying balances and weights of precision. W. B. Valentine was in charge of the section for the Valentine-Abbe Refractometer which was on exhibit.

Other displays by local concerns of varying interest to the chemists were a case of organic chemicals manufactured by the Eastman Kodak Co., optical measuring instruments produced by the Bausch & Lomb Optical Co., samples of Filtros by the General Filtration Co., forgings and castings by the General Railway Signal Co., motors by the Northeast Electric Co., and telephones by the Stromberg-Carlson Co.

Symposium on Corrosion of Metals and Alloys

Copper-Bearing Steel and Perhaps Steel With Other Alloying Elements Resist Atmospheric Corrosion Better Than Ingot Iron, But the Latter Excels When Immersed in Water—Oxygen and Carbon Dioxide Cause Most Damage in Steam and Hot-Water Piping

ALTHOUGH the problem of corrosion is one of the oldest that has confronted engineers, it is only within the last generation that the problem has been very seriously considered. There has been an ever-increasing use of steel and sheet metal in construction, and new and special alloys have been introduced for a host of modern-day mechanisms and devices. Bridges, ships, roofs, agricultural machinery, telegraph and trolley poles, conveyances, storage tanks, etc., all of which were formerly constructed of wood, are now made of steel or iron. The keynote of the Electrochemical Society Symposium was the emphasis on the practical side of the problem. While some of the papers dealt with the question of producing a corrosion-proof metal or alloy, other papers covered tests on simple methods to protect the metals now available.

For the sake of convenience and aside from any scientific basis we may classify the various corrosion studies under the following headings:

1. Corrosion of metal roofing—atmospheric corrosion.
2. Corrosion of pipes, rods, wires, imbedded in moist soil.
3. Corrosion of boiler tubes and hot-water pipes (closed systems).
4. Corrosion of metals submerged in sea water or acid liquors.
5. Corrosion of metallic anodes.

There is another type of corrosion met with in the case of metal electrodes in vacuum apparatus such as audions, Moore tubes, cathode ray tubes, etc., which, however, though similar in many respects, is usually not classified as corrosion, since oxygen and moisture are practically absent or play but a secondary rôle.

In all of the above five cases corrosion is of the electrolytic type, the electric current being produced either (1) by local couples composed of two or more different constituents in the same metal or alloy; (2) by a couple formed by the union or contact—immediate or distant—of two entirely distinct metals or alloys (as for example, a copper sign plate attached to a steel-re-enforced-concrete wall); (3) electrolytic action may be due almost entirely to stray currents from neighboring service lines; or (4) the electric current may be intentionally applied, as in the case of anodes in acid liquors.

COPPER-STEEL EXPOSED TO THE ATMOSPHERE

Of the iron and steel papers presented at the symposium almost every one of them took up the question of the effects of small copper additions. D. M. Buck of Pittsburgh¹ carried out large-scale tests at Scottsdale, Pa., extending over a period of about three years on 16-gage iron sheets, containing various percentages of copper and exposed simultaneously to the weather. In general, Buck finds that the addition of small per-

centages of copper reduces the corrosion rate very markedly, as compared with that of ordinary iron, under conditions where the product is alternately wet and dry. For example, after thirty-two months' exposure to the atmosphere the sheets containing 0.01 per cent Cu lost 33 oz. per sq.ft., those with 0.018 per cent Cu lost 23 oz., and those with 0.2 per cent Cu lost but 6 oz. Buck finds that after some months exposure a firmly adherent film is formed on copper-steel which cannot readily be removed with a wire brush. Some idea of the thickness of this film was obtained by first weighing, then scratch-brushing the samples and weighing again, and then removing the tenacious scale with an ammoniacal solution of ammonium citrate and weighing once more. In this manner very concordant results were obtained indicating that after eight months' exposure the closely adherent scale weighed 2.3 to 2.4 oz. per sq.ft. and at the end of thirty-two months 2.8 to 2.9 oz. The closely adherent scale can therefore be figured to be 0.12 to 0.15 mm. thick. Buck also found that steel carrying 0.03 per cent S requires at least 0.07 per cent Cu, and steel carrying 0.055 per cent S 0.12 per cent Cu. He concludes that the inhibition of corrosion through the addition of copper may be accounted for in two or more ways. The harmful influence of sulphur on corrosion is in some manner controlled by the copper; furthermore, the dense film which is formed on copper steels is a real and efficient protector of the underlying metal.

E. A. Richardson of Cleveland pointed out that Buck's curves show that the dominant factor in the decreased corrosion of copper-bearing steels is the composition of the metal itself and that the adherence of the rust coating is a secondary factor. William H. Walker of Boston referred to tests that indicated that copper-steel produces its own protective covering only when the oxygen concentration is high. When the amount of oxygen is limited, as when the structure is immersed in water, corrosion proceeds comparatively rapidly. L. T. Richardson of New York concludes from Buck's tests that the rate of corrosion appears to be influenced mainly by the composition of the metal surface exposed.

O. W. Storey of Madison, Wis., made a careful study of the report of the American Society for Testing Materials and finds that copper-steels made by the acid process which were high in phosphorus were much more resistant to corrosion than low-phosphorus copper-steels made by the basic process. This finding checks up with conclusions drawn by Buck some time ago. This phase of the subject is, however, not definitely solved. It may be that the addition of phosphorus to some of the pure irons or low-phosphorus basic open-hearth steels will have a favorable influence and make them as resistant to corrosion as the acid open-hearth or bessemer copper-steels are at present. The sheets that Buck reported upon were basic open-hearth of an unpublished phosphorus content.

¹Observations on the Mechanism of the Increased Corrosion Resistance of Steel and Iron Due to Small Copper Contents.

E. A. and L. T. Richardson² investigated samples of iron that have resisted atmospheric corrosion for upward of thirty years. Those samples containing 0.1 per cent copper or more were in good condition, whereas those that were free from copper or contained but traces were in poor condition. This confirms Storey's results on tests of eighty different fence wires. The wires which were in better shape always contained Cu. A. S. Cushman of Washington maintained that the evidence was not complete to attribute the resistance to corrosion of the fence wires to the presence of copper; there are other factors that must be taken into account.

T. S. Fuller³ of Schenectady described simple tests which closely correspond to atmospheric tests but can be readily carried out in the laboratory. Progressive placing of drops of water on the same spot of a sheet of metal and allowing each drop to evaporate before adding the next one showed that the first drop was much more "corrosive" than subsequent drops, indicating that a partial immunity is built up. The activity of the first drop is three times that of the second drop. Ordinary cold-rolled iron corroded more than

conditions, which are not comparable to most of the conditions of service. They believe that the only reliable test is the immersion test. Samples cut from three sheets of the following composition were tested:

Sheet	C	Mn	S	P	Cu	As
K	0.04	0.29	0.038	0.077	0.20	0.015
C	0.011	0.032	0.039	0.055	0.251	0.102
A	0.011	0.015	0.038	0.006	0.038	0.012

The K and C samples corroded rapidly, as compared with A samples, in solutions of bichromate, aluminum sulphate, aluminum chloride, cold hydrochloric acid and dilute nitric acid; on the other hand, in sulphuric acid and in concentrated nitric acid the samples K and C with the higher copper content stood up better. In general, Cushman and Coggeshall find that "wherever and whenever copper as an alloying constituent in steel does not show itself to be inert, it shows itself to be deleterious and in some cases dangerously so." Buck admits that the protective surface film can be removed by electrolytes; he used ammoniacal solutions of ammonium citrate. The fact, however, remains that copper-bearing iron and steel are more resistant to

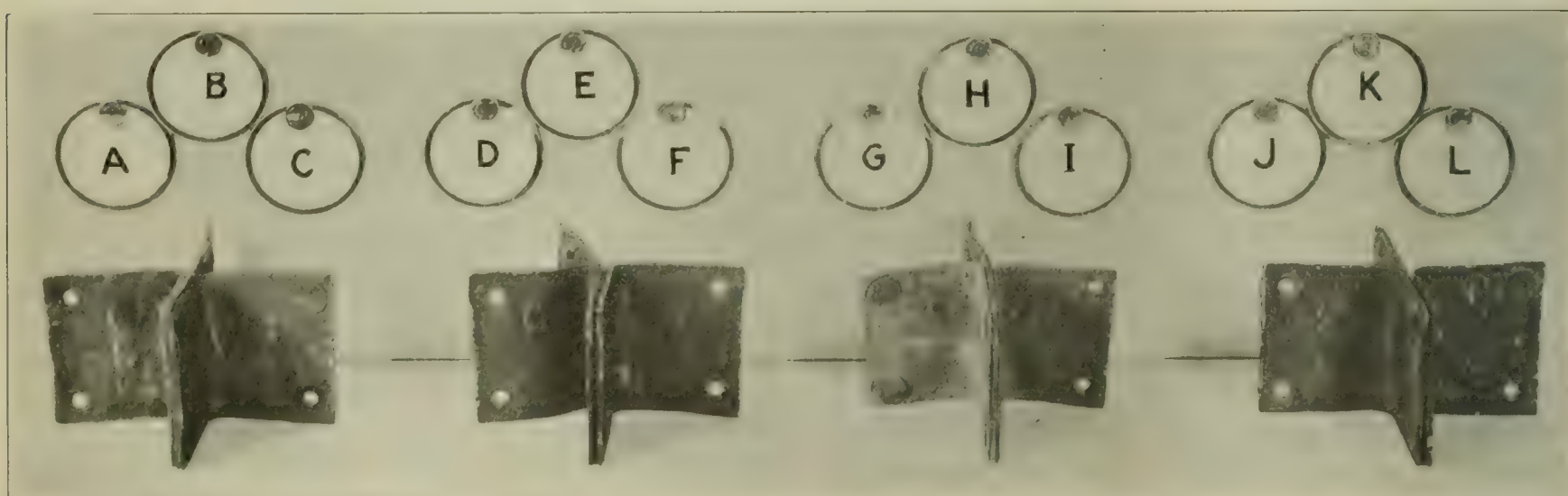


FIG. 1. CORROSION OF IRON AND STEEL WITH AND WITHOUT COPPER, HELD TOGETHER IN VARIOUS COMBINATIONS BY COPPER RIVETS

iron containing 0.29 per cent Cu, and this in turn corroded more than iron containing 2.57 per cent Cu. According to Fuller's test one can determine relative resistance to corrosion in a day in the laboratory as well as with a year's test in the atmosphere. Fuller agrees with Storey and others that there are very likely other metals or elements besides copper that retard corrosion when added to steel in small quantities.

COPPER-STEELS EXPOSED TO PRODUCTS OF COMBUSTION

Storey suspended samples of steel, with and without copper, in the stove flues in households in different sections of the country. He found that steels with about 1 per cent copper are three times as resistant to the combined action of the products of combustion and the alternate heating and cooling of a range as steels with but 0.06 per cent copper.⁴ Aupperle does not agree with these tests, and finds that pure iron lasts eight times as long as copper-steel in hot flues.

COPPER-STEEL IN WATER AND IN ELECTROLYTES

A. S. Cushman and G. W. Coggeshall⁵ look upon the atmospheric test as covering only a special set of con-

atmospheric corrosion than copper-free iron or steel.

Aupperle and Strickland⁶ likewise conducted immersion tests in a solution containing 0.7 per cent sulphuric acid, 2 per cent ferrous sulphate and 0.15 per cent ferric sulphate. The solution was kept in circulation by means of an airlift. The test lasted sixty days: Commercially pure iron with but 0.018 per cent Cu lost 0.380 oz. per sq.ft., as against 0.430 oz. for 0.304 per cent copper-iron and 1.213 oz. for 0.340 per cent copper-steel. Samples of copper-steel that had withstood atmospheric corrosion for a number of years subsequently lost several times as much weight in the immersion test as did the pure iron samples which failed first in the atmospheric test. Furthermore, when dissimilar metals are used for the construction of tanks, boilers, pipes, etc., and when such metals are in contact with water containing ferrous sulphate and sulphuric acid, the iron or steel containing the most copper will be the first to fail. Such tests are illustrated in Fig. 1.

Oliver P. Storey and H. C. Knapp of Madison, Wis., took samples of ordinary sheet iron, 0.25 per cent copper-steel and commercially pure iron and immersed them in dilute sulphuric acid.⁷ The tests were then repeated except that 0.1 to 2.5 g. of copper was added

²The Corrosion of Old Iron.

³Experiments on the Corrosion of Iron and Steel.

⁴The Corrosion of Steel Ranges.

⁵Anomalies Encountered in a Study of Immersion Tests of Iron and Steel.

⁶Observations on the Corrosion of Iron and Steel.

⁷The Effect of Copper and Silver Salts on the Corrosion of Iron by Acids.

to the electrolyte as copper sulphate. It was found that corrosion was from three to five times as severe in the presence of the copper salt irrespective of the copper content of the sample.

In comparing the immersion tests of Cushman, Aupperle and others on copper-iron and copper-steel with the atmospheric corrosion tests of Buck, Fink suggested that the difference between the two tests was largely one in degree. By the acid immersion test we bring about results which may take very many years to obtain by mere exposure of the samples to the weather. This view is supported by Buck's findings as recorded

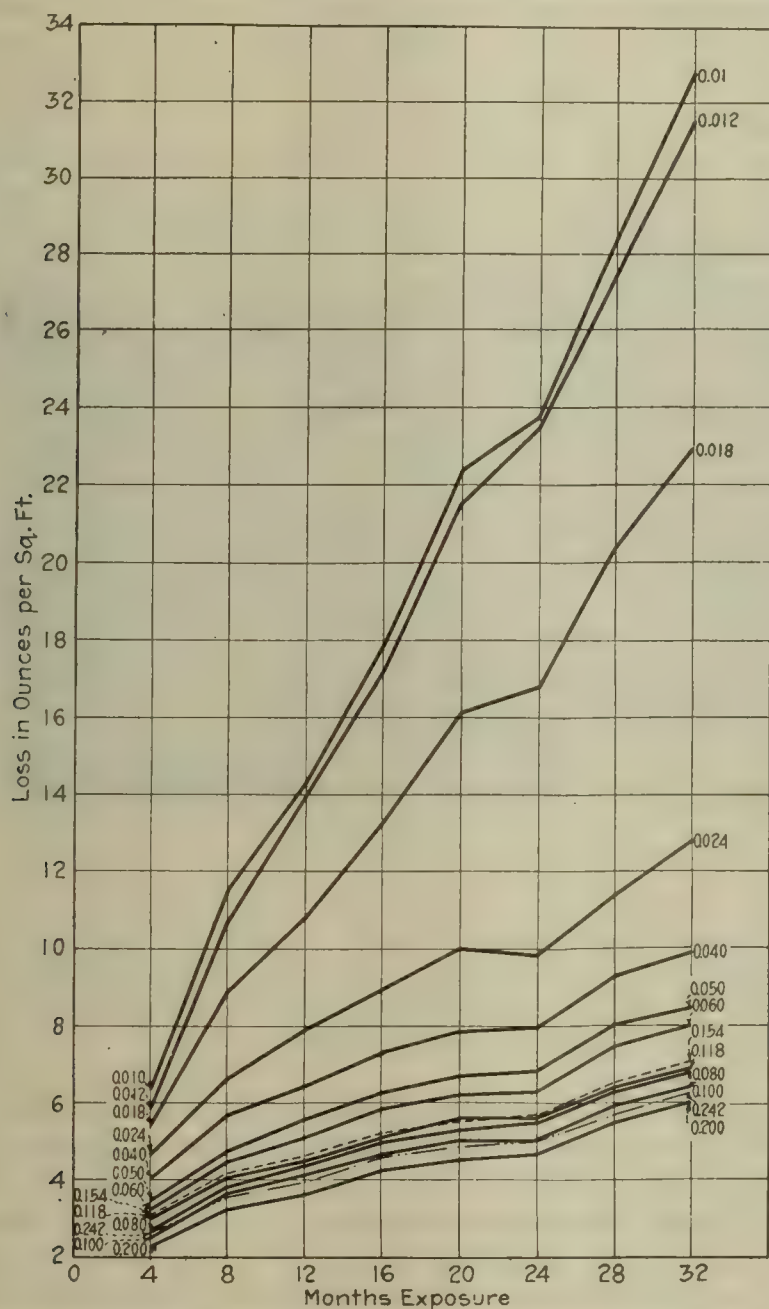


FIG. 2. LOSSES ON SPECIMENS CLEANED WITH CITRATE

in Fig. 2. The addition of copper merely reduces the rate of corrosion; throughout the life of the sheet, the rate is practically constant. Thus, for example, sheet iron with but 0.01 per cent Cu will corrode at the rate of 1 oz. per month per sq.ft. of metal exposed as compared with one-fifth of an ounce per month for sheet iron containing 0.20 per cent Cu.

THE FERROXYL TEST

This test, which has been repeatedly described in the literature, and which consists of imbedding small steel or iron samples in gelatine saturated with ferricyanide and phenolphthaline, is decidedly simple and very instructive. Cushman reproduced on the screen a series of very interesting tests made on iron nails. A photograph of one of these tests is herewith reproduced. (Fig. 3.) This is unusually attractive on account of the distinct lines (dark blue in the original) which

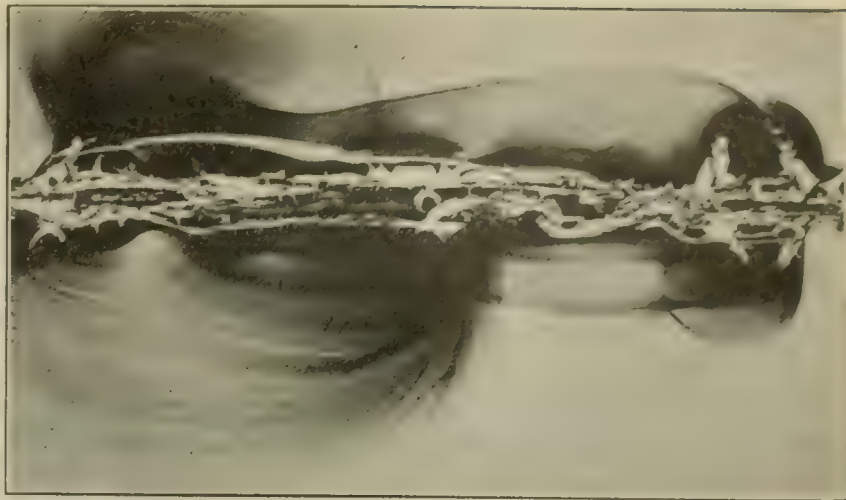


FIG. 3. FERROXYL TEST. A. S. CUSHMAN

have all the appearance of "magnetic lines of force." J. W. Richards and Cushman were of the opinion that these lines are due to electrolytic action; W. C. Moore, however, maintained that the lines were merely due to diffusion. The point is not definitely decided and further investigation would appear well worth while.

PRACTICAL MEANS OF PREVENTING CORROSION OF BOILER TUBES AND HOT WATER PIPES

F. N. Speller, of Pittsburgh, finds that in the case of boiler tube and hot water pipe corrosion, the destructive element is oxygen.⁸

Besides oxygen, carbon dioxide may be the direct cause of boiler tube corrosion.⁹ Worth found that the cause of rapid corrosion of a boiler at a Keport plant was attributable to the presence of soluble bicarbonate of iron in the supply water. Upon heating, large quantities of CO₂ were evolved. The water was then treated by being kept at the boiling point for eight hours in a preheater, where the carbonic gas was liberated and a sludge of ferric hydroxide precipitated. The corrosion trouble then ceased.

PAINT AS A NON-CORROSIVE FILM FOR IRON AND STEEL

H. A. Gardner¹⁰ recommends that paints for priming steel should preferably be made of a substantial amount of one or more basic or chromate pigments, and that these paints should be covered with water-resisting finishing coats of carbon or iron oxide. Zinc and aluminum bronzing powders applied direct to steel surfaces possess much greater rust-preventing properties than the powders of other metals. A high-grade exterior spar varnish should be used for suspending the powders.

CORROSION OF BURIED LEAD CABLES

The results of E. R. Shepard's investigation on lead cables¹¹ agree in general with those of McCollum and Ahlborn¹² of the Bureau of Standards. Shepard extended some of these tests at the bureau. The relation between the moisture content of the earth and the coefficient of corrosion¹³ is shown in Fig. 4. Curves in Fig. 5 show the coefficient of corrosion for different

⁸Practical Means of Preventing Corrosion of Iron and Steel Where Not Exposed Directly to the Atmosphere. This paper will be published in full in a subsequent issue.

⁹Unusual Boiler Tube Corrosion by Carbon Dioxide, by Barzillai G. Worth.

¹⁰Metal Protective Paints. This paper will be printed in full in a subsequent issue.

¹¹Electrolytic Corrosion of Lead by Continuous and Periodic Currents.

¹²Bureau of Standards Paper 72 (1916).

¹³The ratio of the actual corrosion to that which would have occurred if all of the electrode reactions determined by Faraday's law had been involved solely in corroding the anode.

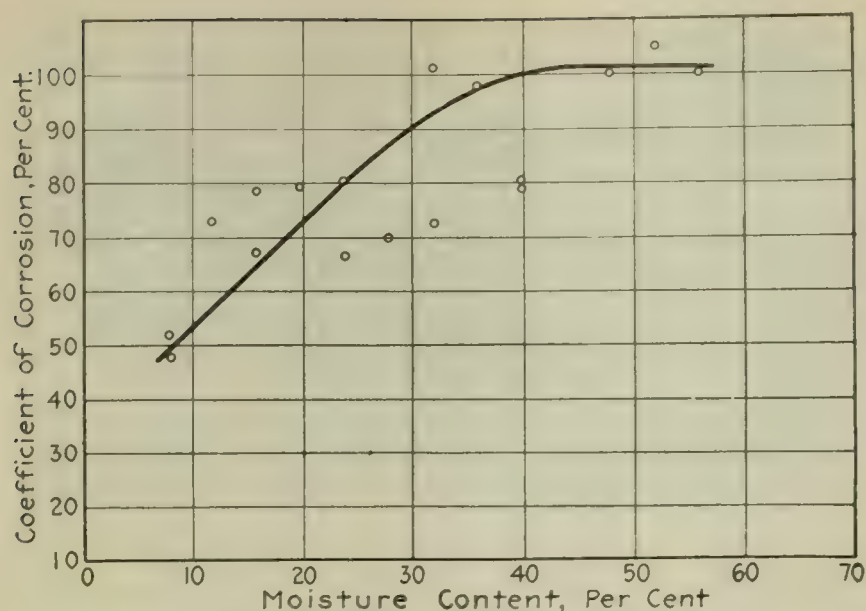


FIG. 4. VARIATION OF COEFFICIENT OF CORROSION WITH MOISTURE CONTENT IN BUREAU EARTH. CONTINUOUS CURRENT, 0.5 M.A. PER SQ.CM.

percentages of the total time the lead test plates were anodic. In other words, with periodically reversed currents the coefficient of corrosion based on the anodic current decreases rapidly with time. With continuous current, the coefficient of corrosion in both tap water and earth decreases with an increase in current density. In reference to the corrosion of lead in sulphuric acid, Bancroft felt that although lead peroxide must go into solution in order that the battery function, on the other hand, the same oxide protects the lead of the grid: One is a loose packing, the other an adherent film.

THE CORROSION OF ALLOYS

One of the most interesting and instructive papers of the symposium was that of H. S. Rawdon on "Some Types of Non-Ferrous Corrosion." The author discussed the structural changes caused by corrosion of non-ferrous metals as belonging to four distinct types—namely (a) Selective attack of certain constituents. (b) Inter-crystalline brittleness. (c) Internal oxidation. (d) Simultaneous action of stress and corrosion. As examples of each type the following are given: Type *a*—Brass (60 per cent Cu, 40 per cent Zn) was exposed to sea water for seven years. The α constituent (65 per cent Cu) was untouched, while the β constituent (50 per cent Cu) was corroded by a leaching

out of the Zn, as shown in Fig. 6. Type *b*—Cable sheath of Pb exposed underground became brittle due to the destruction of the intercrystalline material (usually non-miscible impurities such as Fe, Cu, Ni, Zn or miscible eutectic-forming elements as Sn or Sb). This type of corrosion can be induced by immersion in lead-acetate solution. Type *c*—Boiler safety plugs of Sn deteriorated by change of metal to infusible oxide under influence of moist heat. (See Fig. 7.) The same type of change is found with Al-Zn (15 per cent) alloys. In this case moist heat causes the oxidation and swelling of the eutectic matrix. Type *d*—Brass and lead under combined stress and corrosion will fail far below normal stress. This is due to selective corrosion of the β constituent in the former, and to inter-crystalline brittleness in the latter.

The foregoing cases of non-ferrous corrosion have been chosen as types to illustrate a few of the many forms in which failure by corrosion may occur.

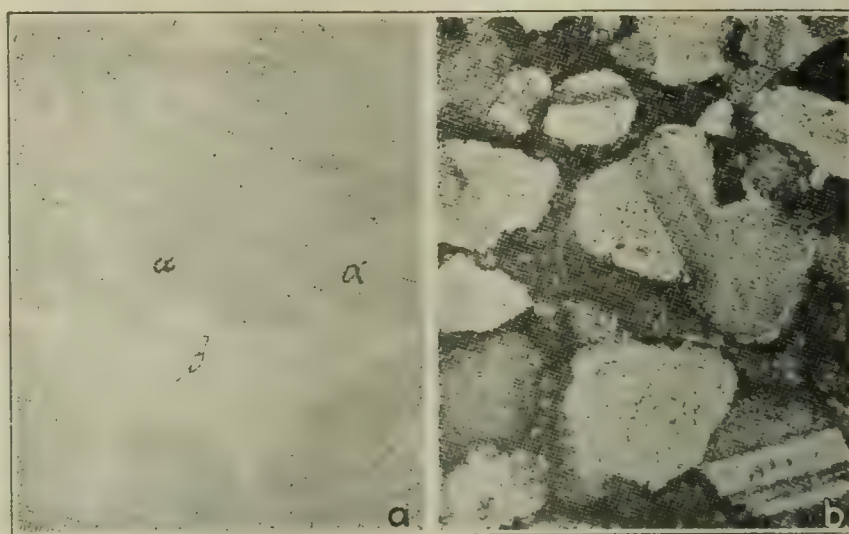


FIG. 6. MICROSTRUCTURE OF MUNTZ METAL SHEET. X 500

a. Microstructure of a Muntz metal sheet showing the two constituents, α and β . Etching reagent, ammonium hydroxide and hydrogen peroxide.

b. Microstructure of corroded sheet of Muntz metal, after seven years' exposure in sea water; the β constituent has disintegrated into a weak pulverulent material resembling copper. Etched with ammonium hydroxide and oxidized in the air.

Although the four illustrations have been described as distinct types for convenience, it is quite evident that they are distinct types only so far as appearance is concerned. Fundamentally, they are all very similar.

The increased corrosion due to internal strains or flaws as in the case of the lead pipe will probably account for the failure of the cast iron acid egg which C. L. Fineman reported had been in service for six months for handling mixed nitration acids when it suddenly cracked.

The principles of alloying to resist corrosion appear to Oliver P. Watts comparatively simple. He believes that to increase the resistance to corrosion of any metal there should be alloyed with it another metal which is more resistant to corrosion and which forms a solid solution with the metal whose resistance to corrosion it is desired to enhance. Fink pointed out that the subject was much more intricate than Watts supposed. E. A. Richardson also took exception to Watts' broad generalities. He quoted the case of alloying silicon and iron. Although the two elements form a solid solution and although silicon is much more resistant to corrosion than iron, yet when alloyed with pure iron (say up to 4.5 per cent) resistance of the iron to atmospheric corrosion is materially reduced. The same is true of arsenic and tin when alloyed with iron. John F. Thom-

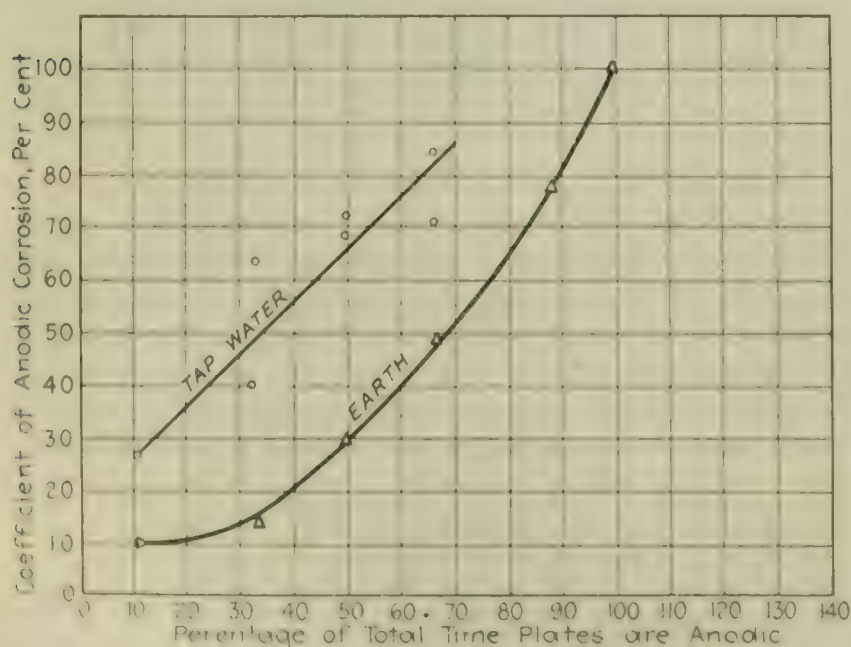


FIG. 5. VARIATION OF ANODIC CORROSION WITH PERCENTAGE OF TOTAL TIME PLATES ARE ANODIC. ON 20 MIN. PERIOD, 0.5 M.A. PER SQ.CM. TIME 100 HR. SATURATED EARTH AND TAP WATER

son shows conclusively in a paper on "A Practical Aspect of the Corrosion Problem" that there are very many factors involved in the selection of an alloy to resist corrosion. Although corrosion resistance is always a necessary factor, it is quite frequently not the determining one which governs practical serviceability. Not only must the chemical factors be taken into account, but also usually the mechanical properties, and very often too the electrical. There is every indication that nickel alloys will be used to much greater extent hereafter.

In closing the symposium, Colin G. Fink summarized the more important points brought out during the two days' discussion as follows: (1) Iron or steel containing about $\frac{1}{4}$ per cent copper will withstand atmospheric corrosion better than iron or steel without copper. (2) Iron or steel containing about $\frac{1}{4}$ per cent copper, when completely immersed in ordinary tap water or in



a. Longitudinal section of a "safety" plug. The filling of tin was changed almost completely by service conditions into a hard refractory mass of tin oxide; a few globules of tin may still be seen in the interior. $\times 1$.



b. Portion of a after polishing the surface. The white areas are globules of tin which fused when the plug became overheated. $\times 2$.

FIG. 7. STRUCTURE OF CORRODED SAFETY BOILER PLUGS

acidulated water, does not resist corrosion as well as pure iron. (3) In boiler practice and in hot water systems (closed systems) the presence of oxygen greatly accelerates corrosion; the removal of this oxygen practically eliminates corrosion. (4) Carbon dioxide in boiler water, together with soluble iron, causes corrosion, and the removal of the CO_2 practically eliminates corrosion. (5) Other elements, such as Cr, Si, Ni, Co, etc., added to iron in well-defined amounts tend to reduce corrosion, but detailed investigations have as yet not been reported. (6) A satisfactory co-ordination of alloy corrosion research needed but lacking.

Fink also made the following suggestions for future study and research: (1) A thorough investigation of the surface film involving careful determinations of the chemical and of the physical properties of this film—e.g., chemical composition, porosity, tenacity, coefficient of adhesion, coefficient of expansion, etc.—as compared with those of the underlying metal. (2) A careful study of the microstructure of the metal near the surface and a similar study of the metal directly underneath the surface film. (3) The effect of chemical and mechanical treatment on the surface film and the underlying metal. (4) A more complete micrographic investigation of the surface changes of metals during the process of corrosion. (5) A better classification of corrosion phenomena—for example, we must define the limits of moisture and salts in air in which the tests were made. (6) A standard of measure of corrosion.

Dye Imports

BY C. R. DE LONG

The following statistics on imports of dyes during 1920 were presented to the Dye Division of the American Chemical Society at the meeting in Rochester April 28. They were prepared by Dr. C. R. de Long, chemist for the U. S. Tariff Commission:

	Lb.
Total imports of coal-tar dyes during calendar years	
1920	3,700,000
Vat dyes other than indigo	855,000
Indanthrene blue GCD	150,000
or 18 per cent of total for this class.	
Indanthrene yellow R & G, about 10 per cent total	
Indanthrene black BB, about 10 per cent total	
Bromindigo	34,000
Ciba scarlet	25,000
Hydron blue	20,000
Ciba violet B	18,000
Mordant and chrome dyes	840,000
Anthracene blue WR	114,000
or 13 per cent of total for this class.	
Alizarine	73,000
or 9 per cent of total.	
Brilliant delphine blue BS	29,000
Eriochrome blue black B	20,000
Omega brown PB	11,000
Acid dyes	765,000
Wool green S	127,000
or 16 per cent of total for this class.	
Patent blue and patent	
Blue A	86,000
or 12 per cent of total.	
Xylene light yellow 2G and R, about 10 per cent total	
Tartrazine	57,000
Quinoline	35,000
Xylene light blue VS	26,000
Acid violet 4BN	22,000
Direct Dye	595,000
Zambesi black	about 40,000
or 7 per cent	
Trisulfon brown B and MB	about 40,000
or 7 per cent	
Trisulfon brown GG	about 40,000
or 7 per cent	
Chloramine brilliant	about 23,000
or 4 per cent	
red 8B	about 23,000
or 4 per cent	
Pyracol orange G	about 23,000
or 4 per cent	
Heligoland black	about 23,000
or 4 per cent	
Sulphur dyes	255,000
Thionol red brown	38,000
or 15 per cent	
Thionol green DY	24,000
or 10 per cent	
Basic dyes	200,000
Auramine	85,000
or 45 per cent	
Phosphine	20,000
or 10 per cent	
Indigo	171,000

The above figures are approximate, and under each class only the more important dyes have been listed.

Foreign Commerce of Belgium

According to the statistics just published by the Belgian Minister of Finance it appears that the commerce of Belgium in 1920 amounted to 22,495,041 metric tons (1 metric ton = 2,204.6 lb.), of which 11,946,448 tons was imports and 10,548,593 tons exports. This commerce was valued at 19,879,549,000 f. (\$1,443,161,451), of which 11,171,467,000 f. (\$810,995,789) was imports and 8,708,082,000 f. (\$632,165,670) exports. The imports for 1920 exceeded those of 1919 by 5,948,420,000 f. and the exports by 6,419,246,000 f.

Beet-Sugar Project in China

A newly organized Chinese concern named the Pui Chih-Tang Kungsu expects to establish a beet-sugar factory near Huangtaichiao, states an issue of the *Trans-Pacific*. The company's capital amounts to \$5,000,000 and is entirely Chinese owned. All machinery and equipment will be imported from America. The capacity of the plant will be about 6,000 tons of sugar a year.

Calculation of Percentage Removal of a Constituent From a Mixture

BY W. B. VANARSDDEL

A VERY common problem in laboratory and plant work is the calculation of the percentage removal of one constituent from a mixture, given the original and final percentages of that constituent in the mixture. Among the instances which might be cited are the following: Recovery of a gas or vapor from accompanying inert gases by passage through an absorption tower; calculation of weight of water to be evaporated from unit weight of a wet material to reduce the moisture content from one specified percentage to another; determination of the proportion of resin or fat recovered by treatment of an oily or resinous material with a solvent. A number of dilution or evaporation charts have been proposed [cf., for instance, Deming, *J. Ind. Eng. Chem.*, vol. 8, p. 265 (1916)], and with slight modifications these might apply to such problems as the second one above; but there seems to be no published work serving just the purpose of the present chart.

It is very easily shown that if a is the original and b the final percentage of a constituent M in a mixture, the percentage of removal of M ,

$$R = \frac{10^4 (a - b)}{a(100 - b)} \quad (1)$$

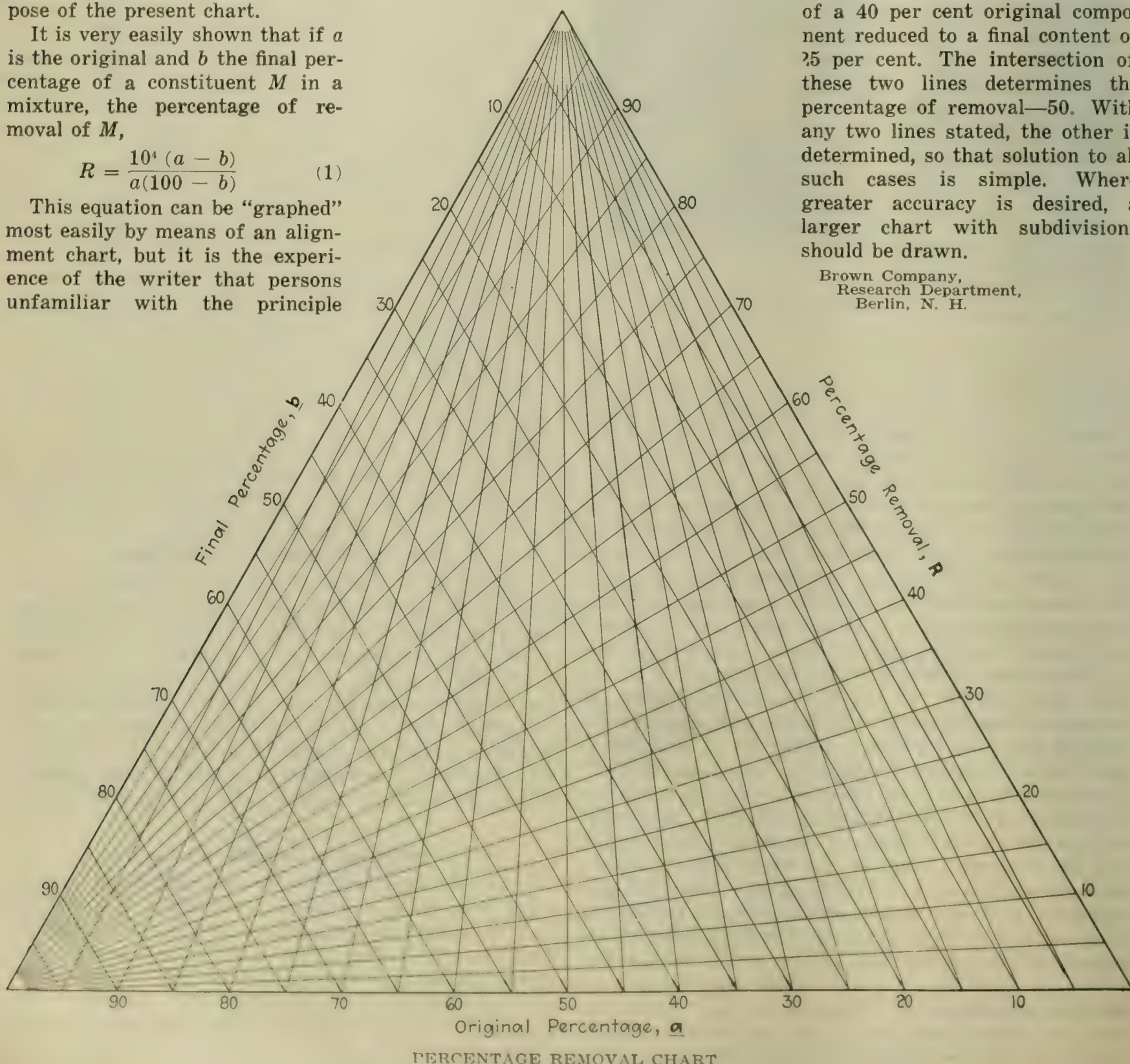
This equation can be "graphed" most easily by means of an alignment chart, but it is the experience of the writer that persons unfamiliar with the principle

of the alignment chart use it with hesitancy and are disinclined to use the auxiliary straight-edge required; a network of curves or straight lines, on the other hand, while more difficult to draw accurately, seems to be used with facility. If drawn to a sufficiently large scale, interpolation offers no particular difficulty; in cases where the range of the variables is limited, only a portion of the network need be drawn, and magnification of the units permits greater accuracy of interpolation. In the present case a network of straight lines is set up, covering the whole range from 0 to 100 per cent for each percentage; the accuracy is therefore low when both a and b are very near 0 or 100 per cent. The triangle was made equilateral merely to increase the average angle of intersection of index lines.

It may not be out of place to remark that in the case of a mixture of gases, even if the temperature changes a and b may be expressed in volume-per cent, and R will still represent percentage removal by weight. This fact is dependent upon the mixture's behaving according to the simple gas laws and therefore, strictly speaking, excludes vapor mixtures. An example for calculation

may be taken from the simple case of a 40 per cent original component reduced to a final content of 25 per cent. The intersection of these two lines determines the percentage of removal—50. With any two lines stated, the other is determined, so that solution to all such cases is simple. Where greater accuracy is desired, a larger chart with subdivisions should be drawn.

Brown Company,
Research Department,
Berlin, N. H.



Behavior of Copper in Molybdenum Ores

Brief Notes on Methods by Which Copper May Be Separated From Molybdenum Ores or Concentrates Previous to Reduction—Precautions to Be Taken in the Analysis for Copper in the Presence of Molybdenum

By J. P. BONARDI AND MAX SHAPIRO

MOLYBDENUM ores are found that contain copper minerals, in some cases in commercial quantities, the presence of which is objectionable because they are usually carried into the molybdenum concentrates. If these concentrates are to be used for making ferro-alloys or steels they are by some purchasers seriously objected to and penalized, depending upon the amount of copper present. Previous to 1917 copper in molybdenum concentrates was particularly undesirable and its presence in excess of 1 per cent, even in high-grade molybdenite concentrates, was usually sufficient to render the material unmarketable. Some dealers did, however, accept concentrates containing more than 1 per cent copper, but when 4 or 5 per cent copper was present the penalties exacted were such as to be prohibitive. Since then various new methods of ore dressing have been tried out with varying degrees of success, which have to a great measure eliminated the copper content in molybdenum concentrates, so that at the present time the copper content can be kept around 0.5 per cent, and usually less, depending upon the relative proportions in the ore.

Very little exact information is at present available as to the copper limitation placed on molybdenum concentrates; it is generally stated as between 0.2 and 0.5 per cent, although some dealers have taken molybdenite concentrates carrying any amount of copper, since their process of roasting and extracting the molybdenum renders the copper insoluble in the residue.

GRAVITY CONCENTRATION

In treating wulfenite ores it has been found by some workers that the vanner proved an excellent machine for removing the associated oxide copper minerals from the wulfenite. Although it was known that wulfenite is somewhat friable it was found that the very fine wulfenite minerals of an unclassified feed would, when submitted to a vanner, readily attach themselves to the moving surface and be retained. This is because the mineral is readily wetted; while the gangue particles and copper minerals, being of lower specific gravity, and not so easily wetted, would be carried off by the stream of water, even though larger in size.

However, in the concentration of molybdenite by the oil flotation process sulphide minerals of copper, usually in the form of chalcopyrite, are likewise carried over with the molybdenite froth and are then found in a more concentrated state than originally present in the ore. Differential flotation, however, bids fair to eliminate this trouble, and very many successful experiments to this end have been made at the Golden Station of the United States Bureau of Mines. Horton,¹ in describing the deportment of chalcopyrite in the concentration of molybdenite, states that by both elec-

trostatic and flotation methods they are concentrated together. The removal of pyrite and chalcopyrite from molybdenite is accomplished to a great extent by giving the ore or concentrates a careful roast. In this way the larger part of the pyrite and chalcopyrite are rendered magnetic and may be removed by means of a magnetic separator, or, through the formation of a coating of oxide on the surface of each particle, the pyrite and chalcopyrite in the ore are readily wetted and sink if the material is subjected to flotation. It is cheaper and more effective as regards ultimate recovery of molybdenite to remove the other sulphides after concentration rather than before. The danger in roasting molybdenite ores is that if the surface of the molybdenite becomes oxidized, its complete recovery by ordinary oil flotation processes will be doubtful.

Thornhill (U. S. Pat. 1,338,264) effects separation of molybdenite from other mineral sulphides by treating pulp with oil, whereby molybdenite appears to "coagulate" in preference to other minerals and can be separated by fine screening.

FLOTATION BY SURFACE TENSION

Another method suggested is that of oxidizing the surfaces of chalcopyrite at ordinary temperatures and later submitting the material to the Wood's surface-tension machine, whereby the chalcopyrite sinks while the molybdenite flakes are floated on the surface and are recovered. It is known that the ordinary type of wet concentrating table will to a certain degree effect a separation, due to the flakiness of the molybdenite and to the fact that it is not readily wetted, which usually makes it the tailing product.

In case the ratio of copper to molybdenum is relatively large it is doubted whether any of the processes suggested above will reduce the copper content much below 1 per cent. The application of differential flotation may in the future be able effectively to separate molybdenite from chalcopyrite within the limits that are allowed, and very likely at the same time produce two marketable products—a copper and a molybdenum concentrate. This would then eliminate the costly roasting processes or hydrometallurgical processes now being attempted to solve this problem.

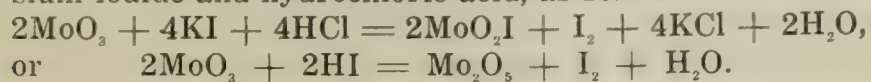
REACTIONS BETWEEN MOLYBDENUM AND IODINE

The accurate determination of copper in copper-molybdenum ores that have come to this station for testing by flotation processes and for the analysis of the products made therefrom is of importance to the metallurgist. After several trials had been made to determine copper by the ordinary methods in such products it was soon found that the presence of molybdenum was a serious hindrance. The standard iodide method of determining copper cannot be used without previously separating the molybdenum from the copper or vice

¹Published by permission of the Director, Bureau of Mines.

¹Horton, F. W., "Molybdenum: Its Ores and Their Concentration," U. S. Bureau of Mines Bull. 111, 1916, pp. 108-9.

versa, since under the conditions of titrating the liberated iodine by thiosulphate in the ordinary way molybdenum likewise liberates iodine and interferes. Free iodine is liberated when a solution containing molybdic acid (MoO_3) is boiled in the presence of potassium iodide and hydrochloric acid, as follows:



This reaction forms a basis for determining molybdenum. See Scott² and Treadwell and Hall.³

INCOMPLETE PRECIPITATION ON ALUMINUM

In the ordinary standard copper-iodide method the bulk of the copper is previously precipitated by aluminum or zinc, which is followed by H_2S water to precipitate the small amount of copper which usually is difficult to precipitate by the previous treatment. It has been found that in the presence of molybdenum, zinc or aluminum in any form—sheet, granulated or powdered—will not completely precipitate the copper. H_2S water as used in the ordinary method for copper cannot be used for carrying down the remaining copper in solution, since this will likewise precipitate MoS_3 along with the copper sulphide. After making several attempts to precipitate the copper completely by zinc and aluminum in various forms without the use of H_2S and under different working conditions it was finally given up as being practically impossible, since it always led to the same erratic results. The chief difficulty with using aluminum strips or sheets is that the precipitated copper adheres so firmly to the metal when molybdenum is present in solution that the deposition of copper stops. Granulated zinc, however, gave the best results, but requires the complete solution of several grams of zinc, which leaves the copper in a very finely divided condition, and which is very difficult to filter off and wash without losing some of the precipitate in the filtrate, due either to its colloidal nature or to oxidation. No H_2S wash water could be used on account of the danger of precipitating MoS_3 .

The use of sodium hydroxide for precipitating out the copper along with the iron-group metals was next tried out and proved satisfactory. By boiling, the copper hydroxide will be rendered insoluble, while the molybdenum passes into the filtrate. The precipitate must then be redissolved and reprecipitated to get rid of the trace of molybdenum remaining in the precipitate. The precipitate is next dissolved in dilute H_2SO_4 , and the copper thrown out of solution by the ordinary procedure, using aluminum strips, copper filtered off, dissolved and titrated in the usual manner with standard thiosulphate. Although the use of this method is fairly satisfactory for determining copper, the time required for carrying out a determination by performing so many precipitations and filtrations would limit its use in a commercial laboratory where many determinations must be carried out in a single day. Besides these objections, the solution after each addition of the caustic must be boiled vigorously or heated for half an hour to render the copper completely insoluble.

ELECTROLYTIC METHODS

A search through the technical journals revealed the fact that all the methods that had been devised for

determining copper in the presence of molybdenum were modifications of the ordinary electrolytic method.⁴

Very likely for a particular class of material an electrolytic method could be used to advantage, but in commercial work it is probable that by the time all the conditions have been properly made, with all the interfering elements removed, it would have been quicker to carry out a determination by other means. The electrolytic method was therefore not tried out.⁴

After trying out several of the standard wet methods as outlined in various textbooks for determining copper it was found that the thiocyanate method, with a few modifications, gave a complete quantitative separation of copper from molybdenum, while the procedure could be easily and accurately controlled.

MODIFIED THIOCYANATE ANALYSIS

Weigh out 0.5 to 5.0 g. of the finely pulverized material, depending upon the grade of sample, copper content not to exceed 0.20 g., into a 250-c.c. beaker or Erlenmeyer flask. Add 10 to 15 c.c. of HNO_3 and heat until the brown fumes are gone. This is the most effective manner of decomposing the sulphides present in an ore. Carefully add 5 to 10 c.c. of HCl and heat about twenty minutes, or until the ore is carried down to near dryness. On straight sulphide material the use of HCl can be dispensed with. Cool, dilute and add 10 to 15 c.c. of dilute sulphuric acid (1:1) and then if necessary just enough additional water to dissolve all the soluble salts in the residue or precipitate formed. If this is not done some nitrates are liable to cake on the bottom of the beaker or flask, or be trapped in the insoluble matter and may not be fully decomposed by the sulphuric acid. The presence of nitrates hinders the precipitation of copper. Evaporate the mixed acid solution down to copious fumes of H_2SO_4 , cool, dilute with a little water, heat to dissolve soluble salts and if much residue is present, filter off, catching the filtrate in a 600-c.c. beaker, and wash residue at least five times with hot water. The final volume will be approximately 250 c.c. This filtrate (or diluted solution from an acid treatment which requires no filtering) is now ready for precipitating out the copper by means of a solution of ammonium thiocyanate, while the molybdenum remains in solution. To the above acid solution add NH_4OH until the solution becomes slightly alkaline, indicated by an iron precipitate, then add dilute H_2SO_4 (1:1) until the solution is made acid and contains about 2 c.c. of free acid in excess.

Next add 2 to 3 g. of anhydrous Na_2SO_3 to reduce the copper. At the same time the sulphite may reduce some of the molybdenum, giving a blue solution, depending upon the concentration of acid. If too much Na_2SO_3

⁴Hoepfner, W., and Bender, O., "Determination of Molybdenum in the Presence of Copper," *Chem. Zeit. Jahrg.*, vol. 42, 1918, p. 315, pp. 301-2; also *Chem. Abs.*, vol. 12, 1918, p. 2293. Treadwell, W. D., "Electro-Analytical Separation of Copper From Tungsten and Molybdenum," *Z. Elektrochem.*, vol. 19, pp. 219-21; see *Chem. Abs.*, vol. 7, 1913, p. 2170. McCay, L. W., and Furman, N. H., "Use of Hydrofluoric Acid in the Separation of Some Heavy Metals From Tin, Antimony, Tungsten and Molybdenum by Means of the Electric Current," *J. Am. Chem. Soc.*, vol. 38, 1916, pp. 640-52.

⁵In describing the electrolytic copper assay in the presence of molybdenum, Hawley states: "In the electrolytic method for assaying copper, molybdenum acts like arsenic and antimony, part precipitating and part remaining in solution. When too much is not present, the addition of a small amount of any chloride will prevent its precipitation. One mg. of sodium chloride will prevent about 6 mg. of molybdenum from precipitating. This small amount of chloride is insufficient to injure the copper deposit. When molybdenum precipitates, the color varies with the amount present. With very little, the color is a chocolate brown that rarely extends to the edge of the cathode. With still more, an iridescent steel-blue color is evident that approaches black as the quantity is increased." (*Eng. & Min. Jour.*, vol. 110, July 24, 1920, p. 162.)

²Scott, W. W., "Standard Methods of Chemical Analysis," 2nd ed., 1917, pp. 275-282.

³Treadwell and Hall, "Analytical Chemistry," vol. 2, 3d ed., 1917, p. 666.

should be added, indicated by a precipitate, add a little more of the dilute acid solution. Heat nearly to boiling and add 10 to 25 c.c. of a solution of NH_4CNS or KCNS containing 2 g. per 10 c.c. An excess of this reagent does no harm. The copper will be precipitated as cuprous sulphocyanate, CuCNS . Heat for a few minutes longer, or until the precipitate has coagulated and settled. Filter through a good grade of qualitative paper and wash with hot water until the blue color on the filter paper, due to reduced molybdenum, has been leached out. Usually five to eight washings will be sufficient. Redissolve the precipitate back into the original beaker by puncturing the filter paper and washing the content into the beaker with a small stream of hot water. Then pour onto the filter 10 c.c. of warm 1:1 nitric acid, which will dissolve the adhering bit of precipitate on the paper and the washed down precipitate held in the beaker. If the precipitate is small it can be easily and readily dissolved with a little hot 1:1 nitric acid poured directly upon the filter. Brown oxides of nitrogen are given off by the reaction.

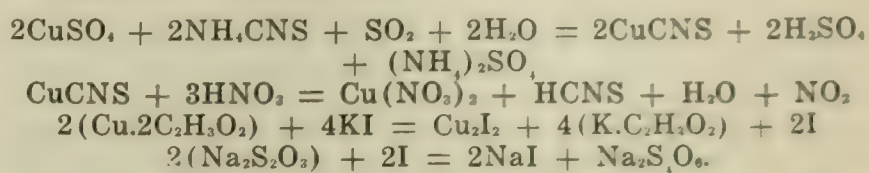
The solution is then placed on the hot-plate and evaporated down practically to dryness. This requires but a very short time and more than balances the time spent in the straight iodide method, where the nitric acid solution of copper containing some bromine water must be boiled to drive off excess bromine, neutralized with ammonia, again boiled until excess ammonia is driven off, neutralized with acetic acid, cooled to room temperature and titrated with standard thiosulphate. The principal advantage in taking the nitric acid solution of the cuprous thiocyanide nearly to dryness at the start is to expel the cyanide formed and the excess nitric acid, thus eliminating practically all the trouble that usually is experienced in titrating low-grade copper solution with thiosulphate in the presence of ammonium salts. For it has been found that if much ammonium salts is present the precipitate of cuprous iodide forms with difficulty and the end point is then very uncertain and unreliable, it being rather doubtful when the blue color will not again reappear through the formation of a little more iodine caused by the slowness of the reaction, due to excessive amounts of ammonium salts present. If accurately performed the blue color should not reappear upon standing from three to five minutes.

After the copper solution has been evaporated as described it is cooled. In case it was carried to complete dryness add two or three drops of concentrated nitric acid, next add 50 c.c. warm water, then a few drops of concentrated ammonia until the solution becomes clear, giving the characteristic deep blue color; avoid using an excess. Usually five to ten drops will neutralize all the nitric acid present at this stage, and at the same time be sufficient to dissolve the first precipitate of copper hydroxide. Next add 5 to 10 c.c. acetic acid, cool to room temperature, add sufficient amount of potassium iodide solution and titrate the brown solution of liberated iodine containing cuprous iodide with standard sodium thiosulphate until the blue color of a starch indicator disappears. It is best to titrate without starch in solution until the brown tinge has become faint and then add sufficient starch solution to produce a marked blue color. Titrate cautiously until the blue color is entirely removed by a single drop. The c.c. of thiosulphate multiplied by the copper value

of the reagent gives the weight of copper in the sample from which the percentage is calculated.*

REACTIONS

Reactions involved are:



According to the above equation $2\text{Cu} = 4\text{KI}$, or 0.2 g. of copper requires about 1.05 g. KI, and 100 per cent excess over this theoretical quantity is always added before titration. Prepare a solution containing 50 g. KI in 100 c.c. Five to 6 c.c. of this solution will take care of any high-grade samples encountered. For low-grade samples 2 c.c. will be sufficient.

INTERFERENCES

Nitrogen oxides, ferric ions, trivalent arsenic and trivalent antimony must be absent, as they will either absorb or liberate iodine. Pentavalent arsenic and antimony do no harm; hence, if these are suspected in the ore, 5 c.c. of bromine water should be used along with the nitric acid, after dissolving the cuprous thiocyanate, care being taken that the excess is boiled off by evaporating nearly to dryness as recommended for the presence of excess nitric acid. The presence of 3 g. of tartaric acid is recommended by Lord and Demorest⁷ to keep arsenic, antimony and bismuth in solution when the copper is precipitated with thiocyanate. The writers have never resorted to the use of tartaric acid, but prefer the use of bromine in ores suspected of carrying much arsenic or antimony.

Many tests were made to prove the accuracy of the method with synthetic solutions, but only a few representative ones will be given:

No.	Mo Present	Cu Taken	Cu Found
1	0.0500	0.0238	0.0239
2	0.1000	0.0513	0.0513
3	0.1500	0.0563	0.0564
4	0.2000	0.0109	0.0107
5	0.4000	0.0051	0.0049
6	0.4000	0.2681	0.2676
7	0.4000	0.0023	0.0025
8	0.5000	0.5638	0.5640

The results shown in Table I were obtained on molybdenum-copper ores and products, made from flotation

TABLE I. PERCENTAGE OF COPPER FOUND BY THE THREE METHODS

No.	Per Cent Mo	Per Cent Cu by Thiocyanate Method	Per Cent Cu by Excess Granulated Zinc	Per Cent Cu by Aluminum Strips
1	5.03	1.40-1.42	1.39-1.43	1.01-1.29
2	4.98	15.82-15.78	15.87-15.70	15.60-15.70
3	0.07	0.24-0.24	0.28-0.25	0.29-0.25
4	45.78	0.42-0.43	0.48-0.41	0.46-0.39
5	15.10	5.61-5.70	5.58-5.70	5.27-5.60

experiments, which were analyzed by three methods: The thiocyanate method, as described above; by granulated zinc, and by the regular aluminum precipitation method. Results on the latter method show the radical results to be expected by the use of aluminum.

*The standard solution of sodium thiosulphate is made by dissolving 19.55 g. of pure crystals in 1 liter of distilled water. Lord and Demorest recommend adding 1 g. of NaOH to preserve the solution. The solution is next standardized by weighing out 0.2 g. of pure copper wire or foil, dissolve in 10 c.c. of 1:1 HNO_3 , carried to near dryness and treated as outlined in the method above. One c.c. of the thiosulphate will correspond to about 0.005 g. of copper.

⁷Lord and Demorest, "Metallurgical Analysis," 1916, p. 206.

Messrs. Anderson and Prest of the Seattle Station, Bureau of Mines, have been able to use the following alternate method with good results on many ores.

PERMANGANATE METHOD FOR COPPER

The cupro sulpho-cyanate precipitate is dissolved in hot 10 per cent NaOH, copper hydroxide filtered off, and the NaCNS in the filtrate titrated with KMnO_4 , using ferric chloride on a spot plate as indicator of consumption of NaCNS. The solution is then made acid with H_2SO_4 and the liberated HCNS titrated until the usual permanganate end color is reached.

Some uncertainty exists as to the factor which will convert the iron value of the permanganate to the copper value. To fix this point, 0.20 g. of copper is dissolved in HNO_3 and carried through exactly as a regular determination.

Scott recommends that the precipitated sulpho-cyanate be weighed in a Gooch crucible after drying at 100 deg. C. The compound multiplied by 0.5226 gives the equivalent metallic copper. Or the dried precipitate may be burned with sulphur to Cu_2S . The factor is then 0.7986. In Scott's view, copper is separated as sulpho-cyanate from a great many elements without interference, except from silver, tellurium and selenium.

Synopsis of Recent Chemical & Metallurgical Literature

Superficial Burning of Low-Carbon Steel—In a paper read before the West of Scotland Iron and Steel Institute, James Mitchell refers to a type of defect which frequently arises in practice, which for want of a better term may be described as superficial burning. In such cases the metal is destroyed on the surface, presumably through the oxidizing effect of the flame employed in heating. It seems probable that this oxidation arises from the action of the surface scale formed on the piece. Microscopically it becomes apparent through decarburization of the superficial layers. After such treatment the failure of the metal is common, the reason being that the surface fissures caused through over-oxidation serve as starting points for the propagation of cracks throughout the steel. It may be argued that when fluxes are used on the metal such conditions do not readily arise. Mr. Mitchell's experience, however, has been that under such conditions fluxes afford a very poor protection, as the surface cinder formed is itself of a very oxidizing nature.

Wheel-Burnt Rails.—A derailment on the Baltimore & Ohio R.R. at Glenwood, W. Va., supposed to be due to a "wheel-burnt" rail—that is, a rail which had been intensely heated momentarily and locally by slipping wheels—led to a study and report of this type of damage by J. E. Howard, engineer-physicist of the Interstate Commerce Commission. Fragments of the broken rail (Fig. 1), the appearance of the rail head both before and after pickling (Figs. 2 and 3), and microscopic examination (Fig. 4) show that the rail—which was a 75-lb. A. S. C. E. section in service for nine years—contained many fractures having origin at the hardened upper surface of the rail.

In his investigations Mr. Howard studied

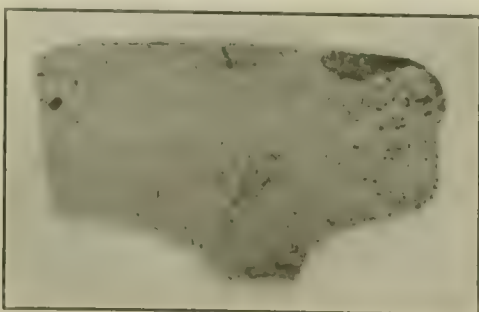


FIG. 1. TYPICAL END VIEW OF BROKEN FRAGMENTS

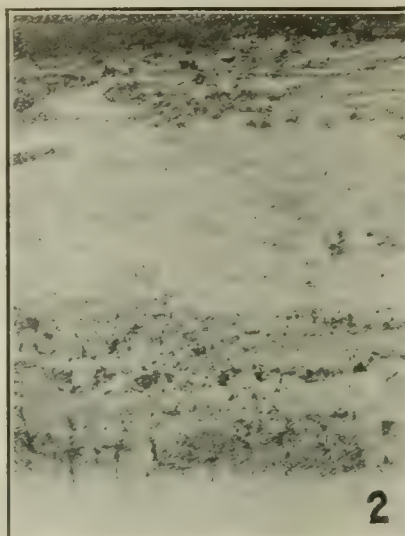


FIG. 2. APPEARANCE OF RUNNING SURFACE BEFORE PICKLING

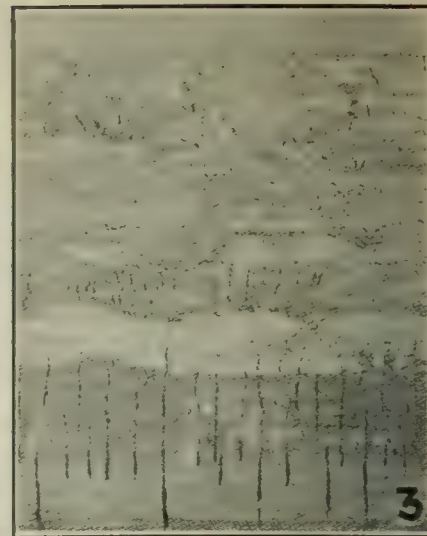


FIG. 3. APPEARANCE OF RUNNING SURFACE AFTER PICKLING

the internal strains and structure in a number of other wheel-burnt rails. He distinguishes between the hardening due to the cold-work attending a rolling load and the thermal hardening due to wheel-slippage. Rail steel embrittled by mechanical hardening commonly displays some residual ductility under wheel stresses, although it is incapable of further flow under tensile stresses. When a longitudinal element of the tread is cut from such a hardened rail it will increase slightly in length, thus showing it to have been under compressive forces. Thermal hardening due to wheel slippage, on the other hand, retains no residual ductility, is incapable of flow under wheel pressures, and the hardened portion is often of insufficient depth to support and distribute the impinging pressures of the wheels. Surface cracks were thus formed in the rail which caused the accident, some of which, under the alternate directions of the tractive forces of engine drivers and the resistance of the train wheels penetrated the head and culminated in rupture.

In order to gain an idea of the stresses which may be



FIG. 4. CRACK THROUGH HARDENED METAL AT SURFACE OF RAIL-HEAD. LONGITUDINAL SECTION. $\times 100$

set up locally by thermal hardening a number of rails were gaged and the changes in lengths noted after various amounts of metal had been cut away, and after various heat-treatments. The mean expansion in 10 in. after channeling the head of the rail and quenching the bar from 1,400 deg F. was 0.0235 in. (gaged length 10 in.). Progressive contraction occurs with increasing temperatures when annealing hardened steel—either hardened by cold-work or by quenching. Thus a hardened spot in a rigid rail head would

be under a compressive stress of 70,500 lb. per sq.in., due to this volume change, while the rest of the rail would have tension induced in it, especially near the top; consequently the effect of local thermal hardening is opposite in direction to that of mechanical hardening. Intense internal strains, induced in rails in this manner, may reasonably be held to have exerted a great influence on the surface cracks exhibited in Fig. 2. However, the approach to rupture in steel in service is not signalized by visible manifestations.

Melting Scrap in Heroult Furnace.—W. E. Cahill describes in *Mining and Scientific Press*, April 16, 1921, p. 535, a 2-ton electric furnace operating at Treadwell, Alaska. With coke at \$50 per ton, and pig iron correspondingly high, it has even become cheaper to make iron castings from this furnace, using hydro-electric power, than from a cupola. Operating "kinks" follow.

"Insulation" is common when starting the furnace on heavy scrap-iron. It often happens that the three electrodes will rest on top of the charge, and no current passes through. A good remedy is to add a few shovelfuls of clean turnings. In extreme cases one can always shovel in some coke, bringing the current over the top of the charge until a steady arc results.

"Iron castings are made about three or four times per week, the usual practice being to pour in the morning. Every afternoon we take off a heat of steel—high-carbon, low-carbon or alloy, depending upon the requirements. The melting of cold steel scrap in a cold furnace gave us considerable trouble at first. The melting starts at the top of the pile directly under the electrodes. The electrodes gradually work their way toward the bottom. As the steel melts it drops down and strikes the cold magnesite hearth and freezes. The electrodes continue their downward path until a pool of molten steel is formed and the melting of the scrap raises the level of the bath. The course is then upward until all the scrap is added. The layer of solid steel on the bottom cannot be melted by keeping the heat on the bath and without overheating or injuring the furnace. The trouble seems to be due to lack of circulation, the hot metal being on the top. This circulation can be insured by the addition of iron ore, which causes the metal to boil and so washes out the layer of frozen metal. Hematite has proved most satisfactory for this purpose, as its action is quick and the effect on the slag is slight. Frequent testing of the bottom with a steel bar is necessary; for, after the steel is free, continued boiling will wash out magnesite, causing slag troubles. This condition is common when using heavy scrap. When proper scrap is available the density of the charge may be so arranged that the electrodes will penetrate near to and will heat the bottom. Great care must be used when the scrap is light, especially if the electrodes are penciled, for the pool of steel formed might not be of sufficient depth to prevent the electrodes from boring into the bottom. It is advisable to know the length of the electrode (that is, the distance from the holder to the furnace bottom), so that if the position becomes dangerous the current may be reduced until it starts to rise.

"Several months ago we had a 'heat' of steel nearly ready to pour, but the power went off and the charge froze in the furnace. A break in the line kept the current off until the next day. By chipping away the slag from under the electrodes we were able to start the circuit. After having the current on the solid chunk for two and a half hours the maximum depth of the pool of molten steel was about 3 in. The furnace was getting very hot, so we started feeding ore. When the carbon content became low pig-iron was added. By alternate addition of ore and pig the steel was finished, and the furnace was poured clean within five hours from the start.

"The charging of the furnace influences the melting. Gates and risers make a good charge for the bottom, giving the proper density; and, being at the bottom, the coating of sand does not interfere with the electric conductivity when starting operations. Light scrap is placed on the top and may be piled a foot or more above the doors. A small piece of coke is placed on top of the scrap directly under each electrode. The coke makes a better contact,

acts as a cushion, and prevents violent surges of current when starting. The former practice of using hand-control for starting has been discontinued, and automatic control is now used. Peak loads seldom exceed 850 kw., whereas the working load is between 500 and 600 kw. After a steady arc is formed, usually about five minutes after starting, lime is shoveled around the electrodes to form the basic slag. Later, as the charge melts, more lime is added. If the scrap melts so as to expose part of the roof to the glare and reflected heat of the arc it is well to work over some of the light top scrap with a bar, so as to shade the arc and prevent unequal heating of the roof."

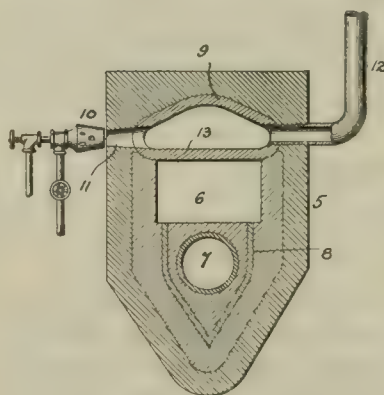
Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Tribenzyl Phosphate in Celluloid Manufacture.—As a colloid agent for cellulose esters, FRITS E. STOCKELBACH, of New York, recommends tribenzyl phosphate in preference to triphenyl phosphate or tricresyl phosphate. As an example, celluloid may be manufactured by mixing 75 parts of nitrocellulose with 25 parts of tribenzyl phosphate or with 10 parts of tribenzyl phosphate and 15 parts of camphor. Celluloid made in this way does not discolor when exposed to light and is much less flammable than the corresponding product made with camphor alone. (1,370,853; assigned to Commonwealth Chemical Corp.; March 8, 1921.)

Modified Induction Furnace for Melting Scrap.—A furnace body 5 has an interior chamber 6 below which is an opening 7 for the primary core and primary coil. Molten metal within the channel 8 forms the secondary, the arrangement being such that the metal in the furnace is kept in circulation by motor effect in channel 8. The circulation promoted in this manner in the lower part of the bath is quite efficient but, owing to the oil and dirt on the scrap metal and the air in the interstices between the fragments, the upper part of the charge may become insulated and separated from the lower part, forming a bridge or arch over the latter in the nature of a crust which is not heated sufficiently to melt, as above pointed out. In order to overcome this drawback and



the consequent loss of efficiency, auxiliary heating means are provided above the upper surface of the charge constituted by a retort 9 of refractory material or the like formed in or adjacent to the roof portion of the furnace. This retort 9 serves as a combustion chamber and is heated interiorly by an oil burner 10 or the like, which in this instance is arranged exteriorly of the furnace and is adapted to project a jet of flame into the retort through an opening 11. (1,370,632; WALTER R. CLARK, of Bridgeport, Conn., assignor to Bridgeport Brass Co.; March 8, 1921.)

Distilling Column for Ammonia.—In the operation of apparatus in which a volatile content of a liquid, as ammonia, is distilled off by passing steam through the liquid, it sometimes happens that the liquor admitted at the top of the column does not flow freely through it, but accumulates to an abnormal depth in the pans composing it, thus checking up the upward flow of steam and to a greater or less extent blocking the operation. This difficulty is due to the fact that the steam rising from the

boiling liquid in the overflow passages opposes the flow of liquid from the pans to the passages to such an extent that the flow of liquid is checked, thus increasing the depth of liquid in the pans. This increase in the depth of the liquid seal in the pans tends to prevent the steam passing up through the column from following its normal path and to cause it to break through into the overflow passages, thus increasing the original difficulty. An improved apparatus has been designed by GEORGE W. CRUPE of Buffalo, N. Y. Referring to the drawing, A indicates a distillation column, composed of a series of superimposed rings B, B. In each ring is a pan, or faux fond, C, having a central opening c, over which is a hood, or passette, D, whereby steam passing up through the column and through the openings c is forced to pass through the liquor in the pans. Leading from each pan to the pan below is an overflow pipe or passage E, whereby the liquor, overflowing from the several pans, passes downward from pan to pan, through the column. Connected with upper part of each of the overflow pipes E, and preferably with the cover plate e of the overflow pipe, is a vent pipe, F, the upper, or discharge, end of which is above the inlet opening of the overflow pipe and preferably directly under the pan or faux fond of the next succeeding ring above.

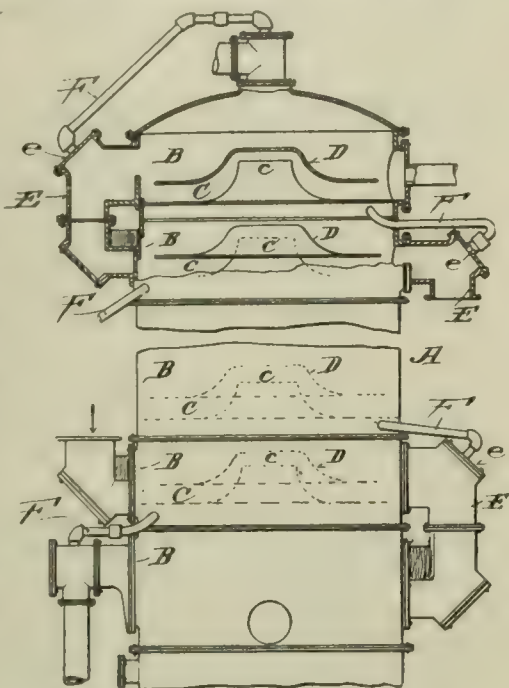
In the operation of the device the steam rising from the highly heated liquor in the overflow passage E is free to discharge through the vent pipe F, instead of passing through the inlet opening of the overflow pipe E, and thus is prevented from obstructing the flow of liquor into the overflow pipe.

By this means a more rapid feed of liquor to the column is made possible, and with a uniform feed of liquor a substantially constant depth of liquor is maintained in each pan, thus insuring uniformity and cleanness of operation. (1,372,649; assigned to Semet-Solvay Co.; March 22, 1921.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

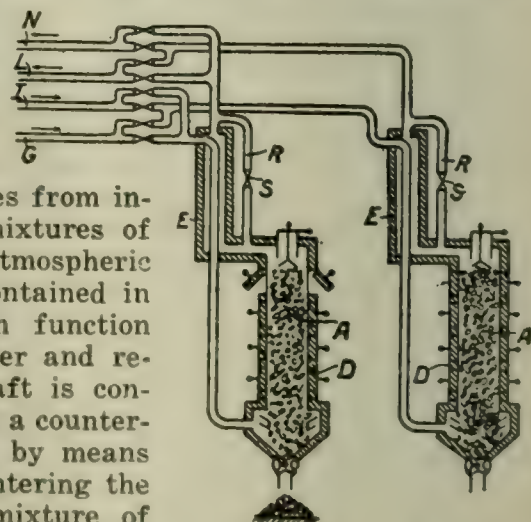
Dispersoids.—Dispersoids or colloidal suspensions of ores, dyes, paints, graphite, sulphur, cellulose or other materials are obtained by pounding or rubbing the ground substance in a dispersion medium which is a non-conductor or a bad conductor of electricity, the moving surfaces having a velocity of not less than 2,000 m. per minute, and preferably of 1,000 m. per second. Dispersion may be assisted by adding solvent chemical agents, or those which form labile compounds with the dispersion medium without much ionization, or those which assist the formation of compounds between the material to be dispersed and the dispersion medium. A colloidal suspension of sulphur may be made by dispersing flowers of sulphur with water or other medium, with or without the addition of protective colloids such as benzol or carbon bisulphide. Molten sulphur may also be converted into the dispersoid condition, the temperature being gradually lowered during the operation. Sulphur may be refined by treating the dispersoid with acid, washing, and dispersing again in pure water. The colloidal solutions may be used for disinfection, or for treating plants. Colloidal graphite is made by dispersing crude graphite with hot water, then cooling while under treatment, allowing to stand, decanting from the sediment, and drying.



Potash olein soap, barium, phenol-sulphonic acids such as naphtho-disulphonic acids may be added to accelerate the process of dispersion. Colloidal ultramarine is made by dispersing a mixture of coarse grained ultramarine and olein soap with water or an organic dispersion medium such as benzol, or alcohol with or without the addition of oil or turpentine: the product is dried. Other colors—e.g., iron, cobalt, zinc, lead, nickel or chrome colors—or lithopone or dyes may be similarly treated. Alkali, oils, or phenol-sulphonic acids may be used, instead of soap, as accelerators. An "enamel substance," such as artificial or natural resin, size, cellulose ester, copal, etc., may be dispersed in organic solvents for the production of enamels "in which the lakes are not dissolved but dispersed." Cellulose—for instance, wood pulp—is dispersed in water with or without the addition of gelatin, protein or soap and alkali, the cellulose is rendered flocculent by addition of acid, separated and dried under vacuum. The mass is homogeneous and may be pressed in molds. Organosols of cellular materials such as cellulose may be obtained by means of benzol, acetone, etc.; small quantities of cellulose ester soluble in acetone can be used as accelerators of dispersion. (Br. Pat. 155,836; not yet accepted; H. PLAUSON, Hamburg, and J. A. VIELLE, Westminster. See also Pat. 156,142. March 2, 1921.)

Arsenobenzene Derivatives.—Stable solutions are obtained by mixing solutions of 3:3'-diamino-4:4'-dioxyarsenobenzene sulphonylate and the sodium salt of 3:3'-diamino-4:4'-dioxyarsenobenzene or the complex silver compound thereof, or by mixing the two ingredients in powder form and dissolving the mixture. The resulting solution contains the two ingredients in chemical combination, that made from the sodium salt not being precipitated by carbon dioxide, and that made from the silver compound not being precipitated by salt or carbon dioxide. (Br. Pat. 155,577, not yet accepted; G. SPEYER HAUS, assignor to Farbwerke vorm. Meister Lucius & Bruning, Hoechst-on-Main, Germany; Feb. 23, 1921.)

Separation of Atmospheric Nitrogen.—Relates to the production of nitrogen by absorption of oxygen from a mixture of nitrogen and oxygen by means of metals such as iron, followed by the regeneration of the oxide produced; and consists in utilizing the heat generated by the absorption reaction to provide the heat required for the regeneration process. Since too large an excess of heat is developed by the use of atmospheric air in the absorption reaction, gases containing only about 10 per cent of oxygen are employed—e.g., flue gases from industrial plants, or mixtures of these gases with atmospheric air. The metal is contained in two shafts A, which function alternately as absorber and regenerator. Each shaft is connected at the top with a counter-current preheater E, by means of which the gases entering the shaft—namely, the mixture of nitrogen and oxygen supplied through pipe G or the reducing gas supplied through pipe I—are heated at the expense of the gases leaving the shaft; viz., pure nitrogen by the pipe L or exhauster reducing gas by the pipe N. The preheater can be short-circuited to any required extent by the valved pipe R. The shafts A are covered with adjustable heat-insulating plates D, in order to control the radiation of heat therefrom. The active mass of metal may also be varied. The danger arising from the formation of soot is avoided by introducing carbon dioxide into the water gas before it enters the regeneration apparatus. The carbon dioxide may be that contained in water gas which has already been through the apparatus. (Br. Pats. 155,814 and 155,815; not yet accepted; C. T. THORSELL and H. L. R. LUNDEN, Gothenburg, Sweden. March 2, 1921.)



Current Events

in the Chemical and Metallurgical Industries

Nitrogen Research to Continue

The U. S. Fixed Nitrogen Research Laboratory at American University, Washington, D. C., will be continued under War Department auspices for the present for the purpose of completing and rounding out experiments now under way and so that a comprehensive report of research activities on nitrogen fixation and utilization may be prepared. There is also a desire to continue this laboratory until the War Department is assured that it can obtain sufficient nitrogen from domestic sources to meet its needs. After that the laboratory is to be turned over to the Department of Agriculture, which is expected to continue the experimentation as to nitrogen fixation and utilization. No forecast can be given at this time as to when the transfer will be made.

This is a part of the ruling of the Secretary of War in the matter of the department's nitrate policy. He also decided that the Nitrate Division of the Bureau of Ordnance should remain as an entity. In addition he reached the conclusion that pending the development of the fixation of atmospheric nitrogen by private industry, to the point where an adequate supply of nitrogen to meet the government's requirements is assured, the government plants at Sheffield, Ala., and at Muscle Shoals, known as Plants No. 1 and No. 2, will be retained in the most economical stand-by condition.

The research work being done at the Fixed Nitrogen Laboratory is on a large scale. Expenditures in connection with that activity now are being made at the rate of \$250,000 a year. More than 100 chemists are employed. Work now will be concentrated on completing the present studies and designs of synthetic ammonia process and on the completion of a comprehensive report on nitrogen fixation and utilization.

Dye Control Amendment Goes to Senate

The emergency tariff bill was reported to the Senate April 30 containing Title V, which is to be known as the "dye and chemical control act, 1921." It was found that sufficient funds are now available to continue the work of dye and chemical control for another six months. This resulted in the elimination of the appropriation carried in the Knox amendment as originally drafted. Several other minor changes were made. As reported to the Senate the dye and chemical title reads:

Sec. 501. (a) That on and after the day following the enactment of this act, for the period of six months, no sodium nitrite, no dyes or dyestuffs, including crudes and intermediates, no product or products derived directly or indirectly from coal tar (including crudes, intermediates, finished or partly finished products, and mixtures and compounds of such coal-tar products), and no synthetic organic drugs or synthetic organic chemicals, shall be admitted to entry or delivered from customs custody in the United States or in any of its possessions unless the Secretary determines that such article or a satisfactory substitute therefor is not obtainable in the United States or in any of its possessions in sufficient quantities and on reasonable terms as to quality, price and delivery, and that such article in the quantity to be admitted is required for consumption by an actual consumer in the United States or in any of its possessions within six months after receipt of the merchandise.

(b) Upon the day following the enactment of this act the War Trade Board Section of the Department of State shall cease to exist; all clerks and employees of such War Trade Board Section shall be transferred to and become clerks and employees of the Treasury Department and all books, documents, and other records relating to such dye and chemical import con-

trol of such War Trade Board Section, shall become books, documents and records of the Treasury Department. All individual licenses issued by such War Trade Board Section prior to the enactment of this act shall remain in effect during the period of their validity, and the importations under such licenses shall be permitted. All unexpended funds and appropriations for the use and maintenance of such War Trade Board Section shall become funds and appropriations available to be expended by the Secretary in the exercise of the power and authority conferred upon him by this section.

Sec. 502. That this title may be cited as the "Dye and Chemical Control Act, 1921."

In its report urging the adoption of the title the Committee on Finance said:

At the present time the importation of coal-tar dyes and certain chemicals is regulated by means of licenses issued by the War Trade Board Section of the State Department, under the provisions of the trading with the enemy act approved Oct. 6, 1917, and the proclamation of the President of Feb. 14, 1918. It is deemed advisable to continue the present licensing system for a period of six months after the enactment of the proposed amendment in order that the Congress may have ample time to enact into law permanent tariff legislation covering importations of dyes and chemicals. The proposed amendment is deemed to be necessary because the powers of the War Trade Board Section of the State Department to grant licenses for the importation of dyes and chemicals are limited to the duration of the present war. The proposed amendment is limited to the dyes and chemicals the importation of which is now limited by licensing, and provides for the granting of licenses upon substantially the same terms as under the requirements for the importation of dyes and chemicals from enemy countries.

The proposed amendment provides for the transfer of the functions of the War Trade Board Section, including its clerks and employees, books, documents, and records, to the Treasury Department. The proposed amendment also provides that any unexpended funds and appropriations made for the use and maintenance of the War Trade Board Section shall be available to be expended by the Secretary of the Treasury in the exercise of the power and authority conferred upon him by the proposed amendment.

Annual Tables of Constants and Numerical Data

The publication of the Annual Tables of Constants and Numerical Data, Chemical, Physical and Technological, which was interrupted during the war, has now been resumed by an international commission acting under the authority of the International Union of Pure and Applied Chemistry.

Subscriptions to Volume IV, containing all numerical data published during the years 1913 to 1916 inclusive, will be received up to May 31 at the following rates: Part I only, \$12.50 bound, \$11 unbound; Parts I and II, \$25 bound, \$22 unbound. Part I, containing the constants from "Compressibility" to "Electricity," will be delivered probably early in July; Part II, with the remaining constants, some months later. Subscription blanks can be obtained from the American Commissioner, Prof. E. W. Washburn, University of Illinois, Urbana, Ill. Remittances should be made to the Chicago University Press, Chicago, Ill.

Orders for Volumes I, II and III will be received at \$7.20 each. Vol. I is, however, not sold separately, owing to limited supply. Volume V, covering the years 1917 to 1920 inclusive, is in preparation and will be ready for distribution late in 1922.

Preliminary Program, American Leather Chemists Association

At the meeting of the American Leather Chemists Association to be held at Atlantic City June 9 to 11 topics will be discussed which will be of interest to the practical men of the industry as well as the chemists.

The committee in charges announces the following preliminary program:

Colloids, Prof. Holmes (University of Cincinnati); Chestnut Wood Tannin, R. W. Griffith; Notes on the Extraction of Leather, Bureau of Chemistry; Post-Mortem Tests on Hide, G. D. McLaughlin; Moisture in Leather and Tannin Materials, T. D. Jarrell; Relation of South America to the Leather Industry, G. A. Kerr; Conditions in the Leather Industry, L. J. Robertson; Tanning Materials in the Far East, Dr. L. Balderston; Demonstration of the Explosiveness of Tannery and Leather Dusts, Bureau of Chemistry; Some Further Comments on the Wilson-Kern Method of Analysis, G. W. Schultz.

A symposium is to be held on the general subject of Synthetic Tannins. Various committee reports for the years 1920-1921 will be presented by the chairmen. The final program will be given out later.

Aims and Organization of the Materials Handling Division, A.S.M.E.

The new Materials Handling Division of the American Society of Mechanical Engineers is planning sessions for the discussion of "Design and Construction of Machinery for Road Building" at the Society's spring meeting to be held at the Congress Hotel, Chicago, May 23 to 26. Four papers will treat this problem from the viewpoint of the contractor, the road builder, and possible future development of mechanical equipment in road building.

The work of this Division, whose membership is rapidly approaching one thousand, is now well under way. The executive committee of the Division has adopted the report of the aims and organization committee, which mapped out a comprehensive working scheme. The executive committee is composed of R. M. Gates, chairman, Philadelphia; H. V. Coes, vice-chairman, New York; N. C. Johnson, New York; F. A. Wardenberg, Wilmington, Del.; and Kern Dodge, Philadelphia. The aims and organization committee is headed by F. M. Feiker of New York. Describing the aims of the Division, this report says:

"Materials handling is largely a mechanical engineering problem. It divides itself into two parts: (1) The consideration of the detailed design and operation of mechanical equipment for handling material, and (2) the economical and efficient application of this equipment in the arts and industries. The purpose of this Division is to organize, direct and promote these two foregoing objects. The formation of a Division will stimulate engineering thought and provide a method of expression which will make possible the more efficient methods and means of handling the commodities in our daily life. The Division shall have the following specific objects:

"To co-ordinate and correlate existing data and information, to find the gaps in the knowledge so as to bridge them, and to render the sum total available to the greatest possible number.

"To work toward standardization of methods and designs wherever feasible and possible with the belief that such standardization will reduce costs of handling materials.

"To promote actively the discussion of materials handling in all its economic and engineering phases to the end that it may take its rightful place in future engineering thought and opinion.

"To point out the economic wastes of duplication of effort, of manual labor and of undirected and unplanned material handling in all its phases.

"To aim to correlate the work of all engineers in materials handling.

"To co-operate with other divisions or other associations and organizations.

"To initiate and aid research.

"To assist in solving national, state and community handling problems.

"To establish an information division which would be prepared to furnish such information as a compendium of all devices now on the market, a list of references classified under materials handling."

The activities of the Division are outlined as follows:

"Materials handling in this division is concerned only with what may be called the problems of secondary transportation of materials and commodities. It does not concern itself with the broad transportation problems of the common carriers, or the tributaries to common carriers.

"Materials handling has to do with the multitudinous operations of 'picking up and putting down' materials in process of production, and the handling problems of the linkages between common carriers and delivery to the user."

Discussing the method of approach to the problem of materials handling, the report says:

"The objective in any materials handling problem is the reduction of costs. The professional division therefore will approach the problem in general as follows:

"Make a survey of the existing industry to ascertain the present state of the art.

"Make studies for the improvement of machinery and equipment for the handling of materials.

"Ascertain ways and means of reducing costs."

Prime consideration will be given to two sets of problems in the field of the Materials Handling Division: (1) The technical problems of the industries, and (2) the commercial fields of materials-handling machinery.

The report sums up the spirit of the new Division with this striking statement:

"The subject of materials handling should be taken out of a rule-of-thumb basis and put on an engineering basis in all its phases. To this end the Professional Materials Handling Division of the A.S.M.E. should devote itself."

Research Fellowships in the College of Mines, University of Washington

The College of Mines of the University of Washington offers four fellowships in mining, ceramic and metallurgical research in co-operative work with the Bureau of Mines. The fellowships are open to graduates of universities and technical schools who are properly qualified to undertake research investigations. The value of each fellowship is \$900 per year of twelve months, beginning July 1. Fellowship holders are required to register as graduate students and to become candidates for the degree of Master of Science in mining engineering or metallurgy, or ceramics, unless an equivalent degree has previously been earned.

The purpose of these fellowships is to undertake the solution of various problems being studied by the United States Bureau of Mines that are of especial importance to the State of Washington, the Pacific Northwest and Alaska. The investigations consist principally of laboratory work directed largely by the bureau's technologists. For the year 1921-22 the following subjects have been selected for investigation:

(1) Beneficiation of coal, especially coal washing.

(2) Electrometallurgy. Electrothermic and electrolytic treatment of various mineral resources.

(3) Ceramics. Survey and testing of the clay resources of the Northwest to determine their economic utilization.

Applicants should send a copy of their collegiate records from the registrar's office of the college where they have been, or will be, graduated. They should also state their professional experience and give the names and addresses of at least three persons who are familiar with the character, training and ability of the applicant. Applications are due not later than June 1, and should be addressed to the Dean, College of Mines, Seattle, Wash.

Sugar Mills in the Hawaiian Islands Listed

Information concerning the sugar mills of the Hawaiian Islands, including the names of the companies, agents, location of factories, date of erection, and capacities, is contained in a list compiled by the Far Eastern Division, Bureau of Foreign and Domestic Commerce, Washington, for which request file No. FE-26004.

An Association of Employees' Clubs

On May 25 a conference will be held in New York City to effect organization of an association of the employees' clubs of America. Active membership will consist of clubs, associations or societies of employees of industrial, financial, mercantile or other organizations having for their main purposes social, athletic, educational, thrift and savings, health, safety or other similar mutual benefit activities; companies having "clubs" holding active membership will be associate members.

The direct purpose is exchange of such service, information and experiences between member clubs as will aid in increasing their usefulness and the enthusiasm of their membership. The more general purposes will be to promote better understanding and more cordial relations among employees and between employees and employers generally.

Plans for the organization have been under way for several months by a temporary committee with headquarters on the 22d floor, Times Building, New York City. All concerns or persons interested in such activities are urged to get in touch immediately with the chairman or other members of the executive committee: C. Lester Horn, chairman, 22d Floor, Times Building; Roger Steffan, educational director, National City Bank, New York City; L. W. DeMotte, director of personnel, American Express Co., 65 Broadway, New York City; D. A. Henderson, personnel manager, Knox Hat Co., 601 Grand Ave., Brooklyn, New York; J. Marshall, staff secretary, Alexander Hamilton Institute, 13 Astor Pl., New York City; George E. Morgan, welfare supervisor, Otis Elevator Co., 260 Eleventh Ave., New York City; Dr. C. E. Ford, General Chemical Co., 25 Broad St., New York City; MacLean Libbey, secretary, Stanley Insulating Co., 200 Fifth Ave., New York City.

Rochester Meeting, Division of Chemistry and Chemical Technology, Research Council

A meeting of the Division of Chemistry and Chemical Technology, National Research Council, was held at the Hotel Powers, Rochester, on the afternoon of April 27. Chairman Cottrell announced that the International Research Council would meet at Brussels on June 27 and that the United States is to be represented by six members. Prof. H. N. Holmes of Oberlin College presented a report reflecting favorably upon the activities of his colloid chemistry committee: Over 100 lectures had been delivered by members of the committee during the course of last year on various phases of colloid chemistry; the interest in colloid chemistry was increasing remarkably fast; Bancroft issued a long list of colloid chemistry problems, many of which have been taken up by the laboratories; Holmes issued a reference list of books and periodical literature compiled for those who cared to study the subject of colloids more fully; Bancroft and Holmes each published a book on colloid chemistry. An equally favorable and highly encouraging report was presented by Dr. E. W. Washburn on ceramic research during 1920. Among other things, a fellowship in ceramics has been established. In the discussion of the report it was suggested to include electrical porcelain in the program for this year. Dr. Bancroft reported on the activities of the contact catalysis committee, referring in particular to the very successful symposium recently held on the subject.

Charles E. Munroe, chairman of the committee on explosives investigations, outlined the work that his committee had performed during the past year: The list of literature references on explosives has been brought up to date, starting with the earliest publications; a detailed record of accidents has been kept, together with accounts of causes and suggestions for future prevention of such accidents. Dr. Munroe further suggested that the numerous investigations on explosives carried out during the war be written up, collected and published. Steps in this direction had already been taken by the British Government and a number of volumes already published.¹ The Council decided to take up Dr. Munroe's suggestion. Dr. J. M. Francis presented a brief report on pharmaceutical research; Dr. Stieglitz dis-

cussed the situation of research in synthetic drugs. Since the armistice the interest in research in these drugs has waned.

Dr. H. T. Clarke brought up the question of preparing lists of research chemicals. The difficulties encountered by investigators at present was to locate certain chemicals essential to their experiments. The idea was to prepare lists of both organic and inorganic chemicals with brief references as to where each could be obtained. The chair appointed a committee to undertake the work. A lengthy discussion followed on the publication of Tables of Critical Constants; Dr. H. K. Moore, chairman of the committee, reported that \$100,000 had been received in subscriptions. Dr. Johnson of Yale advised that Dr. C. J. West, formerly with A. D. Little, Inc., had been appointed editor of the tables.

At the conclusion of the meeting the following officers of the Division were elected for the ensuing year: Chairman, F. G. Cottrell; vice-chairman, Julius Stieglitz; executive committee, F. G. Cottrell, Julius Stieglitz, W. D. Bancroft, Colin G. Fink, W. F. Hillebrand, R. B. Moore; members at large, Treat B. Johnson, R. B. Moore.

Opposes Duty on Iron Pyrites

That a duty on pyrites will not protect the domestic product from sulphur competition was one of the arguments used by C. H. MacDowell, president of the National Fertilizer Association, who was granted a special hearing by the subcommittee on chemicals of the Ways and Means Committee of the House of Representatives. Mr. MacDowell stated that the production of pyrites from domestic sources is very expensive, in addition to being unsatisfactory in some ways for consumption by the interests which are large users of Spanish pyrites. A duty on pyrites, he declared, would have the effect of applying protection to sulphur, a product which exists domestically in such large quantities as to enable the United States to dominate the world's market and consequently is in no need of protection.

The chances seem favorable for some duty on potash. It is regarded as practically certain, however, that the committee will not approve as much as 50c. a unit, which was the amount asked by the domestic producers.

Every precaution is being taken by the members of the Committee on Ways and Means to prevent the dissemination of any information as to the schedules on which the subcommittees are agreeing. Due to the fact that these schedules are likely to be changed by the full committee it is believed that unnecessary agitation would be created by allowing the day-to-day conclusions to be announced. It is pointed out that ample time will remain after the permanent tariff bill is reported for those concerned to "shoot" at any of its schedules. The probabilities are that the bill will not be reported until near the end of May.

National Fertilizer Association to Meet at White Sulphur Springs

The twenty-eighth annual convention of the National Fertilizer Association, which will be held at White Sulphur Springs, W. Va., the week beginning June 20, 1921, will have a program of reconstruction and co-operation.

The program will include addresses and discussions on subjects that are of vital interest to the fertilizer manufacturer in view of present business conditions. These subjects will include costs and cost-accounting systems, chemical and manufacturing problems, sales methods, labor and transportation problems, etc. The officers of the association are now arranging the details and promise a meeting which will be of unusual interest and lasting benefit to everyone identified with the fertilizer industry. On account of the importance of the program a large attendance is expected.

During the same week the Southern Fertilizer Association will hold its summer meeting; the soil improvement committee of the National Fertilizer Association will hold a subscribers' and committee meeting; the soil improvement committee of the Southern Fertilizer Association will hold a committee meeting.

¹Publishers, His Majesty's Stationery Office, London.

Oilfield Developments in Northern Canada

The Canadian Department of Mines has changed its plans with regard to the method of transporting the geologists assigned to the Fort Norman and Windy Point districts. Arrangements had been made with the Canadian Air Force for the aerial transportation of both men and supplies, but this has been found to be too costly, and the slower, but possibly surer, method of transportation by barges is to be used. Barges are being constructed for the purpose, and will travel by way of the Peace, Slave, and Mackenzie rivers. The Imperial Oil Co. will adhere to its original plan of transporting men and supplies by air, the two all-metal airplanes already having made one trip to Windy Point, Great Slave Lake, carrying 1,000 lb. gasoline each. They returned without mishap, and, it is expected, will leave for Fort Norman within a few days.

A good deal of opposition is being brought against the bill in the legislature at Edmonton, Alta., to grant a pipeline right-of-way to the Imperial Oil Co. The route is not specified and very wide powers are asked. The company consequently has withdrawn the bill. The legislature will take up pipe-line legislation next session.

The Imperial Oil Co. will erect a small refinery near Fort Norman during the coming summer to provide gasoline for the company's airplanes and power boats. It is expected that a sufficient quantity will be made to supply other concerns in the district.

The British Columbia Department of Mines has let a contract to Lynch Bros. of Seattle to sink a 2,000-ft. bore-hole near the south fork of the Red River, about 20 miles northwest of Hudson Hope. Prof. John A. Dresser was employed to make a reconnaissance survey of the oil possibilities of this section of the Peace River region, and it is on his recommendation that the hole is being sunk.

Joint Brands and Trade Marks Used in Foreign Markets by U. S. Export Associations

A new feature in the development of foreign trade, reported by the Federal Trade Commission, is the adoption of joint, uniform brands and trade marks by associations organized under the Webb-Pomerene law for the purpose of export trade. Heretofore, in most cases, individual members of an association have retained their own marks on exports; but under the new plan an association brand or trade mark may be adopted to cover all goods shipped by the combine.

In advertising American goods abroad concentration on one or a few brands or marks which convey a guarantee of quality has proved to be much better business than the use by one association of a bewildering number of individual marks which may compete with one another and confuse the foreign buyer. Aside from advertising value, this feature represents an important step toward co-operation in export trade.

The U. S. Alkali Export Association of New York has abandoned the use of individual marks, and reports the adoption of a new association trade mark which will be advertised through agencies in South America, Cuba and Mexico.

The trade mark "Apex" is found on about 200 varieties of paper and board shipped by the American Paper Exports, Inc., of New York to Europe, Asia, Africa and South America.

The Consolidated Steel Corporation of New York advertises under the mark "Consteco."

Trade marks and stenciled designs are used by the Cement Export Co., Inc., of New York; the American Tanning Materials Co. of New York; and other associations operating in export trade under the Webb-Pomerene law.

Employment in Chemical Industries Decreases

A decrease of 2.3 per cent in employment in the chemical industries took place during April, according to an announcement by the Department of Labor. There was a decrease of 3.2 per cent in employment in the stone, clay and glass industries.

Administration Favors Fact Finding

Some opposition is being voiced in the non-metallic mineral industries to certain of the fact-finding activities of the Federal government. In that connection it may be mentioned that there is overwhelming opinion in Congress in favor of compulsory returns from industry of certain fundamental facts. It is the policy of the administration to favor legislation of this type, rather than that which contemplates regulatory supervision. For the immediate present it is expected that compulsory fact finding will be required only as to coal and three or four other basic industries. Once the legislative precedent is established, however, an extension of the policy could be put through promptly if it could be shown that the public interest would be served. One of the best ways to insure the enactment of such legislation is for producers to refuse to supply fundamental data voluntarily.

Aluminum Sulphate Used at Water-Purification Plants in Illinois, 1920

Data collected relative to use of aluminum sulphate at twenty-two of the water-purification plants in Illinois during 1920 show that 2,300 tons of alum was used, ranging from 5 tons at some of the smaller plants to about 780 tons at the largest plant. The cost ranged from \$24 to \$160 a ton. Analyses made at some of the plants show Al_2O_3 , 17 to 17.25 per cent; insoluble matter, 0.1 to 0.2 per cent; Fe, 0.5 to 0.75 per cent. In some instances the alum is purchased without specifications, and in others the specifications vary considerably. The alum has been purchased from four different companies.

Two Cent Duty on Sugar Asked

A duty of 2c. on imports of sugar is being urged by domestic cane producers for the permanent tariff bill. The emergency tariff measure carries a duty of 1.16c. per lb. It is understood that the subcommittee has decided on 1.6c. per lb. for the permanent tariff bill.

A duty of 100 per cent ad valorem is being urged for adonite, arabinose, dulcitol, galactose, inositol, inulin, levulose, mannitol, d-talose, d-tagatose, ribose, melibiose, dextrose testing above 99.7 per cent, mannose, melittose, raffinose, rhamnose, salicin, sorbitol, xylose and others of the higher saccharides required for scientific purposes.

Weights and Measures Conference

The fourteenth annual meeting of the National Conference on Weights and Measures will be held at the Bureau of Standards in Washington, D. C., May 23 to 26. The announcement by Representative Vestal that he sees no reason for delaying further the discussion before his Committee on Weights and Measures of the respective merits of the existing system of weights and measures and those of the metric system insures the discussion of that topic at the forthcoming meeting.

Congress May Ban Deceptive Containers

Legislation prohibiting the use of containers shaped so as to deceive or mislead the purchaser as to the "quantity, quality, size, kind or origin" of the contents may be expected at this session of Congress. It will be in the form of an amendment to the food and drugs act which has been introduced by Representative Haugen, chairman of the Committee on Agriculture.

To Investigate Muscle Shoals Projects

The American Farm Bureau Federation has appointed a committee to investigate thoroughly the questions involved in the Muscle Shoals controversy. The committee is authorized to engage engineers and to incur necessary expense of a thorough probe, with the idea of developing whether or not the government development on the Tennessee River would be beneficial to the agricultural industry. The committee consists of John Brown, Indiana; W. G. Jamison, Colorado, and Chester H. Gray, Missouri.

Personal

Dr. RAYMOND F. BACON addressed the Delaware Section of the American Chemical Society on Monday evening, May 2. His subject was "Some Problems in the American Sulphur Industry."

ERNEST J. P. BENN, member of Benn Bros., Ltd., publishers of the *Chemical Age*, London, England, and other technical magazines, who is making a visit to the United States, was entertained at luncheon at the Engineers' Club on May 5 by the Associated Business Papers, Inc.

EDMUND W. CRAFT of the Thermoid Rubber Co., Trenton, N. J., gave an interesting address on the subject of crude rubber before the members of the local Engineers' Club at a recent meeting. A. H. Greywacz, of the same company, followed Mr. Craft with a comprehensive talk on some of the technical features of rubber processes.

Dr. MAX MUELLER, president of the Rhodia Chemical Co., New York, is on a pleasure trip to the Pacific Coast, accompanied by Mrs. Mueller.

HOWARD M. RAYMOND has been appointed acting president of the Armour Institute of Technology to fill temporarily the vacancy caused by the death of Dr. F. W. Gunsaulus. Acting President Raymond is a graduate of the University of Michigan, and is well known professionally throughout the Middle West. He has been connected with the Institute for the past twenty-six years, and has served as dean of engineering since 1903.

Dr. JOHN E. TEEPLE has been elected president of the Chemists' Club.

JOHN THOMAS, the chief chemist of Scotch Dyes, Ltd., and J. E. Breckinridge, a director of the same company, both of Carlisle, Scotland, are in the United States on a business visit.

Obituary

ARTHUR R. WILLIS, chemical expert for the Tariff Commission, lost his life in an accident on the Potomac River Sunday, April 24. He was twenty-nine years of age and had been with the Tariff Commission nearly three years, having had charge of the compilation of the Census of Dyes and Coal-Tar Chemicals.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, May 9, 1921.

There was some improvement shown in chemical inquiries during the past week and reports of better business are becoming more frequent. Throughout the trade the month of April seems to have shown a decided change over previous months. The inertia of the market has necessarily made the change gradual, nevertheless activity is moderately increasing. While at the present rate it will still require a number of months to reach anything like normal conditions, the progress is encouraging. The labor and freight problems are still the most unfavorable factors confronting the producers of chemicals.

FOREIGN COMPETITION

Foreign competition is being strongly reflected in the chemical market. Imported materials are still figuring

very largely in the situation and in the majority of cases domestic manufacturers realize the futility of trying to meet the importers' prices. There are a few cases, however, where competition is keen between domestic and foreign goods for interior points, with the advantage resting with the manufacturer on account of freight charges. Imported *prussiate of soda*, *citric* and *tartaric acids*, *chlorates*, *bleach* and *caustic potash* are being offered below producers' prices here. *Soda ash* is another item that is attracting some attention. This chemical has been sold for shipment in practically every case. It is understood that sellers of this material are not eager to bring ash in unless sold ahead. Prompt shipments of ash were offered by importers at \$1.90 per 100 lb. ex-dock New York. Producers have not announced any further change in either ash or caustic soda prices and it is understood that a fair business is being placed for home consumption in both items. Standard brands of caustic soda and soda ash have remained steady on spot and the market looked firmer at the close than it did at the opening. The call for small lots of bichromate of soda was sufficient to hold the market around 7½c. per lb. Imported prussiate of soda was slightly firmer during the week under tighter offerings and a better inquiry. Oxalic acid has maintained a firm tone on both foreign and domestic material and demand has kept prices at 17c. per lb. and above all week.

OUTLOOK MORE FAVORABLE

The outlook in general may be considered more favorable. A settlement of the German reparations question will bring about a far-reaching change in affairs. The position of the Allies would be materially strengthened financially and otherwise. It will mean an early revival of trade with Europe. International credits and exchanges would soon be stabilized. With the return of the second greatest trading nation a new revival in world commerce would be seen everywhere. Additional markets for American goods, therefore, would be opened.

GENERAL CHEMICALS

Hydrochloric acid prices are fairly steady in the absence of any pronounced activity. Commercial acid in carboys is quoted at prices based on \$1.65 per 100 lb. for the 20 deg. grade. Larger quantities could be obtained down to \$1.50. Following continued shading in various directions, makers are now quoting lower prices on 66 deg. sulphuric acid. Prices based on tank carlots f.o.b. works are quoted at \$18@20 per ton. Business has been rather slow. Prices on *oleum* and 60 deg. acid have remained practically unchanged. Lack of demand for *ammonium sulphate* prevents possible firmness and prices, while quoted on the former basis, are subject to shading in all directions. Quotations of \$2.75 per 100 lb. for export in double bags can undoubtedly be shaded to a decided extent and the bulk price at works, which has been quoted at \$2.75, can now be had as low as \$2.50 per 100 lb. White *arsenic* can be had as low as 7½c. per lb., although there are a few holders in the market at 8c. per lb. Little interest has been noted in the *bleach* market during the week and prices have been easy in most directions. The resale market is around \$2.50 per 100 lb., with works delivery from second hands down to \$2.25. Manufacturers are holding their quoted prices around \$2.75 per 100 lb. f.o.b. works. Resale *bichromate of potash* is not in heavy supply at present and most dealers quote 11¼@12c. per lb. for limited quantities. In some quarters sales of odd lots have been made down to 11½c. per lb.

Makers of *caustic potash* are quoting lower prices based on 12c. per lb. for the 88-92 per cent material and are unable to attract buyers in view of the state of the market. Resellers of American reshipped material are offering at 4½c. per lb., but the condition of these goods is very doubtful. Importers are quoting German potash at 5½@6c. per lb. An advance in shipment prices from abroad in *prussiate of soda* had a strengthening influence on spot quotations. At the close the market was quoted firm at 11¼@12½c. per lb. The market on *carbonate of potash* continues inactive and prices are rather soft. Offerings of 96-98 per cent

carbonate are heard at 9c. per lb. Holders of this and lower grades are eager to accept any reasonable offer on their material. Makers of *salt cake* are in a position to offer their goods below recent figures. Prices are now named at \$30@\$35 per ton for the bulk. Resellers and importers of *acetate of soda* are competing at prices around 4½c. per lb. Makers are holding off and their prices are around 6½c. per lb. Spot offerings of *nitrite of soda* are not to be found below 5½c. per lb. Stocks in resale hands are still heavy, although the market generally shows signs of strength. Improvement in demand for *copper sulphate* has taken place during the week and considerable business has been placed for agricultural requirements. Export inquiries have also increased and it looks as though France, Italy and South America are going to be fair buyers. In the case of European countries their production is restricted on account of the scarcity of raw material and they are looking to America for supplies. The domestic copper market has remained quite firm for the past few weeks and this condition seems to have convinced consumers of the sulphate that the market has really reached bottom. Leading producers quote carlots at 5½c. per lb. for the standard 99 per cent large crystals. The outlook for business in this chemical is considered better than for some time past. Moderate quantities of standard brand *caustic soda* were on the market around \$3.65@\$3.70 per 100 lb. ex-store N. Y. and \$3.75 f.a.s. steamer. Carlot trading has remained rather quiet in the open market, although it is understood that producers have been able to place a fair business at the works. Contracts are quoted at 3½@3¾c. per lb., basis 60 per cent f.o.b. works. Resale lots of light *soda ash* in single bags were distinctly firm in the final trading and dealers stated that it is doubtful if spot material could be purchased under \$2.05 per 100 lb. Barrels sold higher at \$2.30 per 100 lb. The feeling on spot goods was very steady even though a considerable amount of imported goods was noted to arrive. At the works producers quoted \$1.62½@\$1.72½ per 100 lb., basis 48 per cent, for single bags.

COAL-TAR PRODUCTS

A revival of interest in some directions has been noted in the coal-tar products market. Some very sizable orders have been placed in the resale market during the week, but as a rule sellers have been forced to sacrifice on prices. After the long period of inactivity, however, any movement is a welcome sign to holders. Those with any accumulated stocks are so tired that they are willing to make any concessions that will start some active trading. It is only recently that consumers have been willing to exhibit any interest in taking on stocks. Few price changes have been noticed which can be taken as indicating anything radical. The crude market remained steady during the week with a fair trading in *benzene* and *naphthalene*. Intermediates in general are in better demand with no special changes.

There were rumors of new strength in *benzene* without any confirmation. Competition among refiners has been quite keen for any business that has been around and offers have been made at prices below quotations where there was a possibility of developing actual business. Quotations on pure benzene are based on 27c. per gal. in tank cars and range up to 32c. in drums. *Aniline oil* ranges from 21@26c. per lb. *Beta naphthol* sales in some large volume have been reported in the resale market during the week. The prices quoted have undergone no noticeable change as the transactions were more or less of a private nature. Offerings were generally around 33c. per lb. with sales recorded down to 32c. Makers are finding no business at their quoted prices of 40@45c. per lb. Factors of *H acid* say that the past week has witnessed a little better movement and views of prices of first hands are steady at \$1.40 per lb., while in resale quarters the market was easier and shading possible at \$1.20@\$1.25 per lb. There was little change noted in the market on *benzidine* and trading was moderate with supplies rather steady. The base material ranges from 90@95c. per lb. and the sulphate from 80@85c. Inquiries for *phenol* were more frequent and actual trading was reported in some quarters on a larger scale. Government supplies are still available at 12c. per lb., while in

other quarters nothing much under 10c. was thought possible.

WAXES

Prices on *beeswax* were unsettled, due to freer offerings and rather moderate buying interest. Pure white wax was offered at 45@47c. per lb. with the undertone easier. Crude Brazilian was nominally held at 21@23c. per lb. For the African grade of crude the market closed around 15½@16½c. per lb. Recent heavy importations of *carnauba wax* resulted in easing the spot situation and at the close offerings of the higher grades were noted at 60@62c. per lb. No. 2 North Country was available at 28@30c. per lb., while these figures could have been shaded on actual business. Spot offerings of *Japan wax* were reported at 18@18½c. per lb., indicating that prices were a shade easier. Demand for spot material was quiet and with futures unsettled interest in forward business was also lacking. Despite the uplift in crude petroleum the market for *paraffine wax* was easier throughout the week. Refiners appeared more anxious for business and offerings for scale wax were noted here at prices ranging from 2½@2¾c. for carlots, immediate shipment. Refined paraffine also came out in large volume and at the close there were sellers of 125-127 deg. melting point at 4½c. per lb., with the 130-132 deg. m.p. at 5@5½c. The presence of some distressed material had a depressing influence on the market.

The Chicago Market

CHICAGO, May 6, 1921.

An improvement in the general tone of the industrial chemical market was evident during the past week. Naturally this was noticeable only in certain sections of the market, but the fact that there is any business at all is considered most encouraging. Price changes were few, and most factors seem to think that the majority of items have reached bottom. However, there are several items on the list that are far from the normal level and can be expected to go lower. One of the more important ones in this class is *potassium permanganate*, which has shown a steady decline during the past two months. This material is now offered at 38@40c. per lb. In contrast with the pre-war price of 8@10c., it is only reasonable to expect further reductions.

GENERAL CHEMICALS

Soda ash is quiet, the prevailing quotations being 2½@2¾c. per lb. in small quantities. Caustic soda, 76 per cent, is quite firm and is quoted at \$4.10 per 100 lb. for the solid and \$4.75 for the ground. Holders show no disposition to shade these figures and claim that they are doing a fair volume of business. White granular *ammonium chloride* is in better demand and 9c. per lb. for large casks was the best offer noted. Non-beverage *alcohol*, 190 proof, is quoted by distillers at \$4.85 per gal. for single drums. The completely denatured is lower and No. 6 is available from first hands at 33c. per gal. in 5-drum lots. The mild winter left large quantities of this material on the market and it is available from the holders at almost any price.

Barium chloride is unchanged and is quoted at \$75@\$80 per ton. *Carbon tetrachloride* is very firm and it is doubtful if supplies could be had at a figure lower than 11½c. per lb. *Carbon bisulphide* has also shown a firm tendency and spot material is quoted at 8@8½c., according to quantity. *Formaldehyde* showed a further decline and first hands are asking 15½c. per lb. for barrels. The demand has dropped off somewhat and there seems to be little moving at the present. *Potassium carbonate*, 80-85 per cent, is quoted nominally at 11c., but with large business concessions could probably be secured. Second hands still have control of the *caustic potash* market and 88-92 per cent material is available at 8@8½c. per lb. *Bichromate of potash* is steady, the prevailing quotation being 14½c. per lb. for single casks. *Sodium bichromate* is very firm and holders are asking 9@10c. per lb. for material of standard brands. *Glycerine c.p.* is firmer and is moving in a small way at 17c. per lb. for large or small drums.

The list of acids is unchanged and manufacturers do not seem to contemplate price reductions, at least not in the near

future. There is a fair quantity of *acetic acid*, 28 per cent, moving to the photographic trade at 2½@3c. per lb. in barrels. *Hydrochloric acid* is in limited request and is offered at 2@2½c. per lb. in carboys. There is a somewhat better demand for *sulphuric acid*, which is offered at \$19@ \$20 per ton in tank cars or 2@2½c. per lb. for carboys.

VEGETABLE OILS

Quiet conditions still prevail in this branch of the trade and dealers express little hope for better conditions for several months. *Palm oil* is quoted at 8@10c. per lb., according to the holder. *Soya bean oil* is extremely quiet and is offered at 7½@8c. per lb. in small lots. *Linseed oil* is higher, dealers asking 65@67c. per gal. for the boiled with corresponding prices for the raw.

NAVAL STORES

The local market for naval stores has shown a considerable improvement during the past two weeks. *Turpentine* was advanced sharply, most factors asking 74c. per gal. for a good grade material. *Rosin* is still available at \$8 per 280 lb. for the WG grade, but dealers say that higher prices can be expected.

COAL-TAR PRODUCTS

There were no noteworthy features in the coal-tar market and business was of the same quiet nature that has been characteristic of this branch of the trade for several months. Prices were unchanged, *benzene* being offered at 28@31c. per gal. for the 90 per cent and 30@33c. for the pure. *Toluene* is available at 33c. for the refined grade. *Naphthalene flakes* are moving in a small way to the wholesale drug trade and are offered at 8½@10c. per lb.

The St. Louis Market

ST. LOUIS, May 6, 1921.

Inaugurating our St. Louis letter, we wish to point out that the market comments will be confined chiefly to those articles which are produced and consumed in St. Louis or which move in volume through this distributing center.

Conditions during the past two weeks show some improvement and the general tone is optimistic.

ALKALIS

The *caustic soda* market is very unsettled due to the large consumers buying only for their immediate needs on the spot market and not anticipating their requirements or entering contracts. Prices are \$3.85@\$4.50 per 100 lb. There is little activity in *soda ash*, with a few carload sales reported recently. Round lots are quoted at \$2.95@\$3 per 100 lb., basis 58 per cent. *Sal soda* is moving in the routine way at \$1.95@\$2.50 per 100 lb. *Bicarbonate of soda* is very inactive.

INDUSTRIAL CHEMICALS

There has been no change in price of *aqua ammonia*, and a fair business is being done. The market for *carbon bisulphide* is very firm and buyers should have no hesitancy in ordering liberal quantities. *Copperas* is moving in a fair way and is quoted at 90c.@\$1.00 per 100 lb. f.o.b. producer's works. There has been a decline recently in *sulphur* of ½c. per lb., but this has been counterbalanced by an equal advance in freight rates in the past two weeks. Therefore, *sulphur* continues to hold at 2c. per lb. for the commercial flour.

DRUGS AND PHARMACEUTICALS

Apparently the *acetone* market is firm at 12½@13c., with occasional second-hand lots being offered at a lower figure. There has been a marked improvement in *bismuth* preparations in the past two weeks, the increased demand being probably due to the favorable prices at which they are quoted. The demand for *bromides* is fair, but buyers are ordering only for their immediate needs, hence the market is weak. *Cream of tartar* is in greater demand than expected but *acid tartaric* is weak. *Glycerine* continues weak at 16½c., with no great demand. *Salicylates* are moving fairly well, and there should be no question about buying, as prices have probably reached their lowest.

A fair volume of business in *sodium benzoate* is reported and should show a decided increase very shortly with the approach of the preserving season. Prices on *zinc oxides* remain the same, with an increasing demand for the lead-free, probably due to the revival of the rubber industry. A good volume of business in *zinc stearate* is being done and should continue in view of the summer demand.

VEGETABLE OILS

Linseed oil reacted the past week to a 66c. maximum and is today quoted at 64c. warehouse and in cooperage or 61c. carload for direct shipment from crushers. *Castor oil* is reacting from its low position and is now holding at 9½c.@10c. with a fair demand. *Turpentine* has slowly reacted and is now quoted at 63½c. The recent cold weather has had its effect on the crops to the extent that the yield will be decreased at least 75 per cent in this territory, and as a consequence there is no activity in *insecticides* except for *paris green*, for which there is a good demand on a 30c. basis.

PAINT MATERIALS

The *barytes* market is very firm, with prime quality holding at \$25.50@\$26.50 f.o.b. mills. Apparently the unsettled condition in *lithopone* is disappearing due to the carload buyers again purchasing their usual quantities, and continued activity is expected. Prices are 7@7½c. carload.

ACIDS

The demand for *acids* has been very good and in view of the import price now being on a higher basis than the domestic manufacturers' prices there should be a material increase in sales. *Phosphoric acid sirupy*, with the approach of the soft-drink season, should show quite a bit of life and move in larger volume in the next few weeks. Sales of *gallic*, *pyrogallie* and *tannic acid* have shown a decided increase lately, with many large orders originating in England.

The Iron and Steel Market

PITTSBURGH, May 6, 1921.

Conditions in the iron and steel trade this week are distinctly disappointing, not because they have grown worse, but because they do not record the improvement that was expected from the occurrences of three weeks ago. According to the expectations there should be more business on mill books and a larger operation, but there is not.

In the price equalization of three weeks ago, from a condition in which the independents had much lower prices than the Steel Corporation, the independents advanced their prices somewhat, while the Steel Corporation reduced its prices. As the independents were withdrawing their former prices, they allowed buyers to take advantage of the previous quotations on such tonnages as they were able to specify. By this operation it was thought the independents had rolled up a considerable tonnage of actual business, such as would give them a larger operation. By the Steel Corporation's reducing its prices and of course concurrently revising prices in contracts outstanding, it was the expectation that the corporation would receive specifications against its contracts at a much heavier rate.

The condition the past week, however, has been that the independents have been receiving very little new business and the Steel Corporation has been receiving specifications at what is, on the whole, a very low rate.

The average operating rate of the independents, developed from a symposium of estimates, appears to be only about 30 per cent of capacity, a rate no better than the poorest rate since Jan. 1 and probably somewhat under the maximum rate, which seems to have fallen about April 1. As to the Steel Corporation, its rate is generally believed to be several points below 40 per cent of capacity and at nearly if not quite the poorest rate of the year. In January the Steel Corporation operated at about 90 per cent and the independents at about 30 per cent.

Production of pig iron by the merchant furnaces is at a still lower rate, only between 15 and 20 per cent of capacity. That is to be explained chiefly by the fact that there are stocks of pig iron to be consumed. The great majority of

merchant furnaces are now out of blast, but roughly speaking before the furnaces went out they provided customers with all the pig iron they would take on contract, and also piled iron in their own yards. Doubtless the rate of consumption of merchant pig iron is low, but in all probability it is considerably greater than the present rate of production.

STEEL PRICES HOLDING

The new steel prices are holding, but the real test must come later. There is no incentive at present to cut prices, inquiry being so light. Quotations on leading products are: Billets, \$37; slabs, \$38; sheet bars and small billets, \$39; rods, \$48; bars, 2.10c.; shapes, 2.20c.; plates, 2.20c.; hoops and hot rolled strips, 2.75c.; plain wire, 3c.; wire nails, \$3.25; steel pipe, 61½ per cent basing discount; blue annealed sheets, 3.10c.; black sheets, 4c.; galvanized sheets, 5c.; tin plate, \$6.25.

WAGES

The United States Steel Corporation has announced a general wage reduction, effective Monday, May 16. Common labor is reduced approximately 20 per cent, which presumably means from 46c. to 37c. as the hourly rate, with an adjustment of other wage rates and of salaries. The independents began reducing wages early in December, there being no regularity or uniformity. Some made one large reduction, others two or three smaller ones at intervals. The last important reductions by independents were at the middle of February, involving the leading independents in the Mahoning and Shenango valleys and the leading independent in the Pittsburgh district. While the independent rates have not been uniform, they average about the same as the rates to which the Steel Corporation is now going, from three to five months after the independents took their various actions.

The Steel Corporation makes no change in working conditions, but states that the 12-hour day will probably be eliminated within a year. The basic 8-hour day remains quite generally in force where it previously obtained, men being paid time and a half for hours in excess of eight.

One is given to understand that the Steel Corporation's wage reduction is in relation to the price reductions the corporation made three weeks ago, so that no further modification of the corporation's prices is to be expected at this time. However, the announcement does not seem to have any stimulating influence upon steel buyers, it being regarded rather as a disturbing factor at the moment.

PROSPECTS

Obviously the consumption of steel is at a very low rate compared with the activity of the first nine months of last year, so that there is no prospect of steel being required from the mills at higher than the present rate as long as fundamental conditions remain as they are. The common view is that there will be no material change until next fall, and by reason of temperamental or other differences the time for a definite improvement is variously set from August to October.

PIG IRON

Basic iron remains quotable at \$22.50 valley, with only a very occasional transaction. Foundry iron is quotable at \$24, a 50c. decline, while bessemer remains nominally at \$25. Price prospects are complicated by the fact that freight rate reductions are expected at some indefinite time in the future. Possibly the development of anything like a widespread demand would produce competitive bidding for orders.

COKE

Connellsville coke does not continue to decline as was expected in some quarters. The furnace at Portsmouth, Ohio, which over a month ago bought coke at \$3.50 has renewed the contract for thirty or sixty days more, 500 tons a day, at the reported price of \$3.40, but only the producer holding this contract seems willing to go below \$3.50. Foundry coke remains quotable at \$5 to \$5.50. Prices are per net ton at ovens.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.			\$0.40 -	\$0.45
Acetone.....lb.	\$0.13 -	\$0.13½	.13½ -	.14
Acid, acetic, 28 per cent.....100 lbs.	2.50 -	2.75	3.00 -	3.25
Acetic, 56 per cent.....100 lbs.	4.00 -	4.25	4.50 -	5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	9.50 -	9.75	10.00 -	10.50
Boric, crystals.....lb.	.13½ -	.14	.14½ -	.15
Boric, powder.....lb.	.15 -	.15½	.16 -	.16½
Citric.....lb.			.46 -	.47
Hydrochloric.....100 lb.	1.50 -	1.65	1.75 -	2.00
Hydrofluoric, 52 per cent.....lb.	.13 -	.13½	.14 -	.14½
Lactic, 44 per cent tech.....lb.	.10 -	.11	.11½ -	.12
Lactic, 22 per cent tech.....lb.	.04½ -	.05½	.06 -	.07
Molybde, C. P.....lb.	4.00 -	4.50	4.50 -	5.00
Muriatic, 20 deg. (see hydrochloric).....lb.			.07 -	.07½
Nitric, 40 deg.....lb.	.06½ -	.06½	.07 -	.08½
Nitric, 42 deg.....lb.	.07½ -	.07½	.07½ -	.08½
Oxalic, crystals.....lb.	.17 -	.18	.18 -	.20
Phosphoric, ortho, 50 per cent solution.....lb.	.17 -	.17½	.18 -	.19
Picric.....lb.	.30 -	.32	.35 -	.40
Pyrogallol, resublimed.....lb.			1.90 -	2.15
Sulphuric, 60 deg., tank cars.....ton			12.00 -	13.00
Sulphuric, 60 deg., drums.....ton			14.00 -	15.00
Sulphuric, 66 deg., tank cars.....ton	18.00 -	20.00		
Sulphuric, 66 deg., drums.....ton	22.00 -	22.50	23.00 -	23.50
Sulphuric, 66 deg., carboys.....ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 -	24.00		
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 -	26.00	26.50 -	27.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	32.00 -	35.00	40.00 -	
Tannic, U. S. P.....lb.			.90 -	1.00
Tannic (tech.).....lb.	.50 -	.52	.54 -	.57
Tartaric, crystals.....lb.			.35 -	.39
Tungstic, per lb. of WO.....lb.			1.30 -	1.40
Alcohol, Ethyl.....gal.			4.75 -	5.25
Alcohol, Methyl (see methanol).....gal.				
Alcohol, denatured, 188 proof.....gal.			.34 -	.38
Alcohol, denatured, 190 proof.....gal.			.40 -	.45
Alum, ammonia lump.....lb.	.04 -	.04½	.04½ -	.04½
Alum, potash lump.....lb.	.04½ -	.04½	.04½ -	.05
Alum, chrome lump.....lb.	.13 -	.13½	.14 -	.14½
Aluminum sulphate, commercial.....lb.	.02½ -	.02½	.02½ -	.03
Aluminum sulphate, iron free.....lb.	.03 -	.03½	.03½ -	.04
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07½ -	.07½	.08 -	.08½
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 -	.32	.33 -	.35
Ammonium carbonate, powder.....lb.	.07 -	.07½	.08 -	.09
Ammonium chloride, granular (white salamoniac) (nominal).....lb.	.06½ -	.06½	.07 -	.07½
Ammonium chloride, granular (gray salamoniac).....lb.	.08½ -	.08½	.09 -	.09½
Ammonium nitrate.....lb.	.08 -	.08½	.09 -	.10
Ammonium sulphate.....100 lb.	2.50 -	2.75	2.80 -	2.90
Amylacetate.....gal.			4.00 -	4.25
Amylacetate tech.....gal.			3.00 -	3.25
Arsenic oxide, (white arsenic) powdered.....lb.	.07½ -	.08	.08½ -	.08½
Arsenic, sulphide, powdered (red arsenic).....lb.	.12 -	.12½	.13 -	.14
Barium chloride.....ton	60.00 -	65.00	70.00 -	75.00
Barium dioxide (peroxide).....lb.	.19 -	.20	.21 -	.22
Barium nitrate.....lb.	.10 -	.10½	.10½ -	.11
Barium sulphate (precip.) (blanc fixe).....lb.	.04½ -	.05	.05½ -	.06
Bleaching powder (see calc. hypochlorite).....lb.				
Blue vitriol (see copper sulphate).....lb.				
Borax (see sodium borate).....lb.				
Brimstone (see sulphur, roll).....lb.				
Bromine.....lb.	.40 -	.41	.42 -	.45
Calcium acetate.....100 lbs.	1.90 -	2.00		
Calcium carbide.....lb.	.04½ -	.04½	.05 -	.05½
Calcium chloride, fused, lump.....ton	27.00 -	29.00	30.00 -	32.00
Calcium chloride, granulated.....lb.	.01½ -	.01½	.02 -	.02½
Calcium hypochlorite (bleach powder) 100lb.	2.50 -	2.65	2.70 -	2.90
Calcium peroxide.....lb.			1.25 -	1.50
Calcium phosphate, tribasic.....lb.			.15 -	.16
Camphor.....lb.			.65 -	.68
Carbon bisulphide.....lb.	.07 -	.07½	.07½ -	.08
Carbon tetrachloride, drums.....lb.	.10 -	.10½	.11 -	.12
Carbonyl chloride (phosgene).....lb.			.75 -	1.00
Caustic potash (see potassium hydroxide).....lb.				
Caustic soda (see sodium hydroxide).....lb.				
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08 -	.09	.09 -	.10
Chloroform.....lb.			.38 -	.40
Cobalt oxide.....lb.			3.00 -	3.10
Copperas (see iron sulphate).....lb.				
Copper carbonate, green precipitate.....lb.	.23 -	.24	.25 -	.27
Copper cyanide.....lb.			.50 -	.62
Copper sulphate, crystals.....lb.	.05½ -	.05½	.05½ -	.06
Cream of tartar (see potassium bitartrate).....lb.				
Epsom salt (see magnesium sulphate).....lb.				
Ethyl Acetate Com. 85%.....gal.			.90 -	1.00
Ethyl Acetate pure (acetic ether 98% to 100%).....gal.				
Formaldehyde, 40 per cent.....lb.	.14 -	.14½	.14½ -	.15
Fusel oil, ref.....gal.			3.25 -	3.50
Fusel oil, crude.....gal.			1.50 -	1.75
Glauber's salt (see sodium sulphate).....lb.			.17 -	.17½
Glycerine, C. P. drums extra.....lb.			3.75 -	3.85
Iodine, resublimed.....lb.			.10 -	.20
Iron oxide, red.....lb.			1.10 -	1.25
Iron sulphate (copperas).....100 lb.	.75 -	1.00	.11½ -	.13½
Lead acetate.....lb.			.09½ -	.10
Lead arsenate, paste.....lb.	.08½ -	.09	.15 -	.20
Lead nitrate.....lb.			.09½ -	.10
Litharge.....lb.	.08½ -	.09	1.25 -	
Lithium carbonate.....lb.			.11 -	.12
Magnesium carbonate, technical.....lb.	10½ -	11		
Magnesium sulphate, U. S. P.....100 lb.	2.75 -	3.00	1.25 -	2.25
Magnesium sulphate, technical.....100 lb.			.75 -	.77
Methanol, 95%.....gal.			.78 -	.82
Methanol, 97%.....gal.			.13 -	.13½
Nickel salt, double.....lb.			.14 -	.14½
Nickel salt, single.....lb.				
Phosgene (see carbonyl chloride).....lb.			.47 -	.50
Phosphorus, red.....lb.	.45 -	.46	.35 -	.37
Phosphorus, yellow.....lb.			.11½ -	.12
Potassium bichromate.....lb.				

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar).....	lb.	\$.35 - .40	\$0.30 - \$0.35
Potassium bromide, granular.....	lb.	.17 - .30	.17 - .30
Potassium carbonate, U. S. P.....	lb.	.35 - .40	.45 - .50
Potassium carbonate, crude.....	lb.	.06 - .07	.08 - .09
Potassium chlorate, crystals.....	lb.	.08 - .09	.10 - .14
Potassium cyanide.....	lb.	.30 - .32	.30 - .32
Potassium hydroxide (caustic potash).....	lb.	.05 - .05½	.06 - .08
Potassium muriate.....	ton	50.00 - 50.50	
Potassium iodide.....	lb.		2.75 - 3.00
Potassium nitrate.....	lb.	.09 - .09½	.10 - .12½
Potassium permanganate.....	lb.	.32 - .33	.34 - .35
Potassium prussiate, red.....	lb.	.33 - .35	.36 - .38
Potassium prussiate, yellow.....	lb.	.27 - .27½	.28 - .29
Potassium sulphate (powdered).....	per unit		1.75 - 1.80
Rochelle salts (see sodium potas tartrate)			
Salammoniac (see ammonium chloride)			
Salt soda (see sodium carbonate)			
Salt cake.....	ton		30.00 - 35.00
Silver cyanide.....	oz.		1.30 - 1.35
Silver nitrate.....	oz.		.41 - .42
Soda ash, light.....	100 lb.	2.05 - 2.10	2.15 - 2.40
Soda ash, dense.....	100 lb.	2.40 - 2.45	2.50 - 2.75
Sodium acetate.....	lb.	.04 - .04½	.05 - .05½
Sodium bicarbonate.....	100 lb.	2.50 - 2.60	2.70 - 3.00
Sodium bichromate.....	lb.	.07 - .08	.08 - .08½
Sodium bisulphate (nitre cake).....	ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphate powdered, U.S.P.....	lb.	.05 - .05½	.05 - .06
Sodium borate (borax).....	lb.	.06 - .06½	.07 - .07½
Sodium carbonate (sal soda).....	100 lb.	2.00 - 2.10	2.15 - 2.50
Sodium chlorate.....	lb.	.07 - .07½	.08 - .08½
Sodium cyanide.....	lb.	.20 - .22	.23 - .30
Sodium fluoride.....	lb.	.12 - .12½	.13 - .14
Sodium hydroxide (caustic soda).....	100 lb.	3.65 - 3.75	3.80 - 4.00
Sodium hyposulphite.....	lb.		.03 - .04
Sodium nitrate.....	100 lb.	2.75 -	2.85 -
Sodium nitrite.....	lb.	.05 - .06	.06 - .07
Sodium peroxide, powdered.....	lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic.....	lb.	.04 - .04½	.05 - .05½
Sodium potassium tartrate (Rochelle salts).....	lb.		.27 - .28
Sodium prussiate, yellow.....	lb.	.11 - .11½	.12 - .12½
Sodium silicate, solution (40 deg.).....	lb.	1.25 - 1.35	1.40 - 1.50
Sodium silicate, solution (60 deg.).....	lb.	.02 - .03	.03 - .03½
Sodium sulphate, crystals (Glauber's salt).....	100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide, fused, 60-62 per cent (conc.).....	lb.	.05 - .05½	.06 - .06½
Sodium sulphite, crystals.....	lb.	.03 - .04	.04 - .04½
Strontium nitrate, powdered.....	lb.	.15 - .15½	.16 - .17
Sulphur chl ride, red.....	lb.	.07 - .07½	.07 - .08
Sulphur, crude.....	ton	20.00 - 22.00	
Sulphur dioxide, liquid, cylinders extra.....	lb.	.08 - .08½	.09 - .10
Sulphur (sublimed), flour.....	100 lb.		2.25 - 3.10
Sulphur, roll (brimstone).....	100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent.....	lb.	.18 - .19	
Tin oxide.....	lb.		.40 - .42
Zinc carbonate, precipitate.....	lb.	.16 - .18	.19 - .20
Zinc chloride, gran.....	lb.	.11 - .11½	.11 - .12
Zinc cyanide.....	lb.	.45 - .49	.50 - .60
Zinc dust.....	lb.	.12 - .13	.13 - .14
Zinc oxide, XX.....	lb.	.08 - .09	.09 - .10
Zinc sulphate.....	lb.	.03 - .03½	.04 - .05

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude.....	lb.	\$1.10 - \$1.15
Alpha-naphthol, refined.....	lb.	1.25 - 1.30
Alpha-naphthylamine.....	lb.	.35 - .40
Aniline oil, drums extra.....	lb.	.21 - .26
Aniline salts.....	lb.	.26 - .29
Anthracene, 80% in drums (100 lb.).....	lb.	.75 - 1.00
Benzaldehyde U.S.P.....	lb.	1.00 - 1.50
Benzidine, base.....	lb.	.90 - .95
Benzidine sulphate.....	lb.	.80 - .85
Benzoic acid, U.S.P.....	lb.	.65 - .70
Benzoate of soda, U.S.P.....	lb.	.65 - .70
Benzene, pure, water-white, in drums (100 gal.).....	gal.	.27 - .32
Benzene, 90%, in drums (100 gal.).....	gal.	.25 - .28
Benzyl chloride, 95-97%, refined.....	lb.	.28 - .30
Benzyl chloride, tech.....	lb.	.20 - .25
Beta-naphthol benzoate.....	lb.	3.50 - 4.00
Beta-naphthol, sublimed.....	lb.	.70 - .75
Beta-naphthol, tech.....	lb.	.33 - .45
Beta-naphthylamine, sublimed.....	lb.	2.00 - 2.25
Cresol, U. S. P., in drums (100 lb.).....	lb.	.16 - .18
Ortho-cresol, in drums (100 lb.).....	lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums.....	gal.	.90 - .95
Cresylic acid, 75-97%, dark, in drums.....	gal.	.85 - .90
Cresylic acid, 50%, first quality, drums.....	gal.	.55 - .60
Dichlorobenzene.....	lb.	.07 - .08
Diethylaniline.....	lb.	1.20 - 1.25
Dimethylaniline.....	lb.	.45 - .55
Dinitrobenzene.....	lb.	.30 - .32
Dinitrochlorobenzene.....	lb.	.20 - .30
Dinitronaphthalene.....	lb.	.30 - .40
Dinitrophenol.....	lb.	.35 - .40
Dinitrotoluene.....	lb.	.25 - .27
Dip oil, 25%, tar acids, car lots, in drums.....	gal.	.40 - .45
Diphenylamine.....	lb.	.60 - .70
H-acid.....	lb.	1.30 - 1.50
Meta-phenylenediamine.....	lb.	1.20 - 1.25
Monochlorobenzene.....	lb.	.12 - .14
Monoethylaniline.....	lb.	1.75 - 1.85
Naphthalene crushed, in obls. (250 lb.).....	lb.	.08 - .08½
Naphthalene, flake.....	lb.	.08 - .09½
Naphthalene, balls.....	lb.	.09 - .10½
Naphthalenic acid, crude.....	lb.	.70 - .75
Nitrobenzene.....	lb.	.12 - .15
Nitro-naphthalene.....	lb.	.30 - .35
Nitro-toluene.....	lb.	.16 - .18
Ortho-amidophenol.....	lb.	3.15 - 3.40
Ortho-dichlor-benzene.....	lb.	.15 - .20
Ortho-nitro-phenol.....	lb.	.75 - .80
Ortho-nitro-toluene.....	lb.	.17 - .20
Ortho-toluidine.....	lb.	.20 - .25
Para-amidophenol, base.....	lb.	1.60 - 1.75
Para-amidophenol, HCl.....	lb.	1.75 - 1.85

Para-dichlorobenzene.....	lb.	.15 - .20
Paranitroaniline.....	lb.	.85 - 1.05
Para-nitrotoluene.....	lb.	.85 - 1.00
Para-phenylenediamine.....	lb.	1.95 - 2.00
Para-toluidine.....	lb.	1.25 - 1.60
Phthalic anhydride.....	lb.	.50 - .60
Phenol, U. S. P., drums (dest.), (240 lb.).....	lb.	.11 - .13
Pyridine.....	gal.	2.00 - 3.50
Resorcinol, technical.....	lb.	1.75 - 1.85
Resorcinol, pure.....	lb.	2.25 - 2.30
Salicylic acid, tech., in bbls. (110 lb.).....	lb.	.22 - .23
Salicylic acid, U. S. P.....	lb.	.21 - .22
Salol.....	lb.	.85 - .95
Solvent naphtha, water-white, in drums, 100 gal.....	gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal.....	gal.	.14 - .16
Sulphanilic acid, crude.....	lb.	.30 - .35
Tolidine.....	lb.	1.35 - 1.45
Toluidine, mixed.....	lb.	.40 - .45
Toluene, in tank cars.....	gal.	.25 - .28
Toluene, in drums.....	gal.	.28 - .31
Xylidines, drums, 100 gal.....	lb.	.40 - .45
Xylene, pure, in drums.....	gal.	.42 - .45
Xylene, pure, in tank cars.....	gal.	.45 - .45
Xylene, commercial, in drums, 100 gal.....	gal.	.33 - .35
Xylene, commercial, in tank cars.....	gal.	.30 - .35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark.....	lb.	\$0.23 - \$0.25
Beeswax, refined, light.....	lb.	.25 - .27
Beeswax, white pure.....	lb.	.45 - .47
Carnauba, Flora.....	lb.	.60 - .61
Carnauba, No. 2, North Country.....	lb.	.28 - .30
Carnauba, No. 3, North Country.....	lb.	.17 - .18
Japan.....	lb.	.18 - .18½
Montan, crude.....	lb.	.07 - .08
Paraffine waxes, crude match wax (white) 105-110 m.p.....	lb.	.04 - .04½
Paraffine waxes, crude, scale 124-126 m.p.....	lb.	.03 - .03½
Paraffine waxes, refined, 118-120 m.p.....	lb.	.03 - .04
Paraffine waxes, refined, 125 m.p.....	lb.	.04 - .04½
Paraffine waxes, refined, 128-130 m.p.....	lb.	.04 - .05
Paraffine waxes, refined, 133-135 m.p.....	lb.	.06 - .06½
Paraffine waxes, refined, 135-137 m.p.....	lb.	.06 - .06½
Stearic acid, single pressed.....	lb.	.09 - .10
Stearic acid, double pressed.....	lb.	.10 - .11
Stearic acid, triple pressed.....	lb.	.11 - .11½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.....	280 lb.	\$5.50 -
Rosin E-I.....	280 lb.	6.30 - 6.40
Rosin K-N.....	280 lb.	6.50 - 6.70
Rosin W. G.-W. W.....	280 lb.	6.80 -
Wood rosin, bbl.....	280 lb.	6.25 -
Spirits of turpentine.....	gal.	.82 -
Wood turpentine steam dist.....	gal.	.80 -
Wood turpentine, dest. dist.....	gal.	.78 -
Pine tar pitch, bbl.....	200 lb.	7.00 -
Tar, kiln burned, bbl. (500 lb.).....	bbl.	12.50 -
Retort tar, bbl.....	500 lb.	12.50 -
Rosin oil, first run.....	gal.	.40 -
Rosin oil, second run.....	gal.	.44 -
Rosin oil, third run.....	gal.	.47 -
Pine oil, steam dist., sp gr., 0.930-0.940.....	gal.	1.80 -
Pine oil, pure, dest. dist.....	gal.	1.50 -
Pine tar oil, ref., sp.gr. 1.025-1.035.....	gal.	.46 -
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.....	gal.	.35 -
Pine tar oil, double ref., sp.gr. 0.965-0.990.....	gal.	.75 -
Pine tar, ref., thin, sp.gr., 1.080-1.960.....	gal.	.35 -
Turpentine, crude, sp. gr., 0.900-0.970.....	gal.	1.20 -
Hardwood oil, f.o.b. Mich., sp.gr., 0.960-0.990.....	gal.	.35 -
Pinewood creosote, ref.....	gal.	.52 -

Solvents

73-76 deg., steel bbls. (85 lb.).....	gal.	\$0.41 -
70-72 deg., steel bbls. (85 lb.).....	gal.	.39 -
68-70 deg., steel bbls. (85 lb.).....	gal.	.38 -
V. M. and P. naphtha, steel bbls. (85 lb.).....	gal.	.29 -

Crude Rubber

Para-Upriver fine.....	lb.	\$0.17 - .17½
Upriver coarse.....	lb.	.11 - .11½
Upriver caucho ball.....	lb.	.14 - .14½
Plantation—First latex crepe.....	lb.	.19 - .19½
Ribbed smoked sheets.....	lb.	.17 - .18
Brown crepe, thin, clean.....	lb.	.15 - .15½
Amber crepe No. 1.....	lb.	.17 - .17½

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.....	lb.	\$0.09 - \$0.09½
Castor oil, AA, in bbls.....	lb.	.10 - .10½
China wood oil, in bbls. (f.o.b. Pac. coast).....	lb.	.08 - .09
Cocoonut oil, Ceylon grade, in bbls.....	lb.	.10 - .10
Cocoonut oil, Cochinchina grade, in bbls.....	lb.	.10 - .11
Corn oil, crude, in bbls.....	lb.	.07 - .07½
Cottonseed oil, crude (f. o. b. mill).....	lb.	.05 - .05½
Cottonseed oil, summer yellow.....	lb.	.07 - .07½
Cottonseed oil, winter yellow.....	lb.	.07 - .07½
Linseed oil, raw, car lots (domestic).....	gal.	.60 - .61
Linseed oil, raw, tank cars (domestic).....	gal.	.53 - .53½
Linseed oil, in 5-bbl lots (domestic).....	gal.	.63 - .65

Olive oil, Denatured.....	gal.	\$1.35	—	\$1.50
Palm, Lagos.....	lb.	.06	—	.07
Palm, Niger.....	lb.	.05	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.05	—	.06
Peanut oil, refined, in bbls.....	lb.	.10	—	.10 ¹ / ₂
Rapeseed oil, refined in bbls.....	gal.	.86	—	.88
Rapeseed oil, blown, in bbls.....	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07	—	.07 ¹ / ₂
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.04	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.42	—	\$0.43
Yellow bleached menhaden.....	gal.	.45	—	.....
White bleached menhaden.....	gal.	.48	—	.....
Blown menhaden.....	gal.	.80	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	25.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	11.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	.....
Blanc fixe, dry.....	lb.	.05	—	.05 ¹ / ₂
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.16
Chalk, domestic, extra light.....	lb.	.05	—	.05 ¹ / ₂
Chalk, domestic, light.....	lb.	.04 ¹ / ₂	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04 ¹ / ₂	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	25.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07 ¹ / ₂	—	.08
Graphite, Ceylon chip.....	lb.	.06	—	.06 ¹ / ₂
Graphite, high grade amorphous crude.....	lb.	.02 ¹ / ₂	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05 ¹ / ₂
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1 ¹ / ₂ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.57	—	.....
Shellac, orange superfine.....	lb.	.60	—	.....
Shellac, A. C. garnet.....	lb.	.46	—	.....
Shellac, T. N.....	lb.	.50	—	.....
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	14.00	—	15.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	35.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	.....	.....
Carborundum refractory brick, 9-in.	1,000	1250.00	.....	.....
Chrome brick, f.o.b. Eastern shipping points.....	1,000	1100.00	.....	.....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	80-100	.....	.....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	45-50	.....	.....
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	net ton	.....	55	.....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	.....	.....
Magnesite brick, 9-in. straight.....	net ton	90	.....	.....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105	.....	.....
Magnesite brick, soaps and splits.....	net ton	120	.....	.....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	45-55	.....	.....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	45-55	.....	.....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	45-55	.....	.....

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	15	—	.16
Ferrochrome per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	16	—	.17
Ferromanganese, 76-80% Mn, domestic.....	gross ton	85.00	—	90.00
Ferromanganese, 76-80% Mn, English.....	gross ton	85.00	—	90.00
Spiegelisen, 18-22% Mn.....	gross ton	32.00	—	35.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50	—	.....
Ferrosilicon, 10-15%.....	gross ton	50.00	—	55.00
Ferrosilicon, 50%.....	gross ton	80.00	—	85.00
Ferrosilicon, 75%.....	gross ton	145.00	—	150.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	45	—	.50
Ferrotungsten, 35-50% of U, per lb. of U content.....	lb.	6.00	—	.....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00	—	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.45	—	.50
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.45	—	.50
Coke, foundry, f.o.b. ovens.....	net ton	4.50	—	5.00
Coke, furnace, f.o.b. ovens.....	net ton	3.25	—	3.75
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00	—	16.00
Fluorspar, lump, f.o.b. Hea h'len, New Mexico.....	net ton	17.50	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.50
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 ¹ / ₂	—	.01 ¹ / ₂
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.25	—	.30
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.14	—	.14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.14	—	.14
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.13
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	—	3.25
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	.....
Zircon, washed, iron free.....	lb.	.03	—	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.625
Aluminum, 98 to 99 per cent.....	28.00@28.5
Antimony, wholesale lots, Chinese and Japanese.....	5 ¹ / ₂ @5 ¹ / ₂
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	0.35
Monel metal ingots.....	0.38
Monel metal, sheet bars.....	0.40
Tin, 5-ton lots, S. rail.....	32.00
Lead, New York, spot.....	4.85
Lead, E. St. Louis, spot.....	4.65@4.75
Zinc, spot, New York.....	5.45
Zinc, spot, E. St. Louis.....	4.95

OTHER METALS

Silver (commercial).....	oz.	\$.60
Cadmium.....	lb.	1.00-1.10
Bismuth (500 lb. lots).....	lb.	1.50@1.65
Cobalt.....	lb.	4.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00-75.00
Iridium.....	oz.	250.00@300.00
Palladium.....	oz.	65.00@70.00
Mercury.....	.75 lb.	45.00-46.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	20.50-20.75
Copper bottoms.....	28.00-28.25
Copper rods.....	19.25-20.00
High brass wire.....	18.25
High brass rods.....	15.25
Low brass wire.....	20.25
Low brass rods.....	20.25
Brazed brass tubing.....	29.00
Brazed bronze tubing.....	34.25
Seamless copper tubing.....	22.00
Seamless high brass tubing.....	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	8.50@9.00	18.50	10.00	10.50
Copper, heavy and wire.....	8.00@8.25	16.50	9.50	9.50
Copper, light and bottoms.....	7.00@7.50	14.50	9.00	8.50
Lead, heavy.....	3.25@3.50	7.25	4.00	4.00
Lead, tea.....	2.15@2.30	5.25	3.00	3.00
Brass, heavy.....	4.25@4.50	9.50	7.00	10.00
Brass, light.....	3.00@3.25	8.00	5.00	5.50
No. 1 yellow brass turnings.....	4.00@4.25	9.50	5.50	6.00
Zinc.....	2.00@2.50	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.50	\$3.23	\$3.23
8 ft steel bars.....	2.50	3.00	3.13
Soft steel bar shapes.....	2.50	3.13	3.13
Soft steel bands.....	2.85	3.83	3.78
Plates, 1/2 to 1 in. thick.....	2.50	3.30	3.23

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Arkansas

FORT SMITH.—The Fording Refinery Co., recently organized with a capital of \$250,000, has acquired property at Van Buren, Ark., comprising about 17 acres of land, as a site for the erection of a new oil refinery with initial daily capacity of about 500 bbl. A plant for the extraction of gasoline will also be constructed. E. F. Blanchard is president, and John H. Vaughn, secretary.

Alabama

ANNISTON.—The Anniston Electric Steel Co., recently organized, is considering the erection of a number of additions to the plant of the Anniston Steel Works, which it has acquired for the manufacture of electric steel products. The company will make a specialty of electric steel castings, gray iron and other castings. G. C. Illingworth is vice-president and general manager.

BIRMINGHAM.—The Johnson-Thompson Foundry Co., North 26th St., is planning for the erection of an addition to cost about \$22,000.

California

LOS ANGELES.—The Co-Operative Glass Co., Bank of Italy Bldg., has filed plans for the erection of a new plant at 751 South Daly St., to comprise mold shop, 40 x 75 ft., and main glass manufacturing works, 90 x 180 ft. The Pozzo Construction Co., 421 Macy St., has the building contract.

DOWNEY.—The West Coast Asbestos Co. is planning for the erection of a number of new buildings at its local plant. Equipment will be installed to double the present capacity.

Delaware

WILMINGTON.—The Atlas Powder Co., du Pont Bldg., is planning for the erection of a new plant for the manufacture of carbon products, to be operated by its subsidiary organization, the Darco Corp. The new plant will have an initial output of 6,000 tons, and will include refining works and other departments.

Georgia

MACON.—The Buckeye Cotton Oil Co. is reported to be planning for the rebuilding of its local plant, recently destroyed by fire with loss estimated at about \$135,000, including machinery.

ATLANTA.—The Diamond Holdfast Rubber Co., 33 Auburn Ave., has acquired property totaling about 11 acres, as a site for the erection of a new plant for the manufacture of rubber products, including rubber cement and adhesive rubber compounds. The works will comprise a group of buildings, with main 2-story structure.

Indiana

DUNKIRK.—The Indiana Glass Co. has awarded a contract to the Austin Co., Euclid Ave., Cleveland, O., for the erection of a new 1-story manufacturing plant, 60 x 100 ft.

JEFFERSONVILLE.—Colgate & Co., 105 Hudson St., Jersey City, N. J., manufacturer of soaps and kindred products, has acquired the Indiana Reformatory property at Jeffersonville, from the state, for the establishment of a new branch plant. The company will take possession of the property within a few months and will remodel the different structures and install necessary machinery. The works will specialize in the manufacture of soap products, washing powders and cleansing compounds. It is expected to give employment to about 1,000 operatives for initial operatives.

Louisiana

SHREVEPORT.—The United States Window Glass Co., Morgantown, W. Va., is perfecting plans for the erection of its proposed new plant at Shreveport, to consist of a number of 1- and 2-story buildings, estimated to cost in excess of \$2,000,000 with

machinery. The company is operating a plant at Morgantown, and was recently incorporated with a capital of \$4,000,000. Walter A. Jones is president. The DeVore Co., 908 Nicholas Bldg., Toledo, O., is architect and engineer for the new Shreveport plant.

Maryland

BALTIMORE.—The United States Industrial Alcohol Co. is having plans prepared for the erection of a 1-story addition to its plant in the Curtis Bay section, 60 x 180 ft. The company has recently filed plans for another building at the plant to cost about \$18,000.

FROSTBURG.—Fire, April 22, caused by an explosion, destroyed a portion of the works of the Big Savage Fire Brick Co., with loss estimated at about \$25,000.

MOUNT SAVAGE.—The Mount Savage Fire Brick Co. has awarded a contract for the erection of an addition to its plant to Golin Gerlach, Frostburg, Md. A power plant will also be constructed.

Minnesota

MINNEAPOLIS.—The Minnesota Mfg. Co., 722 North 3d St., manufacturer of sweeping compounds and other chemical products, is having plans prepared for the erection of a 2-story and basement plant, 16 x 132 ft., on Eighth St., near Third St. Perry Crosier, 915 New York Life Bldg., is architect.

Missouri

ST. LOUIS.—The Herman Oak Leather Co., 4030 North Main St., is taking bids for the erection of a 2-story and basement plant addition, 25 x 70 ft., to cost about \$22,000. L. C. Herman is head.

KANSAS CITY.—The Standard Steel Works, 1722 Tracy St., will break ground at once for the erection of a new 2-story addition 25 x 115 ft., at North Kansas City, to cost in excess of \$55,000. Contract for erection recently was awarded to Fred Crites, 2136 Bellevue Ave.

New Jersey

CAMDEN.—The Camden Coke Co. is arranging for the installation of a new battery of coke ovens. The company is a subsidiary of the Public Service Corporation, Newark, N. J., which has secured permission from the Board of Public Utility Commissioners to issue notes for \$1,496,000 to defray the cost of the work.

NEWARK.—The Celluloid Co., 290 Ferry St., is having plans drawn for the erection of an addition to its plant. Alterations and improvements will also be made in existing buildings at the plant.

NEW BRUNSWICK.—Johnson & Johnson, manufacturers of chemicals, drugs, etc., will dispose of a portion of their local plant, consisting of a 2-, 3- and 5-story building, totaling about 122,215 sq.ft. in area.

NEWARK.—The American Pipe & Bending Co. has taken bids for the erection of a new 1-story plant on Coit Street, 60 x 120 ft., to cost about \$20,000. Strombach & Mertens, 1091 Clinton Ave., are architects.

New York

BROOKLYN.—The Burley Welding Works, 22-24 Kosciusko St., is taking bids for the erection of a new 3-story plant, 40 x 100 ft., to cost about \$50,000. Edward M. Adelson, 1778 Pitkin Ave., Brooklyn, is architect.

Oklahoma

SAND SPRINGS.—The Oklahoma Tanning & Mfg. Co., Tulsa, has acquired property at Sand Springs, totaling about 5 acres, for the erection of a new leather tannery. The initial works will cost about \$45,000. Uley Holderman is president.

Pennsylvania

ERIE.—The Keystone Rubber Co., 11th St., is reported to be planning for the rebuilding of its plant, destroyed by fire, April 28, with loss estimated at about \$500,000, including machinery. The fire was caused by an explosion of chemicals.

AMBRIDGE.—The Columbus Steel & Shafting Co., Carnegie, Pa., has completed plans for the erection of its proposed new plant at Ambridge, to consist of a group of 1-story buildings, estimated to cost about \$3,000,000 with machinery. Hopkinson & Schaeffer, 500 Marion Bldg., Cleveland, O., are architects.

Tennessee

CHATTANOOGA.—The Signal Mountain Cement Co., 1022 James Bldg., will soon take bids for the erection of a new local plant for the manufacture of cement, estimated to cost in excess of \$200,000. A. F. Miller, 205 James Bldg., is engineer.

Texas

BURNET.—The Sulphur Oil Co. is planning for the development of ichthyol properties in this section. The company has extensive deposits and it is said that so far as is known at the present time, the material is not found in any other place in this country. A retining plant is proposed for the production of ammonium ichthyolate from the raw material.

COMMERCE.—The Trinity Paper Mills, Dallas, Tex., is completing plans for the erection of its proposed new paper mill at Commerce, to have an initial capacity of 50 tons. The plant will specialize in the manufacture of writing papers, tissue, blotting and other papers. George W. Lull is president.

THREE RIVERS.—The Three Rivers Glass Co., recently organized, is perfecting plans for the erection of its proposed new local plant for the manufacture of flint glass bottles. The initial plant unit will cost about \$30,000, and is expected to be ready for occupancy in the fall. It will be supplemented by other plant buildings at an early date. John Finkbeiner is manager.

Virginia

ROCKY MOUNT.—The Vicama Mica Co. Inc., Hagerstown, Md., recently incorporated, is planning for the operation of mica properties in this section, as well as in North Carolina. The company will also produce feldspar and kindred products. Considerable equipment will be acquired for operations. John W. and J. R. Feldman, 3 Hamilton Row, Hagerstown, head the company.

RICHMOND.—The Pioneer Products Co., recently incorporated with a capital of \$1,000,000, will operate a local plant for the manufacture of rubber products. H. C. Wilder, Malone, N. Y., is president, and W. C. Faulkner, Richmond, secretary.

West Virginia

HUNTINGTON.—The Lambie Chemical Co. is arranging for increased production at its local plant, advancing to about 50 per cent of normal output. The company has recently been engaging at about one-half of this capacity. The working force will be increased by about 40 men, and particular attention given to color production. It is planned to develop the plant to its maximum in this latter line early in the fall. R. D. Lambie is president.

SCOTT DEPOT.—The Di Bella Glass Co., recently organized, will operate a local plant for the manufacture of glass products. The company is headed by H. H. Pine and E. A. Taylor, Scott Depot; and G. T. Pine, Charleston, W. Va.

Wisconsin

MILWAUKEE.—The Western Metal Specialty Co., 1919 St. Paul Ave., is completing plans for the erection of an addition to its plant to cost about \$40,000.

BLACK CREEK.—The Outagamie Limestone Co., 75 30th St., Milwaukee, has plans under way for the construction of a new limestone working plant in the vicinity of Black Creek, estimated to cost about \$200,000, with machinery. F. A. Mass is head.

New Companies

THE COROGO TANNING Co., Lynn, Mass., has been incorporated with a capital of \$50,000 to manufacture leather products. The incorporators are Saul L. Cohen and William J. Rose, Boston.

THE PAEPECKE PAPER MILLS Co., 111 Washington St., Chicago, Ill., has been incorporated with a capital of \$50,000 to manufacture paper goods. The incorporators are Walter P. Paepcke, R. L. McClelland and E. A. Lang.

THE CLEANING COMPOUNDS MFG. Co., New York, has been incorporated with a capital of \$25,000 to manufacture chemical compounds and kindred products. The incor-

I. White and T. N. Ripsom, 366 Madison Ave.

THE MINERALS REDUCTION CORP. OF AMERICA, Berwick, Me., has been incorporated with a capital of \$10,000,000 to operate reduction works for the manufacture of mineral and metal products. Thomas I. Hogan is president; Ralph W. Goss is treasurer.

THE MICA CO. OF CANADA, INC., St. Regis Falls, N. Y., has been incorporated with a capital of \$150,000 to manufacture mica products. The incorporators are O. H. Smith, C. J. Toohey and R. A. Reid. The company is represented by H. A. Ross, Montreal.

THE EMPIRE LABORATORIES, INC., West New York, N. J., has been incorporated with a capital of \$200,000, to manufacture chemicals and chemical byproducts. The incorporators are Jacob J. Storz, Frederick K. Lane and M. F. Curry, 595 Jefferson St.

THE ENO RUBBER CORP., Los Angeles, Cal., has been incorporated with a capital of \$20,000 to manufacture rubber goods. The incorporators are Roy R. Musser, George W. Eno and William M. Morse. William Morse, Jr., California Bldg., represents the company.

THE CENTRAL ILLINOIS PETROLEUM CO., 1703 B'way., Mattoon, Ill., has been incorporated with a capital of \$200,000 to manufacture petroleum products. The incorporators are Daniel S. Campbell, Thomas M. Stanbury and William D. Jones.

THE ESSENTIAL MATERIALS CO., New York, has been incorporated with a capital of \$100,000 to manufacture dyes, chemicals and affiliated products. The incorporators are G. Lau, L. H. Wallace and F. T. Com-moss. P. H. Delehanty, 115 B'way., represents the company.

THE NATIONAL REFRACTORIES CORP., New York, has been incorporated with a capital of \$20,000 to manufacture refractory products. The incorporators are J. M. Devlin, A. M. Klupt and W. Bruchhausen. Duncan & Campbell, 189 Montague St., Brooklyn, N. Y., represent the company.

THE ATLAS DIE-CASTING CO., INC., Worcester, Mass., has been incorporated with a capital of \$200,000 to manufacture die-castings and other metal products. The incorporators are Arthur M. Brewster, Allan Robinson and Malcolm F. MacNeil, 25 Brighton Ave., Boston, Mass.

THE KING-CRAIG OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are John J. Craig, Los Angeles; James W. Reagan, Long Beach, Cal.; and Everett H. King, Inglewood, Cal.

THE WOODSIDE COLOR CORP., New York, has been incorporated with a capital of \$50,000 to manufacture chemicals, colors, dyes and kindred products. The incorporators are C. S. L. Tuynman, W. D. P. Evans and B. L. Blauvelt, 99 Nassau St.

THE JUMBO TILE WORKS, INC., Goldsmith, Ind., has been incorporated with a capital of \$50,000 to manufacture clay tile, bricks and other burned clay products. The incorporators are E. A. Teter, W. A. Parks and J. N. Russell, Goldsmith.

THE RAVENSWOOD PORCELAIN & GLASS CO., Ravenswood, W. V., has been incorporated with a capital of \$500,000 to manufacture glass, porcelain and other ceramic products. The incorporators are J. H. Camp and J. W. Hall, Ravenswood.

THE ADAMS OIL & COMPOUND CO., 549 West Washington St., Chicago, Ill., has been incorporated with a capital of \$20,000, to manufacture compounds, chemicals, oils, etc. The incorporators are Harry R. Adams, Philip R. Monson and Mont C. Adams.

THE BEAVER RUBBER MFG. CO., New York, has been incorporated with a capital of \$250,000 to manufacture rubber products. The incorporators are F. L. Minnigerode, C. M. Coryell and W. P. Kown, 50 Church St.

THE MARYLAND INDUSTRIAL ALCOHOL CO., Baltimore, Md., has been incorporated with a capital of \$700,000 to manufacture industrial alcohol products and other kindred specialties. The incorporators are Edward H. Hammond, R. Bennett Darnall and Harry E. Karr, Fidelity Bldg.

THE WESTERN SEABOARD OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$300,000 to manufacture petroleum products. The incorporators are J. W. Lonn, W. S. McKee and W. C. Bramham, Los Angeles.

THE AREX PRODUCTS CORP., New York has been incorporated with a capital of \$7,750,000 to manufacture chemical products. The

company is represented by Arthur W. Britton, 65 Cedar St., New York.

THE STARR CHEMICAL LABORATORIES, 16 Lewis St., Newark, N. J., has filed notice of organization to manufacture chemicals and chemical byproducts. Jacob Starr, 347 South 11th St., heads the company.

HULL & HULL, INC., Tampa, Fla., has been incorporated with a capital of \$50,000 to manufacture burned clay products. A. G. Runyon is president; Randall Bell, secretary-treasurer, both of Pensacola, Fla.

THE CARPENTIER CHEMICALS, INC., 175 West Jackson Blvd., Chicago, Ill., has been incorporated with a capital of \$10,000 to manufacture chemicals and chemical byproducts. The incorporators are O. T. Carpentier, Edward J. Hess and M. G. Eckersberg.

THE FEDERAL CHEMICAL CO., Nitro, W. Va., has been incorporated with a capital of \$250,000 to manufacture chemicals and chemical byproducts. The incorporators are John V. Ray, C. P. Miller and W. D. Payne, all of Charleston, W. Va.

THE NATIONAL ZINC CORP., New York, has been incorporated with a capital of \$300,000 to manufacture zinc and other metal products. Morris Stein, 945 Aldus St., is the principal incorporator.

THE KERO CHEMICAL CORP., Bay Shore, L. I., has been incorporated with a capital of \$300,000 to manufacture chemicals and chemical byproducts. The incorporators are C. Young, C. V. Reeve and H. W. Barto. F. J. Knorr, Albany, N. Y., represents the company.

THE L. V. S. SOAP CO., Gloucester, N. J., has been incorporated with a capital of \$125,000 to manufacture soap and kindred products. The incorporators are George Link, William J. Van Meter, Gloucester; and Spencer Simpson, Camden.

THE CHAMPLAIN VALLEY OIL CO., Plattsburg, N. Y., has been incorporated with a capital of \$50,000 to manufacture oils. The incorporators are O. L. Trembly, G. P. and R. A. Sharron, and B. F. Feinberg, Plattsburg.

THE RENFRO-JUSTUS PAINT CO., Brownwood, Tex., has been incorporated with a capital of \$10,000 to manufacture paints, oils, etc. The incorporators are J. F. Renfro, C. B. Justus and O. J. McInnis.

THE HANOVER BRICK MFG. CO., Morristown, N. J., has been incorporated with a capital of \$100,000 to manufacture bricks, with plant at Whippany, near Morristown. The incorporators are Richard W. and Jesse L. McEwan, and Charles W. Ennis, 3 Elm St.

THE CALIFORNIA PAINT & SHELLAC CO., Los Angeles, Cal., has been incorporated with a capital of \$20,000 to manufacture paint, shellac and kindred products. The incorporators are C. M. Berry, J. H. Weaver and G. S. Hinson. The company is represented by Alfred Barstow, 600 Kerckhoff Bldg.

THE BOVING MFG. CO., 111 East State St., Trenton, N. J., has been incorporated with a capital of \$100,000 to manufacture tiles and other ceramic products. The incorporators are Christian O. Osterberg, Paul C. Boving and Charles J. Falcey, Trenton.

THE QUINLEY MAGNESIA CO., Cortland, O., with an authorized capital of \$100,000 of 8 per cent cumulative preferred stock and 2,000 shares of no par value common stock, has been incorporated, with J. C. Quinley, L. A. Kirtland and others as incorporators. The company will erect a plant on the Erie R.R. at Cortland for the manufacture of asbestos and magnesium products. An initial daily output of 4,000 lb. of magnesium carbonate is expected by July 1 from the first unit. The product manufactured will be largely for drug and rubber trades and for locomotive lighting, pipe covering, et cetera.

THE MARVELLUM CO., Holyoke, Mass., has been incorporated under the laws of Massachusetts with a capital of \$165,000 and has leased manufacturing space in the Holyoke Valve and Hydrant Bldg. It will start manufacturing a line of specialty cover papers according to a new coloring process. The officers are George Senseney, F. C. Haywood and Russell Bracewell.

The B. & M. Oil Co., Los Angeles, Cal., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are J. M. Brown, Long Beach, Cal.; F. N. Crippen, Pasadena, Cal.; and S. E. Meserve, 417 Union Oil Building, Los Angeles.

The Carbonite Mfg. Co., 324 Stephen Street, Belleville, N. J., has filed notice of organization to manufacture carbon specialties. William H. Moulton heads the company.

Capital Increases, Etc.

THE EASTMAN SALT PRODUCTS CO., Saginaw, Mich., has filed notice of change of name to the Saginaw Salt Products Co.

THE MONONGAH GLASS CO., Fairmont, W. Va., is arranging for an increase in capital from \$1,000,000 to \$2,500,000. R. T. Cunningham is secretary.

THE HARNER OIL & REFINING CO., St. Paul, Minn., a Delaware corporation, has filed notice of change of name to the Harner Oil Refining & Mining Co., at the same time increasing its capital from \$2,000,000 to \$10,000,000.

THE UNITED ALLOY STEEL CORP., 165 B'way., New York, has filed notice of change in capital to an active amount of \$9,525,000, and preferred stock to the value of \$3,300,000. The company recently took over the United Furnace Co., and the Berger Mfg. Co., Canton, O.

THE INDEPENDENT OIL CO., Decatur, Ill., has filed notice of increase in capital to \$50,000.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN IRON AND STEEL INSTITUTE will hold its nineteenth general meeting in the Hotel Commodore, New York, on Friday, May 27. There will be three sessions: A forenoon session beginning at 10 o'clock daylight saving time (9 a.m. eastern time); an afternoon session at 2; and a banquet in the evening at 7.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN OIL CHEMISTS' SOCIETY (formerly the Society of Cotton Products Analysts) will hold its twelfth annual meeting in Chicago May 16 to 17. Headquarters will be at the Congress Hotel.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-eighth annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., the week beginning June 20.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 342 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month; except June, July, August and September.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: May 13, Société de Chimie Industrielle, joint meeting with American Chemical Society, Society of Chemical Industry and American Electrochemical Society; May 20, Society of Chemical Industry; June 10, American Chemical Society.

CHEMICAL & METALLURGICAL ENGINEERING

A consolidation of

ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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Volume 24

New York, May 18, 1921

Number 20

Chemical Industry and The Department of Commerce

IN THE brief time that Mr. HOOVER has been Secretary of Commerce he has given ample evidence of his desire so to conduct the Department as to be of maximum service and benefit to industry. As far as we can observe, his activities do not contravene the expressed policy of the Administration to have "more business in government and less government in business." The function of the Department of Commerce is not to regulate industry but to serve it; and Mr. HOOVER's name is synonymous with service.

Three bureaus of the Department are of particular interest to the chemical industries, namely, the Bureau of Standards, the Bureau of the Census and the Bureau of Foreign and Domestic Commerce. Significant of Mr. HOOVER's estimate of the importance of these bureaus is the fact that in the organization of his department he plans to give them his personal attention. Further to study the relation of these bureaus to industry and expand them as aids to business Mr. HOOVER has selected as his personal assistant F. M. FEIKER, vice-president and chairman of the Editorial Board of the McGraw-Hill Co. Mr. FEIKER's engineering training, knowledge of industry and sense of publicity qualify him exceptionally for this work. The extent to which these three bureaus can serve depends largely upon the support received from Congress, and we believe that the chemical industry can well support the request of the Department for an appropriation of about \$600,000 which is now before the Committee on Appropriations. A favorite method of comparison of all appropriations is to relate them to the huge sums requested for the support of our military establishment. In these terms Mr. HOOVER's request is for a sum said to be equivalent to the cost of only one battalion of troops for one year.

In planning the work of the bureaus mentioned, three points of view are being kept in mind: First, the broad problem of building up a closer contact between the Department and industry; second, the necessity of developing fuller statistical data; and third, a study of industry to discover those areas in which standardization and simplification can be applied to advantage and without detriment. Approximately \$250,000 is being asked for the purpose of building up a closer contact with industry. This will probably be done through the medium of industrial service committees within the Department, comprising perhaps a dozen groups of workers, each headed by a man familiar with the conditions of a particular industry. These industrial service committees will be advisory to the Secretary in determining what the Department can best do for the different industries. In improving the statistical service of the Department five items of prime importance will be considered: 1, statistics of production; 2, statistics of stocks; 3, the percentage activity

in an industry; 4, prevailing basic prices, and 5, the prompt issuance of a report so that the figures will be of current value. The third point of service—the matter of standardization and simplification—is one to which a considerable part of the requested appropriation, say \$350,000, probably will be devoted. Here again a series of industrial service committees will be the medium through which the problem will be attacked.

Our readers will learn with satisfaction that the Secretary of Commerce is in thorough accord with the program of economy to which the Government is committed and that he has not asked for new appropriations without first effecting economies within his Department in a sum aggregating several times the amount now requested of Congress. In view of this attitude and the evidence of careful study and planning for the expenditure of the money not only for the benefit of industry but largely under its own advice and direction, we feel quite justified in urging representatives of the chemical industries to support Mr. HOOVER's request for appropriations.

Professional Services Recognized In Proposed Classification

FAVORABLE recognition is given to professional men in the Government service by legislation introduced at this session of Congress by Mr. WOOD of Indiana and Senator SMOOT of Utah. This legislation provides for "an equitable system for the valuation of the services of civilian employees of the Government," and the professional workers are gratifyingly appraised in the terms of the proposed legislation.

If this Wood-Smoot bill becomes a law the junior-chemist grade will begin at \$1,860 and provision will be made for the higher technical positions up to salaries of \$7,500. The bill very frankly recognizes that it is impossible to define in words the ranks or qualifications of different professional positions. Indeed it uses almost identical language for all of the places in scientific work from \$2,500 to \$7,500 per year and says regarding them that "the distinction between grades is based upon differences in the training and experience required in the work."

We are prone to think that our national legislators are slow to recognize the urgent necessities of professional positions. In the past they doubtless have been. But this is a most encouraging sign, and one which industrial executives employing professional chemists can do well to emulate. The term "chemist" is so broad in meaning that arbitrary fixing of salaries for those qualified for the title is wholly impossible. Let us hope that Congress will officially confirm the proposed plan of Government classification and that our industrial organizations as well will recognize that "distinction between grades is based upon differences in the training and experience required in the work."

A Great Obligation

SOME very interesting statistics have lately come to light. In 1890 there were about 200,000 pupils attending secondary schools in the United States. That means children, or, rather, adolescents who are engaged in courses beyond the eight years required. Whether these are public high schools, or the four upper forms of boarding schools such as Exeter or Andover, or military academies, or what we call private and our British cousins call public schools such as St. Paul's or Groton, or Roman Catholic institutions, makes no difference. It represents the standard four years of education following the grammar school course and leading to matriculation in colleges and the higher institutes of technology. By 1900 there were upward of 900,000 such pupils in the United States. Today the number is over 1,600,000. This number represents more than one-half of the young persons in the world who are enjoying secondary education.

What does it mean? Our population has not increased in any such ratio. It tells us that Young America wants to learn.

In the United States Army a series of continuation schools has been introduced. These have to do with trades rather than with professions, but it represents study. Every prescribed occupation is analyzed into a definite number of things that a plumber, a carpenter, a mason, etc., must know how to do. The courses are definitely laid out, and more than 60,000 United States soldiers are now studying at these various trades.

But what does it all mean? The curricula are hardly satisfactory; many school systems still languish in the throes of politics; we do not respect teachers or give homage to the few men and women who are by nature exceptionally gifted to practice the greatest of all arts, which is that of teaching; we quarrel among ourselves as to whether somebody shall read a chapter from the Bible or not, but we do not bother about ethics—and yet there are over a million and a half students eager to learn, and “we leave it to the authorities.” The authorities are usually politicians, and what they are after is votes.

What are these young people learning, and how shall we meet them? Will they learn that it is better to do work well than to tell somebody else to do it? Here is a great thesis in the philosophy of life. Every real artist knows the joy of work, and so does every true mechanic who has the privilege of liberty. Now, liberty is a much more restricted concept than most of us think it is. There is no such thing as absolute freedom. But why should we not enjoy such liberty as we have?

There is the man, for instance, who works eight hours a day. When the whistle blows or the bell rings his task is finished. Eight or nine hours is all the time he wants for sleep, and the rest is his. If he loves the arts or music or literature or is interested in the sciences, he has the opportunity not only to improve his mind but to enjoy life. He can do what he wants to do under his own rights and privileges. He is a remarkably free man. The superintendent of the works, on the other hand, the man who commands, is little more than a slave. He has given hostages for his position and salary. His work is never finished. He is engaged in administration, and administration is intellectual slavery. He can't

do what he wants to do, because something is always going wrong—if he is competent and has the wit to see it. The only leisure he knows is rest; detective stories, movie shows and musical comedies are the substance of his recreation. He can't develop his mind beyond the interests of the corporation which he serves. He lives an unenviable life.

Now, the question which intrigues us is whether, with this increased education, our young people will learn this fact. Ordinary common labor today is as remunerative as, and even more so than, two of the learned professions: Teaching and divinity. It pays better than the early years, as a rule, of engineering or law or medicine. It is a dignified occupation to work with our hands. And if we are gifted with sanity and a useful mind, we can find contentment in it. But scorn is the enemy of contentment, and those of us who employ others will need to bear this fact in mind as keenly as those who work for us will sense it.

It is a proud thought to consider half of the high school pupils of the world as being in the United States. But unless we meet it right it may be anything but a blessing. It confers a new and greater obligation on those of us who lack the greater freedom because we direct affairs.

Technology Brings Youth to Industry

Every Youthful Minute is a Precious Inch of Gold!

ARGUMENTS between executive and sales manager are rather common occurrences at all seasons of business, but they happen with increasing frequency during the late afternoons in these depressing times. They are not always fruitful of so much good as in the following instance, with quotations practically verbatim:

PRESIDENT—But we can't quote as low a price as the Burnt Clay Co. It costs us more than that to make the stuff.

SALES MANAGER—Certainly it does. Why? Because you are using antiquated methods in producing the ware. They date back beyond the time of the Mound Builders. You are mixing by “feel,” hand-molding standard ware, conveying by wheelbarrow and burning the clay by the “expert's” eye. Why, your plant man told me the other day that he had pyrometric cones in the office “in case he ever needed them.” And if you showed him a recording pyrometer he'd think it was an attachment for a steam engine or an automobile. If your plant were operated with a definite knowledge of materials you are handling and producing you wouldn't have to fear anybody's price.

PRESIDENT (With frown, grin and frown)—That's enough, young fellow. If you know so much about this new scientific-stuff-in-industry business, I'm going to give you a chance to run the plant for a while, even to long-necked bottles, glass-covered scales and the rest of the tricks.

The upshot of this conversation was that the sales manager shortly became superintendent of plant with considerable authority to make changes. Fortunately he was a man with some intimate knowledge of the business all along the line from the clay pits to marketing the product. He knew the old way, but had gained young ideas.

This actually took place several months ago and if the reader could take a walk through the works with him now, see the changes made and in the making; note the economies effected by rearrangement of operations, the reasonable amount of new equipment installed for further cost-per-unit decreases and listen to his discourse on plans for a future scientific control laboratory to get uniform quality of product, he would realize that

the president acted with canny foresight when he gave this chap plenty of leeway.

The next best thing to being a live one is for a man to realize he's a dead one. It is not hard to see why this executive has attained a place in his chosen business. When it had developed beyond the knowledge of his time, he called in youth to carry it on, wherefore he should enjoy the progress and incidentally a few more "inches of gold."

Labor Unions and Industrial Decay

REPRESENTATIVES of the labor unions before the Railroad Labor Board have made the claim that the railroads are wasting at least \$1,000,000,000 a year through mismanagement, and assert that wages should not be touched until all the leaks are stopped. There is an inconsistency in the position, in that the claim has likewise been set up that the ability of the railroads to pay wage rates should not be considered. The *Railway Age* points out the absurdity of the \$1,000,000,000 claim in another way, observing that last year's railroad operating expenses were \$6,300,000,000, of which \$4,000,000,000 would be absorbed by wages, leaving \$2,300,000,000 out of which the \$1,000,000,000 would have to be saved, so that the other expenditures would have to be reduced by about 45 per cent.

The United Mine Workers have a wage scale, arranged when all costs and prices were practically at their peak, and which was high even for those conditions. This scale is signed to April 1, 1922, and apparently is not susceptible of modification meanwhile.

Wages in the building trades are very high, for a day's work or a week's work, and they are much higher still on the basis of the quantity of work done by the artisans in a day. The usual dates for annual settlements of the scales in the building trades are May 1 and June 1, and very few reductions have been made. In several districts strikes are now on.

The average observer of business conditions, if he gave no thought to the fact that the railroad workers and the workers in the building trades are well organized, would undoubtedly say that two of the prominent things that are retarding a return of industrial activity are the high costs of railroading and of building. The cost of mining coal is also very high, but that fact receives little attention simply because people do not want coal just now in any quantity.

If from the total of labor unionism in the United States there be subtracted the unions on the railroads, in the building trades and in the coal mines there is very little left. Of all the workers in the country only between 10 and 15 per cent belong to unions, and if the three monopolies are subtracted only a very small per cent is left.

These three classes of unionism must be taken as representing what unionism means. They represent conditions where unionism is successful. If now we should estimate all the work that should normally be done in the United States and allot it by percentages to crafts, the proportion allotted to coal mining, building and operation of the railroads would be far less than the percentage of wage drawers that are now in these lines of activity.

What does this mean but that these men are not doing their share of the work of society? They are drones, relatively speaking, supported in part by the

rest of the workers. It is not so much that they receive too much money for a day's work as it is that they do not render a full day's work. In this respect they may not differ from their non-union associates, except that they have the power of organization to enforce their ideas. But suppose that unionism should spread and the attempt be made to fasten the principle upon all lines of work. Who would be left to pay the bill? What would be the result of the effort?

The answer to the question was given by Judge GARY at the recent annual meeting of the stockholders of the United States Steel Corporation. It being the twentieth anniversary, Judge GARY reviewed the "principles and policies" of the corporation. He dwelt upon its attitude in being so strongly committed to the "open shop," saying: "The 'natural and certain effects of labor unionism are expressed by three words: Inefficiency; high costs.'" And again: "I firmly believe complete unionism of the industry of this country, as attempted, would be the beginning of industrial decay." Perhaps; and yet maybe no more so than would be true of complete domination by capital. However, Judge GARY has given the answer to the question what would occur if the principles and practices of the railroad unions, the building trades unions and the United Mine Workers were forced upon the entire body of workers. There would be no one left to pay the bill.

Germany Bows To the Inevitable

WITH Germany's acceptance of the demands of the allied governments she assumes a burden which her people can lift only through persistent effort. Ever since the Armistice there has been considerable speculation as to when Germany might recover her commercial status among the world's nations and how that end would be attained. The matter is of more than ordinary interest to the chemical industry because of Germany's former pre-eminence therein. It is timely, therefore, to speculate on the prospects. Considering the German's character it seems likely that under stress of fulfilling the terms of the Peace Treaty he will develop a degree of efficiency and excellence in production such as the world has never seen. In this he will be aided by the government, which will subsidize him through food sold below cost and other similar devices. The consequence may be that for a time the German will appear to be rapidly regaining his lost industrial prestige, with proportionate menace to the industry of our own and other countries. With respect to ourselves, however, the other side of the picture is that the German has no conception of quantity production such as we commonly see in the United States; nor has he a large domestic market for the consumption of his product. Added to this is the inevitable fact that some day he must reap the real harvest of government subsidy of business and come face to face with the necessity of competing with the other nations of the world on an equitable economic basis. With anything like maximum production in this country and with a large and increasing domestic market the United States has little or nothing to fear from German competition. This will be true, however, only by increasing efficiency of production, because we will be forced to meet competition under a low standard of living that must continue in Germany and on the Continent for at least a generation.

Readers' Views and Comments

The Valentiner Vacuum Process

To the Editor of Chemical & Metallurgical Engineering

SIR:—While I was absent from the country your résumé of my extemporaneous talk on nitric acid before the Delaware Section of the American Chemical Society appeared in the March 9 number of *CHEMICAL & METALLURGICAL ENGINEERING*, page 443. In this abstract I note the statement on page 445 that "the Valentiner vacuum process proved to be a failure commercially."

Though I may have conveyed this impression in my talk, it was far from my intention to do so, because this process is operating successfully in this country and also in Germany today. What I wished to bring out was that the vacuum was originally employed to enable the retort reaction to be carried to completion at a lower temperature, but this caused foaming and a tendency for the soda to float on the top of the charge, unduly lengthening the time of distillation; consequently the device was adopted of throttling the gases at the exit of the retort (see U. S. Pat. 920,224, to F. S. Valentiner), thus putting the retort under pressure but keeping the condensation and absorption systems still under a vacuum.

This, I pointed out, was exactly the opposite of what is desired theoretically to obtain the best results.

Condensing and absorbing under a vacuum does, however, produce a water-white acid, and for manufacturers of this grade of acid the larger equipment and the additional pumps, etc., of the Valentiner process are doubtless justified. For ordinary commercial grades of acid for nitrating purposes it seems doubtful, however, whether the Valentiner process can compete with the ordinary distillation at atmospheric pressure from the cost standpoint.

F. C. ZEISBERG.

Wilmington, Del.

Treatment of Acid and Alkali Burns

To the Editor of Chemical & Metallurgical Engineering

SIR:—In his instructive article on "The Treatment of Acid and Alkali Burns," printed in your issue of April 27, Dr. A. K. Smith does not mention hydrofluoric acid; though he does mention the perhaps less common and certainly less dangerous chromic acid, including it inadvertently under "caustics."

During a long experience in charge of manufacturing operations I have had frequent opportunity to observe the effects of various acids on living tissues and there is, I think, none more dangerous than hydrofluoric in the higher concentrations. This acid has, in some cases at least, the peculiar and insidious property of inducing something like a partial anæsthesia in the tissues with which it comes in contact. At first there may be only a period of minor irritation, of duration and intensity varying with the individual but which frequently causes the careless or uninstructed to delay or neglect proper prophylaxis. Later comes agonizing pain, with tissue destruction and a wound of unhealthy character, very slow in healing. With deference to Dr. Smith's greater technical knowledge of this subject, I must say

that I think I have observed in acid burns a poisonous effect extending beyond the initial destruction of tissue. This effect seems most marked with hydrofluoric, less so with nitric, and least with sulphuric. An additional malignant property of hydrofluoric is the effect of its vapor, especially in contact with the finger nails. Hours of misery have followed prolonged holding of a rubber stopper wet on the lower end with the concentrated acid; and following one occasion on which I got a particularly bad dose of the vapors on the fingers blood extrusions began to grow out under two finger nails after a few days. I have seen workmen pass periods of profane discomfort after handling barrel bungs with unprotected fingers, though there were no visible effects on the skin.

Yes, "hydroflu" is surely worthy of a place in Dr. Smith's list. As a destructive fluid I place it second only to some of the home-brewed "hooch" with which our western Pennsylvanians corrode their interior mysteries. I used to make the stuff—the hydrofluoric—in Long Island City, but even along Newtown Creek it was found unbearable, and we were chased to a site on the Jersey marshes, bounded on one side by the Hackensack River and on the three others by a population of scientific workers for whom all metals had magnetic properties and were convertible into various forms of CH_3OH —all, that is, but the lead of our HF equipment. That was as safe as soap in Petrograd; and the merry villager whose favorite outdoor sport was to shatter the unprotected carboy of vitriol or nitric into smoking ruin with an indigenous brick made devotional gestures as he passed—on the far side of the road—the ranked lead boxes of hydrofluoric awaiting shipment.

Seriously, though, it is desirable to advertise that this widely used and indispensable acid is highly corrosive to tissues, and requires special precautions in handling because of the unusual properties already mentioned.

One other word might supplement Dr. Smith's advice. That is the necessity, where large quantities of strong sulphuric acid have reached skin and clothing, of using the largest possible quantity of water and continuing its application for a considerable time. If the acid has saturated any part of the clothing, only a copious and continued drenching—preferably an immersion—will keep the burn from being seriously intensified by the heat produced from contact of water and acid.

Canonsburg, Pa.

DALTON M. GOETSCHUS.

Porcelain Enameling Furnaces

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your issue of April 6 you published a letter from Francis A. J. FitzGerald concerning electrically heated porcelain enameling furnaces. It may be of interest to your readers to know that in the April and June numbers of the *Journal of the American Ceramic Society* there will be published two papers describing commercial installations of furnaces of this type.

E. W. WASHBURN,

Editor

Urbana, Ill.

Award of the Nichols Medal to Gilbert N. Lewis

Proceedings of Meeting—Appreciation of Medalist and Personal Reminiscences—Address on Color and Chemical Constitution With Regard to the Subatomic Structure and the Nature of the Electron Bond

THE Nichols Medal was presented Friday evening, May 6, to Dr. Gilbert N. Lewis, of the University of California, for the best original paper published in any of the journals of the American Chemical Society during the year 1920, and in the judgment of the jury this best paper was the one entitled "The Third Law of Thermodynamics and the Entropy of Solutions and of Liquids," by the recipient and G. E. Gibson.

An Appreciation of the Medalist

BY ARTHUR B. LAMB

I am very glad of my opportunity this evening to say something about the achievements and personality of G. N. Lewis. As we have him with us here in the flesh, I will endeavor to make my remarks about him seem as little like an obituary as possible; I have come, not to bury Cæsar, but laud him.

My acquaintance with him began eighteen years ago, when as a graduate student at Harvard I listened to his lectures on electrochemistry and thermodynamics. Lewis had graduated from Harvard College several years before, in 1896, had taken his Ph.D. in two years of graduate work, had taught a year at Phillips Exeter Academy, and was then back at Harvard as an instructor. In these lectures Lewis accomplished the real *tour de force*, of kindling our interest in and enthusiasm for such subjects as entropy, free energy, and a special thermodynamic function all his own, which he had christened "fugacity." His lectures were remarkable in still another respect. He covered thoroughly an enormous amount of ground. Throughout his lectures Lewis kept pacing back and forth across the platform, covering miles at breakneck speed. From Harvard Lewis was called to a professorship at the Massachusetts Institute of Technology, and a few years later left to be head of the department of chemistry at the University of California.

NATURE OF CHEMICAL AFFINITY

At the outset I must call your attention to a striking coincidence. Sir Isaac Newton in his "Principia" says: "There are agents in Nature able to make the particles of bodies stick together by very strong attractions. And it is the business of experimental philosophy to find them out." Newton thus recognized and propounded the problem of chemical affinity, and this is the very problem which has been the main object of attack in the many brilliant researches of our medalist, Gilbert Newton Lewis, in part therefore at least the namesake of his great predecessor.

Evidently one way to study the nature and magnitude of chemical affinity is to find out the amount of heat and other forms of energy which it can produce. Lewis in his doctor's thesis and in his first independent published article made important advances in this direc-

tion. He developed on thermodynamic grounds a general equation of chemical affinity and showed how in favorable cases by its means the extent of a chemical reaction could be computed from thermal and physical data. More important still, he showed in this article for the first time that a complete solution of this problem required a knowledge of certain then indeterminate constants characteristic of the particular varieties of matter under consideration. It was a study of these very constants which later led others to formulate what is now called the Third Law of Thermodynamics, which Lewis himself has further clarified in the paper for which the Society is now conferring the Nichols Medal—namely, "The Third Law of Thermodynamics and the Entropy of Solutions and of Liquids."

Between this first paper and this last one Lewis has published a score and more of articles dealing with the chemical affinity of a great variety of substances. Certain of them have been particularly important—for instance, his determination of the free energy of formation of water at room temperatures, and also his determination with Dr. Kraus for the first time of the potential of the sodium electrode.

RELATIVITY AND A SYSTEM OF VECTOR ANALYSIS

Lewis has not been content to confine his studies even to so broad a field as chemical affinity. He was practically the first American to discover Einstein. As far back as 1909 he published a paper on "Relativity" in which he developed a new system of vector analysis which facilitated the further study of this subject, and later he developed a wholly new system of non-Euclidian geometry and vector analysis which appears to offer many advantages in the solution of recondite mathematical problems. One can thus see that Lewis in these papers has gone over from the field of chemistry into what is pure mathematics. In this connection it is interesting to point out that he never took any courses in mathematics higher than analytical geometry. He studied the calculus and higher mathematics by himself as a form of recreation.

MILITARY ACTIVITIES

As illustrating still another side of Lewis' mentality and personality, I want to tell a little about his activities during the war. He went to France in the first months of 1916 with Colonel Bacon's contingent in the Chemical Warfare Service. General Fries sent him very soon to act as observer for the Chemical Warfare Service with the Fifth British Army. Lewis had hardly arrived there when the Germans launched their great offensive against that army. It was a thrilling experience, but a valuable one. Lewis withdrew in good order along with the rest of the army, but the closeness of the call may be judged from the fact that he is said to have left his Sam Browne belt behind him. But this did not prevent Lewis from accomplishing

his purpose. On his return he presented a report to General Fries on the progress of this battle and its significance and lessons from the chemical warfare point of view, which General Fries told me was the most suggestive report even from a strictly military point of view of this engagement which he had read. Up to this time General Fries had been unable to secure a satisfactory chief for the Defense Division of the Chemical Warfare Service. Two colonels in the regular army had held this position, but the problems to be faced were so novel and so foreign to their training and education that they had been unsuccessful. General Fries appointed Lewis to this position and he served with conspicuous success.

PERSONALITY

Finally, I cannot close without saying something more specific about the personality of our medalist. Though his intellectual and professional interests are prodigiously highbrow, as I have shown you, he is nevertheless just as keen as the rest of us about more ordinary things. He plays a dashing and successful game of three-handed bridge, where his venturesome instinct finds free scope, but at chess these very tendencies often prove his downfall. With or without the stimulus of ethyl alcohol, in any company he is the focus of the liveliest discussion and the center of the merriest group. Indeed, to describe this side of his personality I cannot do better than adopt the phraseology of the day, though perhaps it is already that of yesterday. Lewis is a "regular fellow."

Some Personal Reminiscences

BY JOHN JOHNSTON

I also am very glad of the opportunity to say a few words in appreciation of Gilbert Newton Lewis, whom you have chosen to honor by award of the Nichols Medal this year. But I am in somewhat of an embarrassment because I find that the things I had planned to say have already been said by my predecessor. We agreed at the Rochester meeting that he should talk more about the thermodynamic papers and I was to talk more about the others; but I find that he spread over into my assignment, and I didn't know that until at dinner tonight when we exchanged papers, I having written down what I proposed to say, coming on the train today, and Mr. Lamb having done likewise. But perhaps you will believe us more when we both agree, because you remember that— isn't it in "Alice in Wonderland" that someone there says, "What I say three times is true"? Therefore, what two different people say once each ought to be as true as what any common person says three times.

I met Mr. Lewis for the first time on the day that I first arrived in Boston in 1907. He took me to lunch, introduced me to my first cocktail as such—or perhaps I should say introduced my first cocktail to me, and ordered among other things corn on the cob, which I had never seen before—I think partly in pursuance of a scientist's curiosity to see just what would happen. This was but the first of very numerous meetings during the year that I spent in Boston. I also know about his proficiency at auction bridge and can confirm exactly what Mr. Lamb said about it. These frequent meetings with him led me to form a very high opinion of him, both as a scientist and as a companion and friend, and nothing since has given me reason to modify that opinion except perhaps to make it higher than it

was. He doesn't really fit in well with the conventional idea that a scientist, and particularly a scientist who is absorbed in the kind of fundamental questions that he is, is a cloistered type of highbrow who is unable to enjoy the good things of life and unfitted for participation in the world's work. As to the former—his ability to enjoy the good things of life—I could bring forward the testimony of his very large number of friends. As to the other—his capacity to take effective part in the world's work—that is well known.

Indeed he is in the proper sense of the word devoted to science and in particular to a study of the simplest terms in which we may express the multiplicity of chemical phenomena. And he works because he is possessed of an absorbing curiosity to know just what is what, possessed of a desire to correlate things apparently diverse, and from such correlation to be in position to predict new things. With this perhaps goes the fact that his papers are models of concise exposition—so concise indeed that many readers, I believe, fail to grasp their true significance or to see that some remark of his may have implied a very great deal of work and thought in order to be able to make it at all. And with this perhaps also goes the further fact that he is less interested in questions of credit and priority than that we should reach a satisfactory and thoroughly consistent explanation of the phenomena.

PUBLICATIONS

I have left myself little time in which to say anything specific about Mr. Lewis' other lines of work. On looking over the list of his published papers I find that the great majority of them were either about thermodynamics directly or so closely related to it that I felt I should leave them to Mr. Lamb. The others, though, are no less important. There are the papers on the theory of relativity, published ten years ago, to which Mr. Lamb alluded, which were written at a time when that theory had not attracted the attention now drawn to it. And there is one which brings in the subject of vector analysis, which Lewis taught himself in order to be able to attack the problem as he thought it should be attacked. Related to this are later papers on the quantum theory and on a system of ultimate rational units—e.g., to take the speed of light as the rational unit of velocity, and the charge in the electron as the unit of electricity.

VALENCE THEORY

His work which is now probably most familiar to you is that on valence theory. His first paper on this general topic appeared in the *Journal* of our Society in 1913. In it he emphasized the distinction between what he called polar and non-polar compounds, this distinction being roughly the same as that between inorganic and organic compounds, the polar compound being typified by a salt such as sodium chloride, NaCl, the non-polar by a substance such as methane. And he pointed out that these differences may be regarded as depending upon the magnitude of the constraints with which the valence electrons are held. Of course it would take too long to go further into that here, and probably you are all familiar enough with it, so that it would be beside the point for me to go into it.

In 1916 his next paper on the valence theory appeared. That was called "The Atom and the Molecule." In this paper he proceeds to extend this idea expressed in the previous paper and outlines the theory of the

cubical atom, the basic figures to which, it may be noted incidentally, are taken from a memorandum dating from 1902, which is therefore fourteen years before this particular theory was published in the *Journal*. He has since published two other papers dealing with this theory which are less well known, both published in 1917 (one in *Science*, the other in the *Proceedings* of the National Academy), and then in 1917 the war came on, and for a couple of years he was away from all writing of theories. The brilliant advocacy of these ideas by Langmuir and his exemplification and extension of their utility has made them familiar to all who take a real interest in our subject.

Presentation

BY JOHN E. TEEPLE

We come now to the presentation of the Medal itself. This has a significance more than we are accustomed to attach to such ceremonies. To the chemist working steadily and systematically, sometimes brilliantly, to advance his science, no appreciation is so welcome as that of his fellow chemists, men who understand what he is doing, what difficulties he encounters, what patience, skill, perserverance and calm analysis are necessary to surmount them and what bearing his work has on the progress of the science as a whole. On the other hand, the judgment of his co-workers regarding a fellow chemist does not go far wrong. Sometimes in a burst of enthusiasm the jury may pin a medal on a man whose work more mature deliberation may indicate to be not quite up to the proper standard. Sometimes, due to lack of knowledge of the man or interest in the subject, exceedingly high-grade work may be overlooked by a jury. Geniuses, as a rule, are not appreciated until a later generation, but in the long run the judgment of a man's co-workers is just, and an examination of the list of the recipients of the Nichols Medal to date shows a roll of honor. I feel that the jury, in selecting Dr. Lewis for the Medal tonight, have done themselves credit.

Dr. Gilbert Newton Lewis, on behalf of the New York Section of the American Chemical Society, it gives me great pleasure to present to you this beautiful William H. Nichols Medal for your original work on "The Third Law of Thermodynamics and the Entropy of Solutions and of Liquids," and I want to congratulate you personally and on behalf of the Society on this honor that has been conferred upon you.

Color and Chemical Constitution

BY GILBERT N. LEWIS

The science of color may be investigated from several points of view and presents different aspects to the physicist, to the physiologist or experimental psychologist, and to the chemist. The physicist is interested primarily in the properties of light while it is in transit, or, as we used to say before the luminous ether became unfashionable, the physicist is interested in the properties of the various types of ether waves. Frequently the phenomenon of light is compared with the phenomenon of sound, and the analogy is correct in this one respect, that both phenomena are characterized by oscillation or vibration or undulation—that is, with some sort of process of repetition, the period or the frequency of which manifests itself to our auditory or visual senses. Aside from differences of intensity, variations in this frequency are responsible for the variety of

the sensations produced through the ear and through the eye. It is this analogy which permits us to transfer the nomenclature of one phenomenon to the other. Thus we sometimes hear people speak of the *tone* of a color.

But while light and sound have in common this property of periodicity, there the resemblance ceases. Sound is produced in air or other material medium by the vibration of a body such as a tuning fork or a violin string, and the vibrations which are audible lie between the range of about 20 per second on the one hand and about 40,000 per second on the other—a range of about ten octaves. On the other hand, the general radiant energy of which light is a portion is produced only by the vibration of a body which is electrically charged. It travels through space even in the absence of any material medium, and that part of the whole gamut of radiant energy which is visible to the eye represents an enormous vibratory frequency—more than a million million oscillations per second.

THE VISIBLE ZONE OF RADIANT ENERGY

The sound produced by a drum differs from the purer tone of a more highly developed musical instrument in that it emits a jumble of many such tones simultaneously, and such a jumble of tones we call a noise. Like such a noise ordinary light is a mixture, representing vibrations of a great variety of frequencies. By means of a prism it is possible to analyze white light into its component tones, and thus we obtain the spectrum, where at every point there is a definite spectral color corresponding to a perfectly definite frequency. The rays that the eye cannot perceive may be seen by the camera and other devices which have made it possible to extend the spectrum and to study radiant energy beyond the limits of visible frequency, and thus investigate the ultra-red on the one side and the ultra-violet on the other. Indeed we now know that all the phenomena of radiant energy, beginning with the low frequencies of wireless telegraphy through the ultra-red into the visible out into the invisible ultra-violet, and from there on out to the region of X-rays, we are dealing with a single phenomenon, varying only in rate of vibration, the rates of which are as follows: Lowest Rubens, 10^{12} ; red, 4×10^{14} ; violet, $7\frac{1}{2} \times 10^{14}$; farthest ultra-violet, 10^{16} ; soft X-rays, 10^{17} , and hardest X-rays, 10^{18} . We see then that of this vast keyboard of radiant energy less than one octave produces visual sensations.

COLOR ABSORPTION

Now the question arises as to what is the source of chemical absorption of light. What is the mechanism? Here is where I will begin to get into trouble. It is evident in the first place that some elements are naturally colored. They are just born that way. Copper in its various compounds, except in a few of the cuprous, is generally colored, although you never can tell what color it is going to display. Many of the salts of the heavier metals are colored, and in those cases it is pretty easy to recognize that the element itself carries within it the color-absorbing mechanism. On the other hand, there are many cases, as you know, of elements which are not ordinary color producers, such as carbon, oxygen, hydrogen, nitrogen, and yet from these may be produced colored substances like nitrogen dioxide, where you have a highly colored substance produced from elements which do not normally give it. Then of course we have the great host of dyestuffs which likewise are made up of elements which do not

normally produce color compounds. It seems to me equally evident that in this case it is not in the atom but in the association of atoms of a particular type that we get the light-absorbing mechanism. Let me as a simple illustration show a few experiments of a primitive character. Here are three copper salts dissolved in alcohol. As you see, although possessing the same amount of copper, they not only have different intensity of absorption, but entirely different color. The cupric nitrate in alcohol has almost the same color which it has in water, rather faint. You will notice the typical blue color of copper salt. The cupric chloride in alcohol has a green color, but nevertheless when poured into the water gives once more the same cupric faint blue appearance. Here is cupric bromide, which you can hardly see through at all. It is a very dark brown in daylight, and yet it contains the same concentration of copper. The copper is always active in forming the color. If we should add to any one of the aqueous copper solutions a small amount of ammonium hydroxide you would get once more a very intense blue color. While we do not know the mechanism in this case, nor perhaps precisely in any other, yet we know pretty much what goes on in these solutions. When copper salts are dissolved in water we do not have the simple arrangement which we usually write as Cu cations and Cl, NO₃, etc., anions.

THE GROUP COLOR EFFECT

The work of numerous investigators has shown that in such cases as these we have unquestionably about the central positive ion a group of molecules or radicals which are held with much firmness in this co-ordination sphere which surrounds them. That cupric ion in water is really a cupric ion with four water molecules very firmly attached to it. They can, however, be driven out by ammonia, and ammonia does drive them out and produces cuprammonium, where we know much more definitely than we do in the other case that we have four molecules of ammonia attached to each one of copper. It is evident then, it seems to me, that in this case the copper atom contains within itself the absorbing mechanism, but that mechanism is affected more or less in its action by associated groups, thus changing the intensity and the frequency of the absorbed light, the light absorbed by its environment. Thus copper attached to four ammonia molecules does not produce just the same effect as copper attached to four water molecules, but it does a surprisingly similar thing. They both cut light out of the radiant energy system in the spectrum zone which we call visible light. Any two color substances are very closely akin. Whether they absorb in the violet or the yellow they are not far apart in their properties.

This problem of finding the source of the color-absorbing mechanism is not an easy one. In one case where I can show you a change of color due simply to a change of temperature we know exactly and quantitatively to what that change is due. In the mixture of two gases, NO₂ and N₂O₄, you will see as I heat this up that the upper part of the chamber becomes quite a good deal browner than the lower part. We can calculate quantitatively the relative amounts of N₂O₄ and NO₂. NO₂ is colored and N₂O₄ is colorless. NO₂ is formed at high temperatures, N₂O₄ at low temperatures.

A solution of cobaltous chloride in aqueous solution, with a small amount of acid added while hot, is very deep blue. If, however, it is cooled by being poured

into ice the color change is so absolute as to be the opposite of that which we had before; it goes from a bright blue to a bright red. The effect is partly due to the hydration by the ice, although the same experiment can be tried in other ways. This was the simplest way to show the experiment. But we see pretty clearly that there the phenomenon is due to a greater or less degree of hydration, probably a greater or less degree of driving out of the chloride ion from a complex by water. In the diluted aqueous solution this color of the cobaltic salt is characteristic. The hydration is diminished by increasing temperature, diminished by increasing concentration.

CHROMOPHORES

It is evident that the absorption of light in the visible spectrum is only part of a larger phenomenon which should be studied in its entirety if we are to obtain the fullest evidence as to the origin of color. Indeed, numerous investigations have shown that many substances which have no power of absorption in visible regions have pronounced absorption bands, as they are called, in the ultra-red, and especially in the ultra-violet. If then through some change in condition a colored substance changes to a colorless substance, as phenolphthalein does on the addition of an acid, it may be that the absorption band has simply ceased to exist, or it may be that the region of absorption has shifted slightly so as to bring it out of the range of the visible. If instead of being able to see less than one octave of the spectrum we could perceive several octaves of light as we do several octaves of sound, most substances would be colored, but those substances which absorbed in the neighborhood of the visible would be found to contain the same types of fundamental color groups or arrangements of atoms which occur in our dyestuffs and which Witt has called chromophores, groups which under a somewhat different environment, or attached to other chemical radicals, might cause visible color.

As in the case of indicators, it has been observed that most organic dyes are capable of existing in two or more forms in which the same atoms are in a different arrangement. Such arrangements, which pass over one to the other with such rapidity that it is rarely possible to isolate the separate substances corresponding to the different atomic arrangements, are known as tautomers, and numerous attempts have been made to show that the process of light absorption is due to the vibration of the atoms between two such arrangements in some sort of resonance with the vibration of light itself. These attempts, however, have failed, and indeed it will become evident that they were doomed to failure when we analyze now the exact nature of the process which must be responsible for the absorption of light.

ELECTRONIC VIBRATION

Let us for a moment forget the complicated facts regarding color absorption, of which I have been able to show only a few of the thousands which have been observed, and consider *a priori* what conditions must prevail in absorbing media. We may return once more to the analogous and more familiar phenomena of sound. If we hear a rattling sound in some piece of machinery we at once conclude that there is some loose part which is taking up a part of the energy of the machine and dissipating it by sound waves and by friction. Again, anyone who has played the piano has had the experience of finding some one note which appears harsh and unpleasant, and has discovered that

the fault is not in the piano itself, but in some piece of bric-a-brac in the same room which is set ajar by that one note and no other. This article, whatever it may be, has happened to be so placed as to determine a period of oscillation identical with one of the notes of the piano. It is said to be in resonance with that note, and the energy of sound of that particular pitch is absorbed by it. So a group of tuning forks of a certain frequency would absorb and act as a shield against sounds of that frequency, while notes of another pitch would pass through unchanged.

When we consider the factors that determine the natural frequency of vibration of such oscillator we find two that are of prime importance. The pitch of a violin string depends upon how tightly the string is keyed up; the tighter it is the higher the pitch or the frequency of vibration. But also the weight of the string is important. Thus while the E string is light and tense, the G string is not only left slack, but it is wound about with metallic wire to give it a greater mass. The greater the mass the lower the frequency of vibration.

These ideas are directly transferable from acoustical to optical phenomena, where, however, the resonators must now be electrically charged, and must possess an enormously high vibration frequency. In the molecules there are two sets of charged particles capable of acting as such oscillators. On the one hand the positively charged nuclei of the atoms, which have a mass approximately equal to that of the atom itself, and on the other hand the negatively charged electron with a mass more than a thousand times smaller. On account of the relatively high mass of the positive particles it seems probable that they never, or almost never, are capable of vibrating with a frequency sufficiently high to come within the scope of the visible spectrum, but rather cause absorption in the ultra-red. On the other hand, those light and indeed almost massless particles which we call electrons are usually held tightly enough so that their natural period is well above that of the visible spectrum, and they can therefore absorb light only in the ultra-violet region. Thus in the great majority of chemical compounds which are colorless the positive parts have too low a frequency and the negative parts too high a frequency to affect the visible spectrum. If, however, the constraints under which these electrons are held are in some way loosened their frequency of vibration will diminish, and ultimately they may become so loosely held as to absorb in the visible.

I once greatly perturbed one of our candidates for a doctor's degree who was coming up for his examina-

tion in organic chemistry by asking him why it was that when most organic substances were heated up they turned yellow. He didn't think that was a fair question. But it seems to me it is a rather interesting question. Why is it that when organic substances are heated up they turn yellow? Why don't they turn green or violet or indigo? If you will remember the spectrum with the red at one end, the violet at the other and beyond that the great range of the ultra-violet—supposing that you consider a substance in which the electrons are loosely held, but not quite loosely enough to get into the visible, it will be absorbing just in the ultra-violet region. Supposing that you make some minor change, perhaps a polarization of molecules, or some similar change in the organic molecules which will lower slightly the absorption period. Then that will

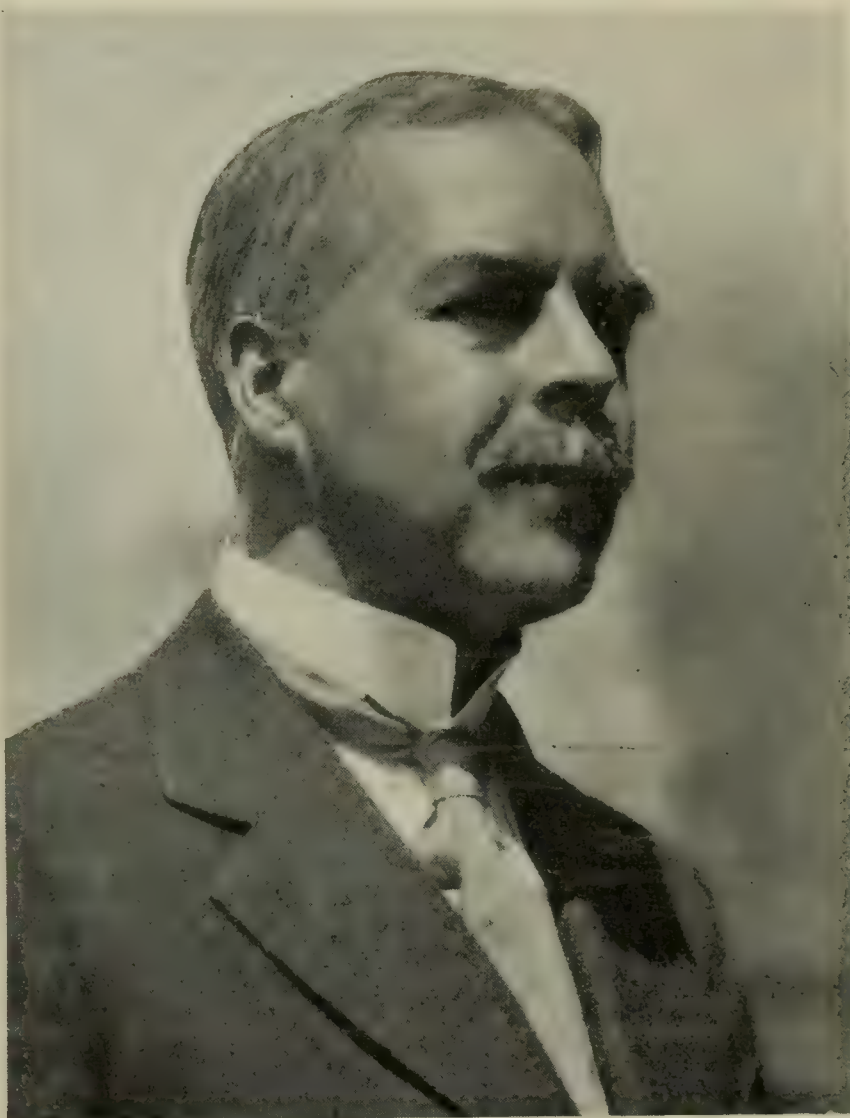
shift down into the visible. The first thing it strikes will be the violet. Taking out the violet leaves a preponderance of yellow, the complementary color which is found in general in the decomposition of all organic substances.

Let us then examine more intimately into the structure of the molecule in order to ascertain, if we may, what relation it bears to the tightness of the constraints which we may conceive to be operating upon the individual electrons. The wonderful development of organic chemistry, which is the chemistry of the carbon compounds, has been due in great measure to the introduction of the so-called structural formula.

The theory of the combination of atoms and the structure of the atom, which I published a few years ago, can hardly be used to predict the phenomena of color, as it was to a large extent derived from the phenomena of color. The

color absorption was one of half a dozen of the leading methods by which we were able to attack the problem of the internal structure of the molecule and the atom. I might mention one more experiment. The substance NO_2 is colored brown, although when it polymerizes to N_2O_4 it is not colored.

There is an organic substance which I want to speak about which is similar, being water white, though a little opaque due to turbulence. It is a solution of triphenyl methyl chloride in benzene. Most of you are familiar with the method by which Gomberg succeeded in obtaining a free radical from this solution by simply adding zinc dust. The zinc combines with the chlorine, leaving the radical triphenyl methyl free, which forms about the zinc in a brown film. That color is not particularly striking, but it is a very peculiar colored substance, belonging to the same class as NO_2 , and I shall have occasion in a moment to speak of both of them



GILBERT NEWTON LEWIS

again. Just to run very hastily over the points involved here, it seemed to me, from the facts of the periodic table alone, that there was a very strong tendency on the part of atoms and molecules to conform to certain very simple types, and to a very small number of types. By a study of the periodic table several investigators were led independently to the idea of a structure of certain atoms, much as I have stated here.

ARRANGEMENT OF NUCLEUS AND ELECTRONS IN THE ATOM

The first one represents by its cross the nucleus of a helium atom, and by the two points, the two electrons which just balance the charge (Fig. 1).

The next one is the neon atom, where we have once

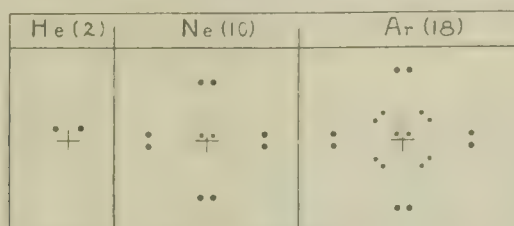


FIG. 1. HELIUM, NEON AND ARGON

more the two electrons in the center, but outside of that this group of eight which Langmuir has called the octet, this group of eight electrons which surround the central group. In the old days I used to speak of this as the cubic theory of the atom, but when my paper appeared I had already rather changed from the idea of cubic to the idea of tetrahedral. The figures are usually made in three dimensions, but let us imagine each of these atoms has a center with four pairs of electrons fairly close together, surrounding in tetrahedral form this central portion, and here in the case of argon with an atom number of 18 and therefore requiring 18 atoms to make a neutral atom, we have one

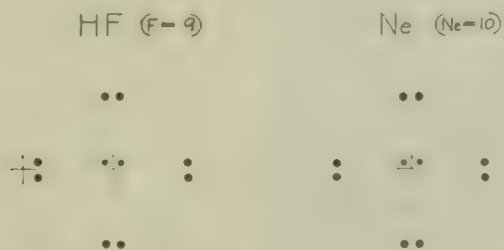


FIG. 2. HYDROFLUORIC ACID AND NEON

of these tetrahedrons composed of four of these electron pairs, and then outside of that another.

These rare gases are not the only ones. These are very simple configurations. Indeed, if I should put on the screen the fluoride ion or the oxide ion they would look exactly like that middle ion picture, and if I put the chloride ion on the screen it would look exactly like the argon picture (Fig. 1). If I put potassium on the screen it would look just like the argon picture. There are certain few types to which these elements belong. They may form these types by forming ions—that is, by lending or gaining enough electrons to form somewhat rudimentary types—and they may form these by another manner, and this, to the chemist, is the essential feature of that theory which I was fortunate enough to work out just before the war: the new theory of the chemical bond.

THE ELECTRON BOND

An electron passing from one atom to another and thus in some way bringing about a chemical reaction

goes way back to the Faraday lecture of Helmholtz. But that represents only a small part of what we may call the function of the electron in chemical change. Fluorine, which is represented by the neutral atom, would have one fewer electron and therefore does not represent the group of eight, can take on that additional electron to make this very considerable configuration which we have here, not by taking that electron away from another atom but by bringing the atom along too. And by that cross over on the left (Fig. 2) I have represented the nucleus of the hydrogen atom, which instead of parting with its electron goes along and together with the fluorine produces this neutral group of eight electrons in the outer shell. So you see by taking on hydrogen you get once more this formation which is characteristic of so many compounds and which is represented by neon. In other words, that pair of electrons held between two atomic centers is the very thing which we have been looking for under the name of the chemical bond.

There is no question that organic chemists have always had a feeling within themselves that this bond between carbon and hydrogen was not a mere product of the imagination but was a real entity, was a real physical thing, and here I believe we may state just what that bond is. It is that pair of electrons which joins two atoms. Here, for example, we have almost precisely the same configurations. Only carbon has to

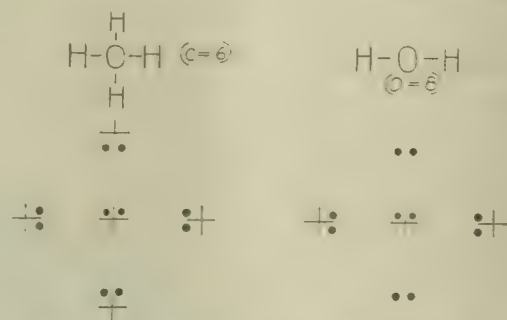


FIG. 3. METHANE AND WATER

take on four hydrogens, having four less electrons itself, and oxygen has to take on two hydrogens to make water, which has the same configuration (Fig. 3).

THE BONDS IN THE HALOGEN GROUP

Then in addition to the bond between these atoms and hydrogen—hydrogen is a very unusual type of atom—we can see how two of these groups holding one pair in common are able to satisfy their complete groups of eight. It is these two figures, and one or two following, which I want to call attention to particularly, because there it seems to me that we have one of the few cases where we know almost precisely what the absorbing mechanism is in colored substances.

You see these figures all look much alike. No matter what formula they are attached to, there are only a few types altogether. This large group in Fig. 4 is fluorine, F_2 . Fig. 5 shows methyl fluoride. The only difference is that it has three hydrogen atoms and different nuclei, of course. The bond, that pair of electrons which is holding together the repellent positive particles, may be a tight bond or it may be a loose bond. It is a tight bond in both of these gases.

Chlorine has a similar structure to the fluorine molecule, except that it has in addition an exterior shell over that which we see in the fluorine molecule. As these two atoms get heavier and heavier the pull on

that central bond becomes greater, and in bromine it is greater than it is in chlorine, and in iodine it is greater than it is in bromine, and we know that iodine vapor at quite a moderate temperature decomposes into two atoms of iodine. Unlike the case where we have a decomposition substance produced, the break is right here between these two electrons, one going to the



FIG. 4. FLUORINE

one and one to the other; we get that peculiar case of which only a handful of instances are known, of the hundreds of thousands of chemical substances, where you have a molecule with an odd number of electrons, and whenever you get a molecule with an odd number of electrons you get color. There is only one known case, that is NO, of one of these substances with an odd number of electrons that are called the odd molecules which do not absorb light. In other words, they are substances one of whose electrons at least is held by so loose a constraint as to absorb light in the visible region. It is the bond electron that is active. I don't know whether it stays in the location shown or not, when the molecule breaks apart, because these molecules are peculiar things; but no matter where it goes, you have always an odd number. And that electron is held by much weaker constraints than all others. You remember when the two odd molecules came together by a bond forming N_2O_4 , the thing became colorless. That is not the case with iodine atoms, and in fact we must now pass to the case of the odd molecules themselves.

This, by the way, is the type of all the organic molecules of which none were known a few years ago and which since Gomber's discovery have been increased by dozens, both for carbon and hydrogen compounds. It is not necessary always for this bond to break before these electrons begin to be loosely held; and so iodine



FIG. 5. METHYL FLUORIDE

which is almost broken shows a gray color in the vapor phase of I_2 . Bromine shows less. Chlorine shows less. Fluorine, as you know, is almost colorless; and there, by every evidence we have, that bond is a tight one. Think, in spite of its tremendous affinity, how relatively inert a substance like chlorine is, compared to a substance like iodine.

ORGANIC BONDS

The typical bond of organic chemistry is shown in Fig. 3 with methane—a tight bond in which the electrons are held with such firmness that they don't absorb light in the visible and they don't absorb light in the ultra-violet, as far as it is possible to investigate that substance.

Ethylene, Fig. 7, is a typical unsaturated organic substance, in which the bond pair of electrons are in the position which is one of greatest stability—the pair of electrons held exactly between two central positive atoms. It is impossible for the double bond, where you have two electron pairs taking part simultaneously, to be in the middle of a line exactly joining these centers. They are crowded apart, and not only our evidence from color but our evidence from chemical reaction and the great variety of other evidence we have shows that the electrons in double bond are held much more loosely. And you will find that of all the color compounds of

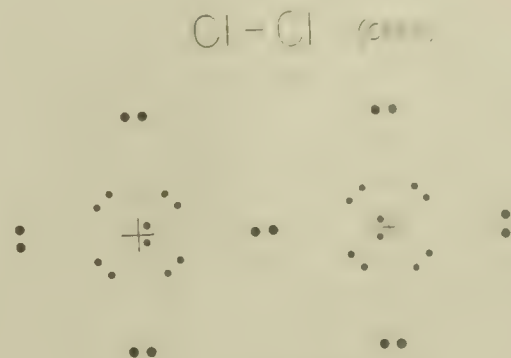


FIG. 6. CHLORINE

organic chemistry except these rare ones which have the odd electron every one contains a double bond, and most of them are composed very largely of radicals with double bonds. That double bond is not ordinarily



FIG. 7. ETHYLENE

sufficient. The electrons, although much less firmly held than in the single bond, are not ordinarily loosely enough held to produce absorption of visible light. Their vibration frequency is in the ultra-violet, but by adding to the unsaturation of these molecules, by doing the various things which the organic chemist will tell you will loosen that bond, even if he hasn't any interest in the problem of color at all, you will find that these enter into the domain of the dyes.

QUANTUM THEORY WILL NOT ALTER PRESENT COLOR THEORY

I do not wish to make this problem of color seem more simple than it really is. It will be long before we reach any complete understanding of the thousands of detailed observations which have been made in this field, and we do not know as yet how far our ideas will have to be modified by that great wave of bolshevism in physics which is known as quantum theory. Einstein, perhaps the profoundest thinker in physical science that this century has known or will know, and whose name has recently become almost a household word through the offices of the daily and the comic press, was one of the first exponents of quantum theory. But, as he once said to me in conversation, "Quantum theory is not yet a theory in itself, it is simply a negation of the older theories." It seems, however, that in the region of loosely bound electrons which characterize our colored substances the further development of the quantum theory will not greatly modify such conclusions as we have discussed today.

A Study of the Saturated and Unsaturated Oils From Shale

An Investigation of the Amount and Causes of Unsaturates in Shale Oils—Cracking During Retorting and Distillation Accompanied by an Increase in Saturation—Unsaturates Vary With Nature of Shale and Methods of Pyrolysis

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WHEN distillates from our shale oils are treated with an excess of sulphuric acid, there is a large loss of oil. This indicates a high percentage of unsaturated compounds and considerable refining loss if the oil is to be refined by the usual acid treatment. Both the refining methods and the utilization of shale oil depend to a large extent on the quantity and nature of the saturated and unsaturated constituents. Hence it is highly desirable to know the percentage and distribution of saturates and unsaturates, the factors which tend to increase the former and diminish the latter, and any physical or chemical properties of the unsaturated compounds which may aid in indicating proper methods of retorting and refining or in suggesting uses for the oil. Most of the experimental work of this paper was done to obtain information for practical purposes and while no attempt has been made to study a large number of oils or to make an exhaustive study of shale oil hydrocarbons, it is hoped that some valuable information has been obtained concerning the extent of their saturation, the cause of the unsaturates, the distribution of the saturates, the effect of cracking on saturation, and some of the properties of the unsaturated substances.

THE DETERMINATION OF SATURATES AND UNSATURATES

In all determinations the oil has been treated with two volumes of sulphuric acid (c.p., dens. 1.84) and the volume of the oil remaining expressed in percentage of the original volume is the percentage of saturated compounds. The difference between this and 100 is the percentage of unsaturated compounds. Some chemists may question the propriety of the term "unsaturated" to designate these substances and also the use of sulphuric acid as a means of measuring the amount of unsaturated compounds, since in addition to combining with unsaturated bodies, water and other substances are dissolved by the acid, basic constituents are neutralized, polymerization may occur and some aromatic compounds may be absorbed.¹ However, this method is apparently satisfactory for practical purposes when used on shale oils and is considered sufficient for the experimental work of this paper. The method² used is as follows: Five or 10 c.c. of the oil is measured into a 9- or 18-g. 50 per cent Babcock cream-test bottle and a double volume of the acid added. The bottle is kept cool by immersion in cold water but is shaken gently at intervals until finally with vigorous shaking there is no longer a rise in temperature. Then the bottle is filled to the neck with acid and centrifuged at 1,000 r.p.m. for three minutes. The oil remaining is now

brought into the graduated neck of the bottle by addition of more acid and the centrifuging is repeated. The percentage of saturates is calculated from the volumes of the remaining oil and the original oil. When the acid concentration is constant, the results check within 0.5 per cent. A correction is made whenever the water content of the oil exceeds this value. When the oil is solid, it is warmed enough to keep it in the liquid condition.

RESULTS OF DETERMINATIONS

Using this method, saturation tests have been made on shale oils from Colorado, Wyoming, Utah, Nevada, Quebec, England and Scotland. The oils tested include crude oils produced by twelve different plant processes of retorting and crude oils obtained from eleven different shales in laboratory retorts. Most of the plants were in an experimental stage. The laboratory retort was of the usual iron, "mercury-distillation" type op-

TABLE I

Oil by Plant Retort			Oil by Laboratory Retort		
Shale	Plant No.	Saturates, Per Cent	Shale	Laboratory No.	Saturates per Cent
Colorado.....	1	17.5	Colorado.....	1	14.0
Colorado.....	2	11.6	Colorado.....	2	22.0
Colorado.....	3	28.0	Colorado.....	3	17.0
Colorado.....	4	15.5	Colorado.....	4	12.8
Colorado.....	5	13.6	Colorado.....	5	19.7
Colorado.....	6	15.5	Wyoming.....	6	15.5
Colorado.....	7	16.0	Wyoming.....	7	17.8
Utah.....	4	15.8	Wyoming.....	8	20.0
Utah.....	8	26.5	Wyoming.....	9	16.3
Utah.....	9	16.0	Wyoming.....	10	12.4
Nevada.....	10	41.2	Quebec.....	11	12.0
England.....	11	16.0			
Scotland.....	12	38.0			

erating without steam. The results obtained by these determinations are given in Table I. The saturates in the oils tested very between 12 and 41 per cent. This indicates a high percentage of unsaturated compounds in the crude oils from all of the above sources and methods of retorting.

CAUSES OF THE HIGH PERCENTAGES OF UNSATURATES

—LOW CONTENT OF HYDROGEN

One explanation of this high percentage of unsaturates in shale oils is that the kerogen or oil-yielding material of the shale does not contain sufficient hydrogen to produce saturated compounds with a large portion of the carbon in the hydrocarbons volatilizing during the destructive distillation of the shale. This is indicated by the fact that free carbon is present in all spent shales and by the results of chemical analyses of the kerogen or shale. Analyses of the kerogen from Scottish shales reported by Mills³ show a hydrogen to carbon ratio of about 1 to 6.9. Robertson states⁴

¹Technical Paper 181, U. S. Bureau of Mines, p. 11.

²Modified from Egloff, Gustav, and Twomey, MET. & CHEM. ENGR., March, 1916, p. 247, and Technical Paper 181, U. S. Bureau of Mines, p. 11.

³J. Inst. Pet. Tech., 1916, p. 238.

⁴Proc. Roy. Soc. Edinburgh, vol. 34 (1914), p. 190.

that for Broxburn shale this ratio varies between 1 to 6 and 1 to 8 and over, and that the greater the proportion of hydrogen the larger the yield of oil. An average of six ultimate analyses made on Nevada, Utah and Colorado shales by J. D. Davis of the United States Bureau of Mines⁵ gives a ratio of 1 to 7.8. The ratio of hydrogen to carbon is about 1 to 5.6 for the average gravity paraffine hydrocarbon found in mineral oils and is 1 to 6 for an olefine. We would not expect an organic substance such as kerogen, which apparently contains no free carbon and which has a hydrogen to carbon content of 1 to 7, to decompose with the formation of a large percentage of paraffines in which this ratio must be 1 to 5.6 unless considerable free carbon is formed. It is probable that the higher the hydrogen content of the shale the greater will be the percentage of saturates in the oil, and it is evident that cracking would tend to increase the saturation of the oil if the hydrogen content of the permanent gas and coke is much less than one-seventh of the carbon content. In other words, it is possible that the smaller the yield of oil from a given shale which is completely carbonized the higher may be the percentage of saturates in the oil. While the above data are not sufficient for far-reaching conclusions, they indicate that there is not enough hydrogen in the organic material found in shales to produce saturated compounds with all of the carbon, and consequently for a maximum yield of oil it must be highly unsaturated.

CRACKING OF THE OIL

Some of the inventors of shale retorts in this country have suggested another explanation for the high percentage of unsaturates. It is generally known that the overheating of petroleum oils causes a decomposition or cracking of the oil and that this cracking at atmospheric pressure is accompanied by an increase in the percentage of unsaturated compounds. Using this as a premise, they conclude that the high temperature used in the destructive distillation of the shale cracks the oil and produces the unsaturates. Acting on this principle, retorting processes have been planned to operate at a minimum temperature, thereby preventing cracking and thus producing a more saturated crude oil. Some advocate steam-retorting as a preventive of cracking and claim to obtain a more highly saturated product in this way.⁶ Redwood states⁷ that in Scottish practice retorting with steam prevents the formation of olefines. Others claim that the beneficial effects of low-temperature carbonization of coal on the distillates applies also to shale. However, the writer has not been able to find any published data to prove that the cracking of shale oil tends to increase the unsaturates or that more saturates are obtained when the retorting is done at low temperatures or with steam. In November, 1919, G. W. Wallace⁸ reported that he had found that shale oils crack more readily than petroleum oils and that a large amount cracking occurred during distillations at atmospheric pressure. In January of last year the writer began a study of the extent of this cracking and found that the oils tested cracked to an unusual degree when distilled at atmospheric pressure and were also unusual in that the oil after distillation contained a much larger amount of saturated

compounds than the original crude oil.⁹ This unexpected increase in saturation, produced apparently by cracking of the oil, indicated that the high percentage of unsaturates might in part be due to low-temperature carbonization, which, while serving as a preventive of decomposition as intended, acted also at cross-purposes and produced an oil lower in saturates.

EXPERIMENTS IN SHALE RETORTING

The influence of low- and high-temperature retorting on saturation and the effect of the presence of steam and hydrogen gas during retorting were studied by distilling samples of a Colorado shale in a laboratory retort under four different conditions. In the first two distillations the oil was removed at as low a temperature as possible without steam; in the third and fourth distillations the oil was removed at as low a temperature as possible introducing steam at the base of the retort; in the fifth and sixth distillations the oil was removed at a low temperature introducing hydrogen instead of steam; and in the seventh and eighth distillations the oil was removed by a more rapid application of heat but its rapid escape prevented by an iron, air-cooled, reflux condenser, which returned the heavier oil to the hot shale in the retort. The temperature of the shale was obtained by a 900 deg. F. Tagliabue thermometer inserted in a thermometer-well which reached to a point near the center of the shale. The vapors coming from the retort were passed through a water-cooled vertical condenser and the oil and water condensing were received in a graduated cylinder or a cylindrical trap. The permanent gases were conducted from the receiver through 5 per cent sulphuric acid in a Meyer tube and measured by a wet-test gas meter. At the end of the distillation boiling water was passed through the outer tube of the condenser to melt and remove any oil which had solidified in the inner tube. The oil in the receiver was then measured and after

TABLE II. DATA ON RETORTING

	Without Steam		With Steam	
	No. 1	No. 2	No. 3	No. 4
Oil, gal. per ton.....	74.6	75.0	78.5	78.2
Permanent gas, with oil, cu.ft. per ton...	1,980	2,005	2,620	2,206
Permanent gas, total, cu.ft. per ton.....	3,436*	3,744†	3,035*	10,530†
Spent shale, lb. per ton.....	1,187	1,178	1,214	1,050
Fixed carbon and volatile matter in spent shale, per cent by weight.....		16.8		5.7
Gravity of crude oil.....	0.887	0.890	0.916	0.910
Saturation of crude oil, per cent.....	26.2	24.0	15.6	17.6
Temperature when flow of oil started, deg. F.....	550	500	420	425
Temperature when oil was one-half off, deg. F.....	745	750	740	750
Temperature when oil ceased, deg. F....	800	815	825	800
Final temperature, deg. F.....	875	900+	900	900+
Amount of steam used, per cent water is of oil by vol.....			520	710
Volume of steam, cu.ft. per ton‡.....			83,180	115,250
	With Hydrogen		High Temperature	
	No. 5	No. 6	No. 7	No. 8
Oil, gal. per ton.....	77.2	77.9	69.9	70.0
Permanent gas, with oil, cu.ft. per ton...	1,825	1,675		
Permanent gas, total, cu.ft. per ton.....	2,530*	3,060†	2,540*	2,635*
Spent shale, lb. per ton.....	1,173	1,100	1,223	1,216
Fixed carbon and volatile matter in spent shale, per cent by weight.....		9.5		18.7
Gravity of crude oil.....	0.900	0.907	0.874	0.872
Saturation of oil, per cent.....	20.6	18.6	30.1	30.2
Temperature when flow of oil started, deg. F.....	600	585	595	610
Temperature when oil was one-half off, deg. F.....	750	745	750	755
Temperature when oil ceased, deg. F.....	850	850	885	900
Final temperature, deg. F.....	900	900+	900+	900+
Amount of hydrogen used cu.ft. per ton... 10,590	16,620			

* Heating discontinued soon after the oil flow ceased.

† Heating continued for one hour after the oil flow had ceased.

‡ Calculated for 20 deg. C., 615 mm., the conditions under which the hydrogen was measured.

⁵Bull. 641, U. S. Geological Survey, p. 161.

⁶R. D. George, Railroad Red Book, July 1920, p. 647.

⁷I. I. Redwood, "Treatise on Mineral Oils and Their Byproducts," p. 52.

⁸Inventor of the Wallace retort.

⁹This experimental work is presented in the third division of this paper.

TABLE III. DATA ON FRACTIONATION OF OILS

First Distillation	Without Steam Nos. 1 and 2	With Steam Nos. 3 and 4	With Hydrogen Nos. 5 and 6	High Temp. Nos. 7 and 8
Water, per cent by weight.....	0.2	0.4	0.35	0.0
Oil, per cent by weight.....	94.0	86.6	88.6	96.9
Coke, per cent by weight.....	4.4	10.0	8.8	2.5
Gas, by difference.....	1.4	2.95	2.25	0.6
Gas, volume in c.c.....	1.090	2.430	1.810	310
Gasoline, to 410 deg. F. per cent vol....	20.3	13.6	17.0	29.0
Kerosene, to 575 deg. F., per cent vol....	22.1	20.4	20.9	29.8
Heavy oil, to coke, deg. F. per cent vol..	53.6	57.1	54.0	39.2
Gravity, once-run oil.....	0.870	0.875	0.871	0.864
Saturation, once-run oil, per cent.....	36.4	35.2	36.3	36.0
Increase in gravity.....	0.0185	0.038	0.0325	0.009
Increase in saturation, per cent.....	11.3	18.6	16.7	5.9
Increase in volume of saturates, per cent.....	36.2	83.7	64.3	15.6
Maximum boiling point, deg. F.....	707	705	695	700
Second Distillation				
Gasoline to 410 deg. F., per cent.....	25.4	24.1	24.7	31.7
Cracked oil to 410 deg. F., per cent ..	5.2	10.5	7.6	2.7

washing with water was kept at 100 to 130 deg. F. in tightly stoppered bottles for three days in order to secure a rather complete separation of water. At the end of this time the volume of the oil was remeasured and samples taken for the saturation tests. The portions of oil obtained under each condition were combined and a fractional distillation made on each. These fractionations were made on 50-c.c. portions in a standard 100-c.c. Engler distilling flask. The coke values were obtained by weighing the flask before and after the distillations. The oil percentage by weight was calculated from the gravity and volume of the oil. The weight-percentage of gas was obtained by difference and its volume was measured by meter. A second distillation of the once-distilled oil was made to 410 deg. F. to determine the increase in this fraction caused by cracking. The results of the retorting experiments are given in Table II and of the fractionations in Table III.

RESULTS OF SHALE-RETORTING EXPERIMENTS

The most important result shown by the data in Table II is that no one of the four conditions of retorting produced from this shale a crude oil containing over 30 per cent of saturates. This is doubtlessly due to the low hydrogen content of the shale and indicates that the nature of the shale and not the process of retorting is by far the predominating factor in determining the percentage of unsaturates. Where the cracking is minimized by the steam-retorting the unsaturates are about 15 per cent higher than in the retorting with the reflux condenser, where the decomposition is at a maximum. The presence of free hydrogen in the retort does not affect the saturation of the oil, except as it acts similarly to the steam in preventing some of the cracking through speeding up the removal of the oil vapors.

The position of the thermometer and the manner of application of heat to the retort were such that the readings taken when the oil was about half off more nearly indicate the decomposition temperatures of the shale than the other readings. These temperatures are between 740 and 755 deg. F. and are independent of the presence of steam or hydrogen. This temperature is probably somewhat of a constant for a particular shale and like the hydrogen content of the shale is not dependent on the process of retorting. The maximum boiling point of the shale oils (705 deg. F.) is probably lower than the average decomposition temperature of the shale, consequently the longer the oil vapors are subject to the higher temperatures in the retort the greater the tendency to decompose the unstable portions

of the oil. The introduction of steam or hydrogen increases the rate of flow of the vapors, thus diminishing the decomposition, and under these conditions there is a somewhat larger yield of oil of higher specific gravity and lower content of saturates. The cracking of the shale oil vapors is apparently a decomposition of unstable unsaturates with the formation of coke, gas and a rather high percentage of saturated lighter oils. Hence if we would increase the saturates in the crude oils by retorting conditions, we must not limit the decomposition to the shale alone but subject the oil vapors to the higher temperatures long enough to secure a decomposition of the unstable, unsaturated compounds.

Table III shows the results of a fractional distillation of the oils obtained under the four different conditions of retorting. The oil obtained with steam, containing 16.6 per cent of saturates, cracked to the greatest extent on distillation, yielding 10 per cent of coke, 2.95 per cent of gas and 86.6 per cent of oil containing 35 per cent of saturates. Where the increase in saturation is less, there is a corresponding decrease in the coke, gas and cracked-gasoline values and there is a less decrease in gravity, all of which would be associated with a smaller amount of decomposition. The once-run oil in all four cases is much the same in gravity and saturation, excepting that the oil retorted by a maximum of cracking (Nos. 7 and 8) is lighter due to a higher content of gasoline and kerosene and has a correspondingly less proportion of heavy oil. The decomposition, which was not completed in the retort, is apparently complete when the crude oil is distilled at atmospheric pressure without steam or other preventives of cracking.

EFFECT OF DISTILLATION OF THE OIL ON SATURATES AND UNSATURATES AND THEIR DISTRIBUTION

A study was made of the effect of distillations at

TABLE IV. DISTILLATIONS OF CRUDE ASPHALTIC OIL

Oil Percentage- off	Still Temp., Deg. F.	Vapor Temp., Deg. F.	Gas, c.c. per Cut	Gravity of Oil	Saturates, per Cent by Vol.
(a) First distillation, sample 800 c.c.....					
I.b.p.*	275	178		0.939	26.5
10	497	402	25	0.829	48.0
11.25	500	410			
20	565	466	40	0.868	40.5
30	630	521	115	0.892	36.0
40		590	210	0.910	35.5
50	715	622	310	0.921	35.0
60	746	612	1,190	0.914	34.0
70	766	607	2,020	0.891	40.0
80	795	528	4,035	0.882	46.0
85.5	875	435	2,150	0.892	46.0
(b) Second distillation. Once-run oil.....					
I.b.p.	243	155		0.888	40.0
10	435	350	0	0.785	56.0
19.34	476	410			
20	486	419	0	0.838	48.0
30	517	464	0	0.867	44.5
40	550	506	0	0.885	42.5
50	580	546	0	0.899	42.0
60	605	566	0	0.909	40.0
70		604	0	0.917	39.0
80		646	0	0.927	36.5
90	775	730	0	0.934	30.0
98.9	885	700	1,050	0.940	26.0
(c) Third distillation. Twice-run oil.....					
I.b.p.	238	152		0.889	40.4
10	445	370	0	0.788	55.0
19.84	488	410			
20	492	411	0	0.839	47.0
30	526	464	0	0.865	44.0
40	556	484	0	0.881	41.0
50	572	546	0	0.897	40.5
60	619	582	0	0.909	40.0
70		620	0	0.915	39.0
80	685	658	0	0.926	38.0
90	780	726	0	0.935	35.5
99.8	896	700	700	0.937	34.4
(d) Products of distillations in percentage by weight.					
	Crude Oil	Once-Run Oil	Twice-Run Oil		
Water.....	0.2	0.22	0.2		
Oil.....	80.9	98.76	98.71		
Coke.....	16.5	0.77	0.9		
Gas (by difference).....	2.4	0.25	0.19		

* Initial boiling point.

TABLE V. DISTILLATIONS OF PARAFFINE-BASE SHALE OIL

Oil Percentage-off	Still Temp., Deg. F.	Vapor Temp., Deg. F.	Gas, c.c. per Cut	Gravity of Oil	Saturates, per Cent by Vol.
(a) First distillation, 800 c.c. crude oil.....					
I.b.p.	314	224	.....	0.877	41.2
3.8	493	410	.....	.....	.....
10	532	467	0	0.836	60.0
20	580	508	0	0.844	59.0
30	620	585	80	0.853	58.6
40	662	606	140	0.856	59.6
50	690	643	420	0.854	60.2
60	725	657	980	0.853	60.5
70	755	670	1,400	0.851	61.0
80	780	705	1,820	0.845	58.0
90	802	705	5,460	0.844	56.0
97.3	804	625	1,455	0.922	32.5
(b) Second distillation, once-run oil.....					
I.b.p.	280	205	.....	0.851	58.8
7.2	476	410	.....	.....	.....
10	492	432	0	0.795	60.8
20	530	486	0	0.836	60.7
30	565	524	0	0.844	60.5
40	592	550	0	0.851	60.4
50	623	578	0	0.854	60.4
60	647	613	0	0.857	60.3
70	680	650	0	0.859	59.8
80	709	675	70	0.865	58.8
90	737	700	240	0.867	53.8
99.5	840	715	1,590	0.873	47.8
(c) Third distillation, twice-run oil.....					
I.b.p.	268	196	.....	0.849	58.5
8.8	476	410	.....	.....	.....
10	485	425	0	0.791	61.2
20	521	475	0	0.833	61.0
30	552	514	0	0.843	60.8
40	581	542	0	0.848	60.5
50	605	570	0	0.853	60.4
60	629	600	0	0.855	60.3
70	659	635	0	0.860	60.3
80	693	665	0	0.863	60.2
90	735	708	70	0.866	59.2
99.5	843	718	880	0.871	40.4
Thrice-run oil.....					
				0.848	58.6
(d) Products of Distillations in Percentage by Weight:					
	Crude Oil	Once-Run Oil	Twice-Run Oil		
Water.....	0.1	0.0	0.0		
Oil.....	95.0	99.16	99.5		
Coke.....	3.4	0.59	0.35		
Gas (by difference).....	1.5	0.25	0.15		

atmospheric pressure on the cracking of shale oils and on the amount and distribution of the saturates and unsaturates. The results obtained with three different types of oils will be given somewhat in detail. These oils include an asphaltic oil from a Utah shale, an oil rich in paraffine from a Nevada shale and an oil of mixed-base variety from a Colorado shale. The samples for distillation were taken from 5-gal. cans which were originally filled from batches of oil obtained in quantity from shales representative of those being worked at three different places in the states mentioned. An 800-c.c. portion of each of the oils was distilled at atmospheric pressure (24.2 in. in Golden, Col.) from a 1,000-c.c. pyrex distilling flask. The vapors were condensed in a vertical water-cooled condenser ending in a trap from which any permanent gas formed by cracking was conducted through a wet-test gas meter and measured. The oil from the trap was removed at such intervals as to obtain 10 per cent fractions, and when each fraction was complete a reading was taken of the still temperature, vapor temperature and the amount of gas formed. The gravity of each cut was determined by hydrometer and after removing a sample for a saturation test the remainder was composited and is designated as once-run oil.

After determining the gravity and saturation of the once-run oil a portion (580 or 600 c.c.)¹⁰ was distilled a second time from a similar flask and the same kinds of data taken as in the first distillation. The twice-run oil thus obtained was then composited as before and a third distillation made (except with the mixed-base oil)

¹⁰With the mixed-base oil the gasoline to 410 deg. F. was excluded and the second distillation made with 500 c.c. from a composite of the remaining oil.

in the same manner, recording similar kinds of data. The percentages of coke were determined by weighing the empty flask before the distillation and the flask with contents after the distillation. The temperatures were taken with Tagliabue thermometers. For the vapor temperatures the bulb of the thermometer was in the usual position and for the still temperatures it was placed in the center of the flask about 2 to 3 mm. from the bottom. The data obtained with the asphaltic oil are given in Table IV, with the paraffine base oil in Table V, and with the mixed-base oil in Table VI.

RESULTS OF DISTILLATIONS OF SHALE OILS

A study of Tables IV, V and VI will justify the following statements relative to the cracking and the the saturated and unsaturated content of the oil:

(1) There is a large amount of decomposition during the distillation of the crude oil. Measured in percentage of permanent gas and coke formed, it is 4.9 for the paraffine-base oil, 10.2 for the mixed-base oil and 18.9 for the asphaltic oil. It is also manifest by the lowering of the vapor temperature and by a decrease in the specific gravity of the fractions.

(2) The cracking occurs after the still temperatures have reached 600 deg. F. (vapor temperatures 500 deg. F.) and is most rapid when the still temperature is about 800 deg. F.

(3) Compared with the first distillation, the decomposition during the second and third distillations is very slight, occurring only at the higher still temperatures when the distilling flask is nearly dry and probably at a temperature exceeding that indicated by the thermometer. This shows a high stability for the heavy fractions of the once-run oils and indicates that after the first distillation shale oils do not crack more readily than petroleum oils.

(4) The decomposition of the crude oils is accompanied by a considerable increase in the saturation of the oil. This is shown by an increased saturation in the heavier fractions and by a higher saturation value for the once-run oils. The volume of the saturates increased 29.0 per cent for the asphaltic oil, 38.8 per

TABLE VI. DISTILLATIONS OF MIXED-BASE OIL

Oil Percentage-off	Still Temp., Deg. F.	Vapor Temp., Deg. F.	Gas, c.c. per Cut	Gravity of Oil	Saturates, per Cent by Vol.
(a) First distillation, 800 c.c. crude oil.....					
I.b.p.	248	153	.....	0.920	16.0
10	448	346	0	0.783	43.0
15.9	504	410	0	0.826	39.0
25.9	568	482	0	0.861	33.0
35.9	635	540	230	0.888	28.6
45.9	689	588	810	0.908	27.0
55.9	729	615	2,570	0.904	29.0
65.9	.....	660	3,350	0.905	31.5
75.9	810	705	3,400	0.906	31.5
85.9	840	675	6,000	0.909	30.0
92.6	850	625	4,210	0.992	28.7
(b) Second distillation, once-run oil*.....					
I.b.p.	245	175	.....	0.904	30.0
10	464	396	0	0.785	51.0
12.6	476	410	.....	.....	.....
20	504	462	0	0.855	39.0
30	543	510	0	0.875	37.0
40	578	549	0	0.893	34.2
50	610	578	0	0.905	31.4
60	644	624	0	0.918	30.6
70	680	648	0	0.927	30.0
80	720	680	195	0.932	28.4
90	760	714	520	0.938	27.0
98.5	885	705	3,280	0.955	18.0
Twice-run oil.....					
				0.897	32.7
(c) Products of Distillations in Percentage by Weight:					
	Crude Oil	Once-Run Oil			
Water.....	0.3	0.0			
Oil.....	89.5	97.73			
Coke.....	8.4	1.55			
Gas (by difference).....	1.8	0.72			

* The gasoline to 410 deg. F. was excluded.

cent for the paraffine-base oil, and 73.6 for the mixed-base oil. (Additional values for this increase may be found in Table III.)

(5) The second and third distillations have little effect on the percentage of saturates and unsaturates, but they show clearly the distribution of these constituents. The lighter fractions have the highest saturation (50 to 60 per cent) and the saturates decrease with the increase in gravity and boiling point and reach a minimum (18 to 40 per cent) in the heaviest fraction.

(6) The decomposition is apparently one of heavy unsaturated compounds which are unstable at the still temperatures necessary for distillation at atmospheric pressure without the introduction of steam or other gases, and is accompanied by the formation of permanent gas, coke and lighter oils containing a high percentage of saturates.

While it is quite obvious that the compounds undergoing decomposition are heavy and unstable, more experimental evidence is desirable in support of the statement that the substances decomposing are unsaturates. A subsequent paper will present the results of study along this line, the determination of some of the properties of the heavy constituents of shale oils, and a discussion of the results obtained in the different portions of the investigation.

Colorado School of Mines,
Golden, Col.

Section of Sugar Chemistry and Technology, A.C.S.

AT THE Rochester meeting of the American Chemical Society, thirty-three papers were presented before the Section of Sugar Chemistry and Technology, as compared with the very few read at the St. Louis meeting and seventeen at the Chicago meeting last September. Approximately 150 enrolled as members of the section. The members voted to request that the section be made a division; that present officers be re-elected until the creation of the division; that the executive committee be authorized to pass judgment on all papers for the next meeting, assigning a time limit for reading and accepting or refusing papers, as seems best.

In addition to a number of papers presented which described improved methods of analysis and laboratory equipment designed to make possible more accurate factory control work, the following papers were concerned more especially with the technology of cane and beet sugar manufacture.

A Comparison of the Results in the Process of Desugarization With the Steffen Lime-Process, the Barium Process and the Strontium Process, by M. Potvliet. Experimental work indicated by the title was described. Processes were compared on the basis of purity of resulting liquors 81.4 per cent for the lime, 93.79 per cent for the barium and 90.90 per cent for the strontium process. Fewer operations were said to be necessary to extract the sucrose from molasses by the barium and strontium processes. Of the sugar originally present in the molasses there was obtained as granulated sugar by the lime process 35.45 per cent, by the barium process 43.94 per cent and by the strontium process 43.18 per cent. It was claimed that not the slightest trace of barium is present in the final sugar and that more raffinose is found to be eliminated by the barium process. In the discussion which followed the presentation of this paper, the statement regarding the entire absence of barium was questioned.

The Effect of Varying Hydrogen Ion Concentration Upon the Decolorization of Cane Juice With Carbon, by J. F. Brewster and W. G. Raines. *The Effect of Some Decolorizing Carbons on the Color and Colloids of Cane Juice*, by J. F. Brewster and W. G. Raines. These two papers reported the results of experimental work with four different carbons. Emphasis was laid on the fact that decolorization depends greatly on the hydrogen ion concentration, but that it is not best to use too high hydrogen ion concentration on account of inversion. It was found that simply acidifying also produced decolorization; this point was considered in the conclusions. It was found also that by adding the carbon, heating, and acidifying with H_3PO_4 to the desired hydrogen ion concentration, and also adding enough lime before filtration sufficiently to reduce acidity, equally good decolorization was obtained and the $Ca_3(PO_4)_2$ was removed at the same time. Inversion was tested by boiling the juice at various hydrogen ion concentrations. Both color and colloids removed were determined after the use of different carbons, and these results were compared with color and colloids removed by the sulphur-lime process. Regulation of the hydrogen ion concentration is a much better method for controlling acidity than the usual method of titration.

A Study of Beet Gum—I. Separation From Final Molasses, by H. S. Paine and C. F. Walton, Jr. A considerable amount of gum was prepared from final molasses by dialysis, and various preliminary tests made of its composition and properties. A minimum specific rotation of about -29 deg., changing after hydrolysis to about $+58$ deg., was indicated. The gum was precipitated by an alcohol-acid mixture. The material yielded 32 per cent furfural phloroglucide. A positive test for galactan by the mucic acid method was not obtained. The gum increased the viscosity of sugar solutions and incidentally color, to a much greater extent than would be expected from its actual weight. Crystallization experiments indicated that the gum exerts a marked effect in diminishing the rate of crystallization of sucrose.

Colloids in Beet Sugar House Liquors and Products, by H. S. Paine, C. G. Church and F. W. Reynolds. The primary object was to determine the amount and character of the colloidal material present at successive stages in the factory, to ascertain the importance of the rôle played by colloids in sugar-house difficulties, and to attempt the solution of such difficulties. Colloids were determined by dialysis. Organic rather than inorganic colloids apparently play the predominant part in factory troubles of colloidal character; the organic colloidal material not eliminated by clarification consists to a considerable extent of one or more gums. Gum was found in relatively considerable amount in washed cold saccharate cake. A substance resembling pectin in its reactions was found in diffusion juice, but not in the subsequent products. Under usual factory conditions the amount of colloids present is apparently primarily dependent upon the character of the beets worked.

Sugar Filtration in Factories and Refineries, by H. J. Runyon, Jr. This was a very interesting paper from the engineering point of view both to sugar-houses and refineries but applies principally to refining practices. The author stated that lime and phosphoric acid defecation has become unsatisfactory in refineries with the advent of pressure filtration, because the precipitate is too gelatinous; it has been largely displaced by kieselsguhr and the use of filters of the Sweetland type.

Breadth and Scope of Chemical Patent Claims*

Review of Decisions Holding Patent Claims Void for Undue Breadth and of Others Holding Them Valid for Merited Scope—Citations From Cases Bearing on Chemical Equivalents and Essential Differences

BY C. H. BIESTERFELD

INVENTORS working along chemical lines are frequently confronted with the question of properly drafting comprehensive claims to cover a number of substances which they have successfully employed in new processes or compositions. In many cases such substances belong to the same chemical family and in some cases they do not. In some cases they constitute distinct species and in some cases only equivalents. The courts have clearly decided questions relating to the scope and construction of chemical claims which cover a group of substances, and the following is a digest of most of the cases.

CASES HOLDING CLAIMS VOID FOR UNDUE BREADTH

Incandescent lamp patent, 73 O. G., 1,289. The claims covered "carbonized fibrous or textile material," although the patentee had made filaments out of carbonized paper only, and had not discovered any other species of carbonized fibrous or textile material. It was proved that bamboo was particularly valuable as a filament and the court held that the claims were void for undue breadth, saying that there was no generic quality in all such materials which adapted them to the purpose.

Matheson vs. Campbell, 78 Fed., 910. The patentee tried to cover "any sulpho acids of any radical," which included 100 or more substances, and he described only a few. The evidence showed that most of the group of 100 were inoperative. Held that he could not speculate on the equivalents of his invention and he was not entitled to a monopoly of all substances which might be found by future experiments to be equivalents of his three or four disclosed substances.

Rickard vs. DuBon, 97 Fed., 96. The claim recited "applying an alkali to the leaves," but the specification named only KOH and the evidence in the trial showed that NaOH was inoperative when applied to leaves. The court held the claim void as being too broad.

Bracewell vs. Passaic Print Works, 107 Fed., 467. The claim covered all zinc compounds, although the specification described only zinc oxide, hydrate and carbonate. The evidence showed that zinc sulphide and chloride would fail and that the chemists were agreed that untried zinc compounds could not be used with certainty. Patentee tried to have the specification read into the claim, but the court refused, since his specification said "any zinc compound may be employed." The court held the claim void, saying: "He stretched his net to catch as infringers all users of zinc compounds, and if he has stretched it to the breaking point, he has only himself to blame. The courts should be liberal in construing patents, but they cannot rewrite the description and claims; they cannot construct an entirely

new patent even to save a meritorious invention. If the complainant's contention be correct, a patentee can claim blindly an entire group of compounds, relying on the court after subsequent investigation and experiment to limit the claim to the one which gives the best results. This will not do."

Lumber Anti-Stain vs. Nester, 178 Fed., 927. Claim 1 recited "applying to wood a weak alkaline solution," and the specification described NaHCO_3 . Claim 1 was met in terms by lime water applied to wood, and the court refused to limit the claim to NaHCO_3 because the patentee had nowhere shown any intention to so limit it. Claim 1 was held void. Claim 2 covering only NaHCO_3 was also held void because the patentee had regarded lime water and NaHCO_3 as equivalents.

Empire Circuit Co. vs. Channon, 168 Fed., 705. The claim said "non-combustible and non-conducting material," the specification describing a fire curtain made of asbestos or the like on one side, and metal on the other. The prior art showed a curtain of firebrick on one side and the court held the claim anticipated, refusing to narrow it because the patentee had nowhere indicated his intention to place a limited meaning upon the broad terms used.

Dosselman vs. Neymann, 167 O. G., 983. Patent Office decision. The claims recited "ketonic finish softening material," but only acetone was described in the specification and it did not appear that all ketones would operate for the purpose described. The claim was rejected.

Ex parte Steinmetz, 224 O. G., 363. The claim recited "titanium compounds," but the specification described only TiC and TiO_2 as being fit for electrodes. Commissioner Ewing held the claims too broad.

Excelsior Drum vs. Scheip & Vandergrift, 173 Fed., 312. The claim recited "a reinforcing band," but the specification described only a spirally wound band surrounding a horn between its ends. The claim was held void as being too broad on the ground that a broad claim cannot be based on a description that is limited to a single device and does not present it as an example of a preferred structure. This case shows that the doctrine has been applied to mechanical cases also.

CASES HOLDING SUCH BROAD CLAIMS VALID

American Sulphite vs. Howland Falls, 60 Fed., 395. The claim recited "a continuous lining of cement," and the specification stated that the lining might be of any material which is acid resisting and capable of being made plastic and adhesive. . . . A convenient material is portland cement . . . cement mixtures, sand and portland cement, sand and tar, etc." Held that the claim covered all cements having the properties set forth and that equivalents must be such as skilled chem-

*Journal of the Patent Office Society, vol. 2, No. 12, pp. 598-608, August, 1920.

ists might be expected to find as answering the requirements of the described conditions.

Fullerton vs. Anderson, 166 Fed., 443. The claim called for bleaching nuts by a "weak acid," while the specification stated that acetic acid, among other acids, was suitable for liberating chlorine for bleaching. Sulphuric acid was not described, but the court held that it came within the term "weak acid" and that the patentee was not obliged to experiment with all weak acids and that any acid which would liberate chlorine would be covered. The court intimated that some weak acids might be inoperative but that the commoner ones would be operative, and therefore the broad claim was valid. In this case any chemist could readily mention the weak acids which would liberate chlorine for bleaching purposes.

Welsbach vs. Sunlight, 87 Fed., 221. The claims covered "paraffine or other suitable material," and the specification said that any substance setting hard at ordinary temperatures and burning without mechanical destruction of the mantle would suffice. It was proved that collodion was known to have these properties at the date of the patent and it was therefore held an equivalent. The claims covered, under the construction given them by the court, all substances which were known by chemists to answer the requirements of the specifications.

Malignani vs. Hill-Wright Electric Co., 177 Fed., 430. The claims covered all substances which would "gasify by heat and combine with gases generated by the filament," while the specification mentioned arsenic, sulphur and iodine for the purpose of removing the oxygen. This claim was held valid, the court saying that the patentee was not required to specify all known substances which might be used and that the claim covered all such known substances, including phosphorus. This case held as valid a comprehensive claim which was functionally stated.

There is a unanimity of opinion in all these cases. They hold that in order to sustain a broad claim covering a whole class or group of substances, it must appear either (1) that the inventor has shown with reasonable certainty in the specification that all the members of the group claimed are operative, or (2) that it would be obvious to the average chemist that all the members of the group are operative. If upon trial the evidence shows some members to be anticipated or inoperative, the claim is held void unless the patentee in his specification indicated that he confined himself to his described substances and their equivalents.

HOW CAN INVENTOR CLAIM PROTECTION?

The question arises, How may the inventor obtain protection for those members of the class which his specification enumerates? Is it necessary for him to try them all out before filing a broad claim? Will it suffice for him to claim only one preferred substance and state in the specification that the others are equivalents, thereby hoping to gain the protection of the doctrine of equivalents? In *re Ellis*, 167 O. G., 981, is apparently the only decision which attempts to solve this difficulty. *Ellis* had claimed all "cyclic CH₂ hydrocarbons" as ingredients of finish solvents, and his specification had named about twenty such hydrocarbons. The term "cyclic CH₂ hydrocarbons" was apparently the only generic expression which could include the substances named. The Court of Appeals

held the claim valid in a well-considered decision in which the following points were brought out:

(1) It is unnecessary to investigate experimentally all members of the class, but only necessary to enumerate a fairly representative number to make it appear that the whole class is operative.

(2) There must be a claim in the case sufficiently broad to cover the whole class and such claim must define the essential quality of the class which renders it operative for the purpose described.

(3) Should any members of the class be found later to be inoperative, the court will restrict the claim to cover only the members described and their equivalents.

In regard to the first point, all that is necessary is to describe a fairly representative number, say from ten to twenty of the members of the class, to establish a *prima facie* case of operativeness for the whole class.

CLAIM MUST BE COMPREHENSIVE

In regard to the second point, there must be a comprehensive claim, and it will not suffice to claim only one member. The only authority cited by the Court of Appeals is *Read Holliday vs. Shulze-Berge*, 78 Fed., 493, but this case was only dictum and it confused the distinction between species and equivalents. An equivalent is a thing which performs the same function, and performs that function in substantially the same manner as a thing of which it is alleged to be an equivalent. (Walker, par. 354.) An equivalent for one ingredient of a patented composition of matter is anything which in that composition performs the same function as that ingredient. (Walker, par. 370.) A patentee is always entitled to equivalents regardless of whether or not he has broad claims to cover them. One of the very few chemical cases clearly illustrating this doctrine is *Treibacher vs. Roessler & Hasslacher*, 219 Fed., 210. Here the claim covered a "pyrophoric alloy containing cerium alloyed with iron, substantially as and for the purposes described," while the specification stated that nickel or cobalt and their equivalents might be used in place of iron, there being, however, no broad claim to cover such equivalents. The court held that Mg was an equivalent of iron and accordingly a cerium:magnesium alloy infringed the claim. This same doctrine is supported in the mechanical cases, such as *Weinans vs. Denmeed*, 15 Howard, 341; *Bundy vs. Detroit*, 94 Fed., 524-538; *Metallic Co. vs. Brown*, 104 Fed., 345; *Soehner vs. Stove Co.*, 84 Fed., 185; *Vrooman vs. Penhollow*, 179 Fed., 296; *Whitin Machine Works vs. Houghton*, 178 Fed., 444.

Species on the other hand are not equivalents, and therefore comprehensive claims are needed to cover them. (*Monroe vs. McGreer*, 81 Fed., 954.) Species are distinct inventions and involve patentable differences. "No range of equivalents can overcome a patentable difference." (*Cheatham Electric vs. B.R.T.*, 238 Fed., 172.) In *re Ellis* the various cyclic CH₂ hydrocarbons constituted distinct species and therefore a broad claim was needed in order to cover them.

With regard to the third point of in *re Ellis*, the question arises as to how far the court will go in reading the specification into the claim, in case the claim is met by the prior art or is too broad in view of the fact that some of the members of the broad class have been shown to be inoperative. The answer is that if the patentee in his specification indicated that he intended to claim broadly the court will hold

him to it and the claim will be void absolutely. In *Cambria Iron Co. vs. Carnegie Steel Co.*, 96 Fed., 850, the patentee claimed a process of mixing molten metal and indicated that he intended to claim broadly, and the court so considered it. In this connection it may be stated that the courts will read the specification into a claim where a non-patentable function has been claimed and the specification describes as essential the element which was functionally claimed (*Westinghouse vs. Boyden*, 170 U. S., 537); or where an essential subordinate feature was omitted in the claim (*Lamb Knit Goods vs. Lamb Glove Co.*, 120 Fed., 267); or where a subordinate essential element was omitted in the claim (*Walker*, par. 182; *Wellman vs. Midland Steel Co.*, 106 Fed., 221), but where the specification shows that the patentee deliberately intended to claim broadly the claim will be construed broadly and will not be restricted for the purpose of escaping anticipation or invalidity (*Empire Circuit Co. vs. Channon*, *supra*, and other cases cited in the beginning of this article; *General Sub Construction Co. vs. Netcher*, 167 Fed., 549). The court indicated in *re Ellis* that in the event of finding any of the members of the class of cyclic CH_2 hydrocarbons inoperative, the claims would be restricted to the substances named in the specification and their equivalents. This was because *Ellis* intended to cover in his claims only his described substances and their equivalents.

The question arises, What would *Ellis* be entitled to in the way of equivalents? Would he be entitled to every cyclic CH_2 hydrocarbon not mentioned by him which was found operative? The answer seems to be that where experimentation is necessary to determine which members are operative and which members are not, the patentee cannot cover such members in his claims unless he has mentioned them in his specification. (*Matheson vs. Campbell*; *Rickard vs. DuBon*; *Bracewell vs. Passaic Print Works*.)

PATENTEE SHOULD HAVE BENEFIT OF HIS RESEARCH

These decisions are not quite conclusive, however, for in each of these cases only a few members of a large class were described in the specification. It is believed that where a patentee describes a large number of members of a class, such as in *re Ellis*, he should be entitled to every operative member of that class, even though some members are later found to be inoperative. The reason for this will be clear when we consider that it very often requires considerable original research and thought to conceive and work out a broad class for a particular process or composition, whereas the inventive skill necessary to experiment with various members of the class when once an earlier inventor has already broken the ice and opened up the class will be much inferior to the inventive act of the inventor of the class. In fact it hardly appears to amount to invention at all to determine experimentally what members of a class once discovered are operative or inoperative, for the average skilled chemist could readily perform the task. Where no invention is required to discover a new member of a known and patented class, it is to be considered an equivalent of the members described by the patentee. (*Read Holliday vs. Shulze-Berge*; *American Sulphite vs. Howland Falls*, *supra*.) Such equivalents discovered subsequent to the date of a patent would be covered even by its specific claims and therefore the patentee should have the right to draw claims to cover

broadly any subsequently discovered equivalents. There is no decision, however, clearly giving him this right. The nearest case is *Minerals Separation Co. vs. Hyde*, 242 U. S., 261, where different ores were treated and different preliminary tests were necessary to determine the amount of oil needed and the extent of agitation. The court said: "The process is one for dealing with a large class of substances and the range of treatment within the terms of the claims, while leaving something to the skill of persons applying the invention, is clearly sufficiently definite to guide those skilled in the art to its successful application."

CASES ON CHEMICAL EQUIVALENTS

It will therefore be apparent that the claims of a patent, however broad, cover only the substances described in the specification and their equivalents. (*Hall Borchert vs. Ellenam*, 213 Fed., 341.) The patent covers only such substances not described therein which the average skilled chemist at the date of the patent knew to be equivalents of the substances described (*Heath vs. Unwin*, 2 Web., 236), and such equivalents as might be discovered later without the exercise of invention. (*Read Holliday vs. Shulze-Berge*; *American Sulphite vs. Howland Falls*, *supra*.) It is not sufficient to show that a substance unknown at the date of the patent proves by tests to be an equivalent, if invention was exercised. (*Paint Co. vs. Bird*, 175 Fed., 346.) Generally the issuance of a patent negatives the fact of equivalency where it is contended that the substance claimed in the patent is an equivalent of previously patented substances. (*American Sulphite Pulp vs. Hinckley Co.*, 217 Fed., 57, where a claim for an acid-resisting lining of cement was held not infringed by a new composition claimed in a subsequent patent, the new composition being unknown at the date of the first patent.) Where an ingredient substituted for a substance mentioned in the patent performs the required function better than the patent ingredient and in a different manner it may still be an equivalent. Thus, a claim covering dynamite made from infusorial earth and nitroglycerine was infringed by an equivalent explosive made from mica and nitroglycerine, although mica did not absorb the nitroglycerine like the infusorial earth and as a result produced a more powerful explosive. (*Atlantic Giant Powder Co. vs. Mowbray*, 2 Bann. & Ard., 447.) Where a patentee fails to obtain results with a certain substance he cannot claim it as an equivalent; thus where an inventor was unsuccessful with mica he could not cover it as an equivalent of the glass which he described and claimed broadly as "non-porous vitreous material." (*Folger vs. Dow Electric Co.*, 133 Fed., 295.) Where a patentee intentionally avoids a certain substance, the composition which includes it is not an equivalent and does not infringe. Thus where a patentee claims a disinfectant consisting of camphor oil containing HCHO and states that no water should be present, it is not infringed by a disinfectant containing aqueous formalin and eucalyptus oil. (*Orr vs. Aschenbach*, 225 Fed., 71.)

In *Tilghman vs. Proctor*, 102 U. S., 730, saponification by lime water at a low temperature and pressure was held equivalent to saponification by water at a high temperature and pressure.

In *Miami Copper Co. vs. Minerals Separation Co.*, 244 Fed., 752, the patentee formed a froth by mechanically beating air into mineral pulp containing under

1 per cent oil by means of a mechanical beater and he referred to this process in his claim by the broad term "agitating." The alleged infringer formed a froth by bubbling air through a column of pulp, the resulting agitation being mild and not mechanical. The two processes were held equivalent to each other.

In *Hoskins Manufacturing vs. General Electric*, 212 Fed., 422, an alloy of nickel 65 per cent, chromium 12 per cent, iron 15 per cent and manganese 8 per cent was held to infringe a resistance element composed of a nickel:chromium alloy upon the theory that the addition of the iron and manganese did not materially change the alloy as a resistance element.

In *Gordon vs. Turco-Halvah Co.*, 233 Fed., 430, the claim specified peanut butter, but the specification stated that oily matter generally might be used, and the court held that maize oil was an equivalent. In a second patent in this suit the claim specified cottonseed oil and the specification described no equivalents nor said anything about them, and the court limited the claim to cottonseed oil. The restriction of the claim in the second patent seems to have been rather severe.

If a patentee in his effort to avoid claiming too broadly should unnecessarily restrict his claims, the court will construe them disregarding the limitation, provided the specification shows that the limitation pertains to the operative environment rather than to the inventive step and the limitation does not import a function which the patentee considered important or essential. (*D'Arcy Spring Co. vs. Marshall Mattress Co.*, 270 O. G., 347; *Arnold Creager vs. Barkwill*, 246 Fed., 441; *Loraine vs. General Electric*, 198 Fed., 100.) Where the Patent Office rejects a claim and the applicant accepts a more restricted claim, he is bound by it, although he may have unduly restricted. Where a claim is clear there is no room for construction and the patentee cannot be heard in court to contend for that which he unnecessarily surrendered in the Patent Office in avoiding a rejection. (*United States Glass Co. vs. Atlas Glass Co.*, 88 Fed., 493.) In such cases he is, however, still entitled to equivalents and is not exactly pinned down to the exact language of his claims. (*Consolidated Roller Mill vs. Coombs*, 39 Fed., 25.) It might be mentioned in this connection that a chemical product claim is not limited to the product of the process described, even though that is the only known process. (*Maurer vs. Dickenson*, 113 Fed., 870.)

Electrolytic Zinc in England

Great Britain has never been self-sufficient in zinc production. For instance, in 1913 the production was 60,000 tons and the consumption 220,000 tons. During the past five years the annual production had been 50,000 tons, against a consumption of 180,000 tons. Today its zinc industry is sorely depressed and is operating at less than 20,000 tons per annum since the recent closure of all the large smelters in South Wales. Although British supplies of high-grade ores are important, they cannot be mined and distilled at present prices for spelter. In fact, Germany is the only country which can produce at a profit, solely due to the depreciated exchange. Samuel Field has recently read a paper before the Faraday Society stating that the electrolytic process can now be regarded as a commercial possibility, in view of the fact that it can handle low-grade ores and recover other metals contained as a byproduct. Power in large blocks was to be had in

1917 for 0.34d. per kw.-hr. ($\frac{3}{4}$ c.) and probably would not go above that if the works were placed near the collieries. There are actually large bodies of complex zinc ores within close reach of certain Scotch collieries, making almost ideal conditions. The cost should then be, in a 10-ton plant, using three-stage purification, and labor at 10s. per 8-hr. shift (30c. per hr.):

	£	s.		£	s.
Calcination	2	00	Supplies	1	00
Power	5	11	Salaries and wages.....	4	10
Reagents	3	00	Interest and depreciation.	3	00
Melting cathodes.....	1	10			
			Total	20	11

Or \$100 per long ton.

With a concentrate of 40 per cent Zn, 10 per cent Pb and 5 oz. silver, delivered at £5 per ton, and crediting byproducts recovered, the total cost of zinc should not be more than £24 per long ton (5.2c. per lb.).

While no plans for large-scale production are under development, the British Metals Extraction Co., Ltd., has a small plant in operation near Swansea, South Wales. It is on somewhat more than a laboratory scale, having made about 100 tons zinc, and accumulated valuable information necessary for tonnage production.

Graphite Industry in 1920

The quantity of domestic flake and amorphous graphite sold by producers in the United States in 1920 amounted to 9,510 short tons, an increase of 28 per cent over the quantity sold in 1919.

The value of the graphite sold in 1920 was about \$626,201, as compared with \$778,857 in 1919. These figures are based on reports made by producers to the U. S. Geological Survey.

Operators in Colorado, Nevada and Rhode Island reported sales of 4,694 short tons of amorphous graphite in 1920 at an average price of \$10.60 a ton. This was \$3.52 per ton less than the average price in 1919.

The sales of crystalline graphite in 1920 amounted to 9,632,360 lb., valued at \$576,443, as compared with 8,086,191 lb., valued at \$731,141, in 1919. The average price per pound in 1920 was 5.9c.; in 1919 it was 9c. Alabama led in the production of crystalline graphite, the sales in 1920 amounting to 4,894,648 lb., or 51 per cent of the total quantity sold.

The sales reported from New York and Pennsylvania amounted to 3,552,687 lb., or 37 per cent of the total in the United States, and the remaining 13 per cent was reported from California, Montana and Texas.

The Acheson Co. reported the sale of 7,399,749 lb. of artificial graphite made at Niagara Falls.

DOMESTIC GRAPHITE SOLD IN 1915-1920

Year	Amorphous		Crystalline		Total	
	Quantity	Value	Quantity	Value	Quantity	Value
1915	1,181	\$12,358	3,537	\$417,273	4,718	\$429,639
1916	2,622	20,723	5,466	914,748	8,088	935,471
1917	8,301	73,481	5,292	1,094,398	13,593	1,167,879
1918	6,560	69,455	6,431	1,454,799	12,991	1,524,254
1919	3,379	47,716	4,043	7,731,141	7,422	778,857
1920	4,694	49,758	4,816	576,443	9,510	626,201

GRAPHITE MANUFACTURED BY THE ACHESON GRAPHITE CO. 1915-1920

	Pounds		Pounds
1915.....	5,084,000	1918.....	9,182,272
1916.....	8,397,281	1919.....	8,163,177
1917.....	10,474,649	1920.....	7,397,749

GRAPHITE IMPORTED INTO THE UNITED STATES IN 1920*

Country of Origin	Quantity		Country of Origin	Quantity	
	(Short tons)	Value		(Short tons)	Value
Ceylon.....	9,204	\$1,077,290	Italy.....	137	5,072
Madagascar.....	4,710	286,383	Austria.....	58	1,195
Canada.....	2,170	157,015	Germany.....	30	2,502
Brazil.....	.....	.....	Other countries.	317	20,087
Mexico.....	3,659	131,832			
Chosen (Korea).....	810	29,936			
				21,095	1,711,312

* These figures are preliminary and subject to revision.

Condensation of Zinc Vapor*

A Zinc Retort and Separate Condenser Were Maintained Under Close Temperature Control, and the Amount of Zinc Dust Determined When Condensing It From a Stream of Carbon Monoxide, Water Vapor or Nitrogen

BY OYSTEIN RAVNEP

AS IS well known, zinc is generally produced by heating and reducing zinc oxide by means of carbon. At the high temperature employed the metal is distilled and the vapors condensed. However, the vapor is not completely liquefied, but part of it is deposited as a finely divided powder (zinc dust), which entirely lacks the properties of metallic zinc.

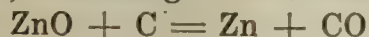
Lately, electric power has been advantageously used for producing zinc. In this case also the oxide is reduced by means of carbon, but the heat is supplied by an electric current. This process has many advantages, but the formation of a considerably greater amount of dust apparently cannot be avoided. Thus a roasted ore with 20 per cent Zn will give almost exclusively dust, ore with 40 to 50 per cent Zn will give equal amounts of zinc and dust, and ore with 60 to 70 per cent Zn will give two parts zinc to one part dust.

As zinc dust has not even approximately the same value as metallic zinc, it is generally returned to the furnace, charged together with the ore and the process repeated. The spelter thus obtained is sometimes distilled again in order to obtain pure zinc. We have therefore two distillations, and consequently the formation of dust twice during the complete process.

Very few systematic investigations have been made to determine the cause of the formation of zinc dust. Early investigators have noted (for instance, at the Belgian smelters, where closed retorts are used) that the formation of dust is more conspicuous at the beginning of distillation. At that time gases are evolved from the charge, and the zinc vapors therefore become more diluted. It has also been shown that the temperature of the condenser influences the formation of dust.

EXPERIMENTAL PROCEDURE

It was the purpose of the following tests to show as far as possible what results might be expected when distilling zinc under various technically possible conditions. Tests were therefore made to distill zinc in various gases and with various condensing temperatures. Many tests have been made particularly with carbon monoxide, as this gas is always present in great quantities, according to the reaction



Zinc from an electric furnace was used, guaranteed to contain 99.9 per cent Zn. The following impurities were found: Pb 0.073 per cent, Cd 0.018 per cent, Fe 0.005 per cent, As 0.003 per cent; total 0.099 per cent.

The tests were made in such a way that a definite, weighed amount of zinc was introduced in a porcelain boat into an electric tube furnace, heated to 915 deg. C.

The furnace (Fig. 1) was provided with entrance and exit tubes for the gas, a Le Chatelier pyrometer (T), and was connected with a receiver for condensation of the zinc vapors.

The furnace consisted of a steel pipe, wound with resistance wire and covered with insulating material. The pipe was tightly closed at one end; the other end was provided with a flange. As will be seen from Figs. 1 and 2, the furnace was closed with a steel plate provided with an asbestos plug of such a length that the temperature of the muffle was kept constant at 915 deg. C.

The condensing receiver was arranged so that the vapors entered a glazed clay cylinder, at the bottom of which the liquid zinc was collected in a porcelain crucible. The dust was deposited in the chamber around the crucible, and such of it as escaped from the cylinder was collected in a bottle with glass wool, and in a U-tube containing a little glycerine to keep the air out. The clay cylinder was closed at the top

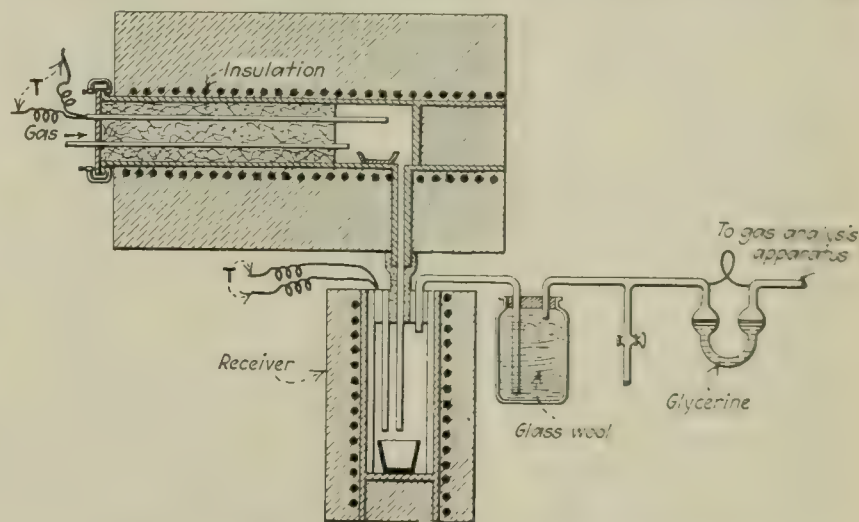


FIG. 1. SKETCH OF EXPERIMENTAL RETORT AND CONDENSER

with a tight-fitting asbestos plug. It was also provided with a Le Chatelier pyrometer (T) and was heated in an electric crucible furnace.

The results from the tests may suitably be arranged in the following groups:

Group 1 comprises:

1. The influence of the dilution of the zinc vapors on the amount of dust.
2. The influence of the carbon monoxide on the formation of dust at various velocities of the gas and temperatures of the condenser.

Group 2 comprises the influence of moisture (steam) on condensation.

Group 3 comprises the influence of nitrogen on condensation of zinc.

DILUTION OF ZINC VAPOR

Thirty liters of carbon monoxide was used for each test. It was made from potassium ferrocyanide and

*Translated from *Tidsskrift for Bergvaesen*, 1919, No. 10, p. 121. Portions of a dissertation prepared at the Institute of Inorganic and Physical Chemistry, Dr. P. Farup, director, Technical High School of Norway.

TABLE I.				
Test	Velocity of of the CO Stream, c.c. per Min.	Amount of Zinc in the Receiver, g.	Amount of Dust, g	Dust, per Cent
1	0	16.75	0.18	1.07
2	5	17.42	0.34	1.95
3	10	28.48	0.56	1.97
4	20	25.52	1.42	5.56
5	30	26.60	2.05	7.71

concentrated sulphuric acid, metered and passed through potassium hydroxide, calcium chloride and concentrated sulphuric acid. The amount of zinc used was 30 g.

Table I shows the results from the first series of tests with the condenser at a constant temperature of 470 deg. C. In the first test the furnace temperature was 940 deg. C. (20 deg. above the boiling point of zinc); in the others, 915 deg. C. That is to say, the first experiment represents distillation of zinc under atmospheric pressure of its own vapor. It is evident from the test that the more dust that is obtained the more diluted the zinc vapors are.

Now the laws in regard to the condensation of zinc vapor are the same as the laws for condensation of gases in general. If a given amount of saturated zinc vapor is contained in a chamber, the walls of which have a lower temperature than the vapor, metallic zinc will precipitate along these walls. If the walls have a temperature below the melting point of zinc (418.2 deg. C.) the metal will be deposited as a finely divided solid. If, on the contrary, the temperature of the walls is above the melting point of the metal, liquid zinc will be obtained, and the condensation will continue until the pressure of the zinc vapor has dropped to that value correct for the prevailing temperature. When this condition has been reached, the condensa-

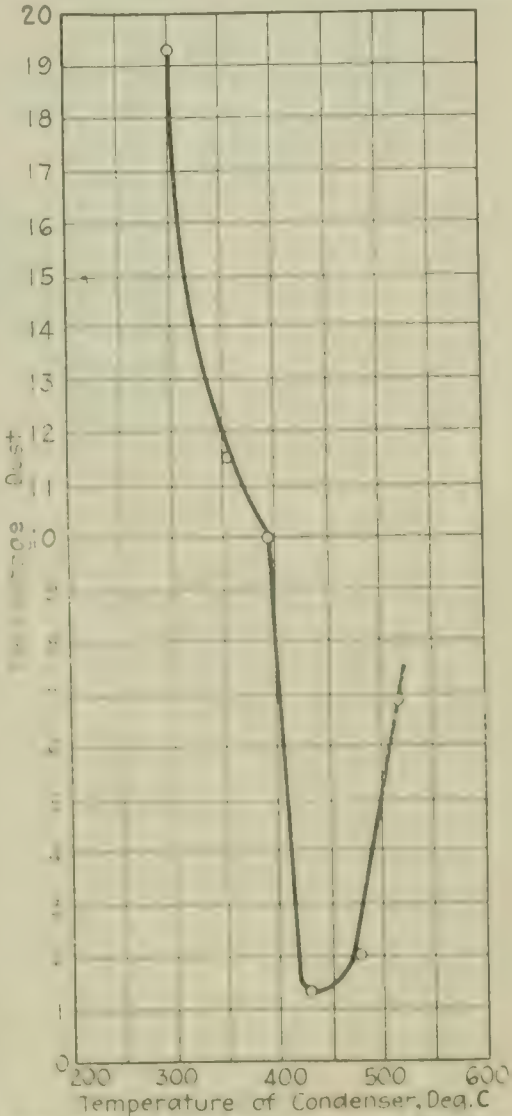


FIG. 2. AMOUNT OF DUST MADE WHEN CONDENSING ZINC FROM A STREAM OF 10 C.C. CO PER MINUTE

saturated with zinc vapor. In other words, saturated vapor is simply a gaseous substance in equilibrium with its liquid or solid phase.

Therefore, as a given quantity (30 g.) of zinc vapor is condensed, liquid zinc is formed, the amount of which for a certain temperature of the condensing receiver is greater the less diluted the vapor.

HIGH CONDENSER TEMPERATURES

Table II and the curve Fig. 2 show the results from the second series of tests with increasing temperatures in the condenser, but with a constant velocity of

TABLE II. VARIATION IN DUST PRODUCTION AS CONDENSER TEMPERATURE CHANGES

10 c.c. CO per min.							
Test.....	1	2	3	4	5	6	7
Temperature in the condenser, deg. C.....	300	360	400	430	470	520	600
Amount of zinc in the condenser, grams.....	23.10	24.86	25.11	24.67	28.48	26.52	23.80
Amount of dust, grams.....	4.44	2.86	2.52	0.30	0.56	1.82	1.84
Dust, per cent.....	19.22	11.52	10.04	1.22	1.97	6.86	7.73
Average analyses of gases coming from the condenser:							
CO ₂ , per cent.....	2.6	3.2	3.5	4.9	8.4	8.8	10.3
CO, per cent.....	96.4	96.0	95.3	94.3	90.9	90.6	89.0
Remainder, per cent.....	1.0	0.8	1.2	0.8	0.7	0.6	0.7
ZnO in dust, per cent.....	3.91	4.05	3.98	4.28	4.41	5.21	12.62

carbon monoxide of 10 c.c. per minute. For each test, 30 liters carbon monoxide and 30 g. zinc were used, and the furnace temperature was 915 deg. C.

The curve in Fig. 2 shows a decided minimum in the amount of dust produced when the condenser is held at the melting point of the metal, 418.2 deg. C.

Table III, with the curve in Fig. 3, shows the results from a third series of experiments with increasing temperatures in the receiver, but with a constant

TABLE III. VARIATION IN DUST PRODUCTION AS CONDENSER TEMPERATURE CHANGES

20 c.c. CO per min.					
Test.....	1	2	3	4	5
Temperature in the condenser, deg. C.....	380	400	430	470	520
Amount of zinc in the condenser, grams.....	25.68	23.84	24.21	25.52	26.23
Amount of dust, grams.....	2.65	1.79	0.36	1.42	2.83
Dust, per cent.....	10.32	7.51	1.49	5.56	10.79
Average analyses of gases coming from the condenser:					
CO ₂ , per cent.....	3.6	3.9	5.2	7.1	8.2
CO, per cent.....	95.2	95.4	94.5	94.4	91.2
Remainder, per cent.....	1.2	0.7	0.3	0.5	0.6
ZnO in dust, per cent.....	3.82	3.79	4.21	4.54	5.60

velocity of carbon monoxide of 20 c.c. per min. The only difference from the preceding series of tests is the fact that the velocity of the carbon monoxide is twice as great; 30 liters of carbon monoxide and 30 g. of zinc were used for each test. The furnace temperature was 915 deg. C.

As shown graphically in Fig. 3, the amount of dust increases with the temperature of the condenser, when this is above the melting point of zinc. Curve 3, also shows in comparison with Fig. 2, as the first series of tests did, that the amount of dust increases with the dilution.

MINIMUM DUST FORMATION

Both the curves (Figs. 2 and 3) show clearly that the minimum amount of dust is obtained when the temperature of the condenser is the same as the melting point of the metal. This fact may be explained as follows:

When the temperature of the condenser is below the melting point of the metal, the zinc will be condensed in a finely divided, solid state (dust), and the amount of this dust will increase with decreasing temperature. That the amount of dust increases with increasing

temperature in the condenser above the melting point of the metal may be due to the fact that zinc acquires a perceptible vapor pressure as soon as the melting point has been passed.

According to Clausius, the vapor pressure of the zinc

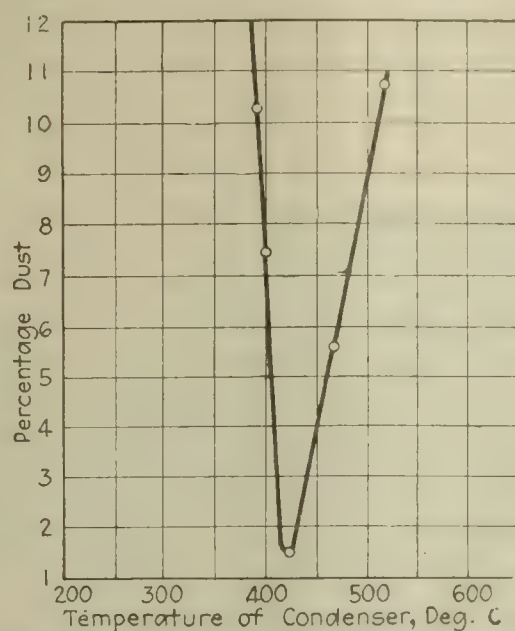


FIG. 3. AMOUNT OF DUST MADE WHEN CONDENSING ZINC FROM A STREAM OF 20 C.C. CO PER MINUTE

may be determined for any temperature, as soon as it is known for one certain temperature. We have:

$$\frac{d \ln p_1}{dT} = \frac{L}{RT_1^2} \quad (1)$$

Here p denotes the vapor pressure, and L the molecular latent heat of vaporization at absolute temperature T_1 . R is the calorimetric gas constant = 1.985.

By integrating equation (1) we obtain:

$$\ln p_1 = -\frac{L}{RT_1} + C \quad (2)$$

If we now know the pressure of the zinc p_2 at a corresponding temperature T_2 , the constant C may be determined.

$$\ln p_2 = -\frac{L}{RT_2} + C$$

By inserting this value for C in equation (2) we obtain, when we assume L to be constant between the temperatures T_1 and T_2 :

$$\ln p_1 = \ln p_2 - \frac{L(T_2 - T_1)}{RT_1 T_2}$$

or

$$\log p_1 = \log p_2 - \frac{L(T_2 - T_1)}{2.3RT_1 T_2}$$

Schenck¹ finds p_2 to be 10 mm. at 582 deg. and $L = 27,670$ cal. From these data and the preceding

TABLE IV. FOUND AND CALCULATED VALUES OF AMOUNT OF ZINC DUST

Test (Table II)	Temp. of Receiver	Amount of Dust Found, g.	Calculated	
			Amount Uncondensed Zinc, g.	The Zinc Pressure, m.m.
4	430	0.30	0.031	0.29
5	470	0.56	0.096	0.89
6	520	1.82	0.297	2.79
7	600	1.84	1.539	14.00

equations the pressures for other temperatures may be calculated as in Table IV.

The amount of uncondensed zinc is calculated as follows.

At 430 deg. the vapor pressure of zinc is 0.29 mm. and that of the carbon monoxide 760 — 0.29 = 759.71 mm. Therefore, for one volume of carbon monoxide

which leaves the receiver, $\frac{0.29}{759.71}$ volumes of zinc vapor escape. Thirty liters of carbon monoxide at 20 deg. was used for the test. At 430 deg. its volume will be:

$$\frac{30(430 + 273)}{20 + 273} = 71.98 \text{ liters CO}$$

The zinc escaped is therefore:

$$\frac{0.29 \times 71.98}{759.71} = 0.0275 \text{ liter zinc vapor}$$

at 430 deg. and 760 mm. pressure.

Reduced to 0 deg. and 760 mm., it will be:

$$\frac{0.0275 \times 273}{430 + 273} = 0.0107 \text{ liter zinc vapor}$$

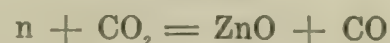
As zinc in the gaseous state is monatomic, 22.4 liters of zinc vapor at 0 deg. and 760 mm. corresponds to 1 gram-atom of zinc or 65.37 g.; 0.0107 liter of zinc vapor therefore corresponds to 0.031 g. zinc.

It will be seen from Table IV that the actual amounts of dust produced are greater than the calculated values of uncondensed zinc. This may be because more zinc is taken along with the gases than the amount corresponding to the vapor pressure of the metal at the temperature in question. However, to judge from the tests, the principal cause of high dust production seems to be some subsidiary chemical reactions.

The gas analyses in Tables II and III show that the percentage of carbon monoxide in the gases, as well as the amount of zinc oxide in the dust, increases with the temperature of the receiver. It may therefore be assumed that the carbon monoxide is split up according to the formula:



During the condensation, small drops of zinc are formed, and if now carbon dioxide is present, according to (3), a film of zinc oxide may be formed around these, according to the formula:



This film will prevent the separate drops from running together; they follow the stream of gas, and are collected as dust.

As is evident from Tables II and III, it was not possible to obtain the total amount of zinc in the condenser. It was discovered that the greater part of this amount lacking was deposited in the pipe leading from the furnace; after every test it needed to be removed by drilling.

This mass of zinc was not distributed along the whole pipe, but had settled on only a part of it where the temperature during the test had been between approximately 800 and 700 deg. Further down, where the temperature had been lower, no zinc had been deposited. It was also seen that the mass contained not only metallic zinc but also zinc oxide and carbon. The explanation is advanced that at 700 to 800 deg. the reaction velocity of $2\text{CO} = \text{CO}_2 + \text{C}$ is particularly high, with a corresponding high production of ZnO on the condensate. Carbon and zinc oxide are therefore formed, which, together with some liquid zinc, cause the obstruction such as often occurs at electric spelter furnaces.

The gas stream is gradually cooled as it passes on, and the reaction velocity of $2\text{CO} = \text{CO}_2 + \text{C}$ decreases,

¹Physikalische Chemie der Metalle.

not only on account of the lower temperature, but also because a little carbon dioxide is now present.

INFLUENCE OF MOISTURE ON CONDENSATION

These experiments, to determine the influence of moisture on condensation, were made in such a way that carbon monoxide was passed through wash bottles containing water, which at each test were kept at a definite temperature.

The percentage by volume of water vapor in the gas may be calculated as follows: When carbon monoxide is passed through water of a certain temperature and is in contact with the water a sufficient time, it will absorb a definite amount of water vapor, corresponding to the pressure of the water at the prevailing temperature.

The resulting gas mixture will consist of $\frac{x}{760}$

volumes of water vapor, and $\frac{760 - x}{760}$ volumes carbon

monoxide, where x signifies the pressure of the water at the temperature used.

At 2 deg. water has a vapor pressure of 5.302 mm.

At 20 deg. it has a vapor pressure of 17.391 mm.

At 45 deg. it has a vapor pressure of 71.311 mm.

Table V shows the results from these tests. The temperature of the condenser was 430 deg. C., and the

TABLE V. INFLUENCE OF WATER VAPOR ON CONDENSATION

Test.....	1	2	3
Temperature of water in the wash bottles, deg. C. . .	2	20	45
Per cent by volume of water in the gases entering the furnace.....	0.69	2.29	9.39
Amount of zinc in the condenser, grams.....	23.25	17.0	8.0
Dust in the condenser, grams.....	1.56	.....	.....
Dust, per cent.....	6.63	.....	.....
ZnO in dust, per cent.....	10.51	.....	.....

velocity of the gas 20 c.c. per min. The furnace temperature was 915 deg., and the amount of zinc used was 30 g.

By comparing Experiment 1 (6.63 per cent dust) with Experiment 3 in Table III (1.49 per cent dust), it will be seen that even a small amount of moisture considerably increases the formation of dust. The tests show also that the higher the content of water in the gases the less zinc will be deposited in the receiver. It will be partly oxidized before entering, and will settle as oxide along the walls, so that the furnace finally will be clogged up. In Experiments 2 and 3 the zinc in the condenser was completely covered with oxide.

When making zinc on a large scale, the charge should therefore be as free from water as possible.

INFLUENCE OF NITROGEN ON CONDENSATION

Commercial nitrogen was first passed over copper, heated to a red heat, and then through concentrated sulphuric acid. The furnace temperature was as before, 915 deg., and the temperature of the condenser was 430 deg. Thirty grams of zinc and 30 liters of nitrogen were used for the test. The nitrogen was passed through the apparatus with a velocity of 10 c.c. per min. There was found in the receiver 16.20 g. zinc, very brittle and of gray color. As the distillation had taken place in an atmosphere containing nitrogen, the zinc was dissolved in 30 per cent sulphuric acid and analyzed for nitride, Zn_3N_2 . The solution was boiled with potassium hydroxide in a Kjeldahl apparatus, and the ammonia formed was absorbed in N/10 sulphuric acid. For 16.20 g. zinc 2.3 c.c. N/10 sulphuric acid was used—i.e., it contained 0.16 per cent nitride.

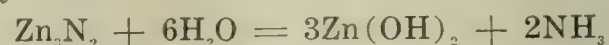
The zinc which was drilled out from the pipe between the furnace and the receiver was found to contain 0.14 per cent nitride. A blank test was run on the potassium hydroxide, finding it nitrogen free.

Another test conducted in the same way as No. 1, but with 20 c.c. nitrogen per min., gave 23.65 g. zinc in the condenser and 1.78 g., or 7.51 per cent dust.

For 23.65 g. zinc 3.2 c.c. N/10 sulphuric acid was used—i.e., nitride = 0.31 per cent.

ZINC NITRIDE

As mentioned above, the zinc was brittle and of a dull gray color. This may be due to the nitride. In the periodic table of the elements, the properties of any one element are determined by the properties of the elements in the same groups and series. Zinc will be found in the same group as beryllium, magnesium and calcium and close to aluminum in the following group. All these metals react easily with nitrogen, forming nitrides. Zinc nitride is described in the literature as a gray powder which is easily decomposed by water:



In another test, three pieces of zinc, weighing in all 30.5 g., were heated in the furnace to 640 deg. Nitrogen was passed through the furnace during the heating as well as the cooling, and it was found at the end that the zinc pieces were still in the porcelain boat and had not run together, even though zinc melts at 418.2 deg. They were, instead, covered with a gray powder, which formed a film around each one. The nitrogen had therefore attacked only the surfaces of the zinc pieces and later protected them from further action. An analysis of the fragments gave an average of 0.70 per cent nitride.

As the pieces had not run together, it is reasonable to assume that the reaction between the nitrogen and the zinc had begun below the melting point. In the Norwegian patent 23,165, "Synthetic Production of Ammonia From Its Elements," it is stated that ammonia is formed when nitrogen and hydrogen are passed over zinc at a temperature below the melting point of the metal. According to this patent, the zinc will act as a catalyst as low as 200 deg. C. To judge from the tests, it is therefore not impossible that in the above-mentioned ammonia process a nitride is first formed on the surface of the zinc and that it is this which facilitates the combination between the two elements.

One further finds in *Chemisches Centralblatt*, 1916, vol. 2, No. 2, that dry gaseous ammonia reacts with zinc dust and forms nitride. The most favorable temperature is 600 deg. C., and a product with up to 10.6 per cent nitrogen is obtained; since Zn_3N_2 corresponds to 12.5 per cent N, the end product contained 85 per cent nitride. As nitride has a high dissociation pressure at its temperature of formation and it is therefore difficult to obtain it entirely free from zinc, the substance may be assumed to be a mixture or solid solution of $\text{Zn}_3\text{N}_2 + x\text{Zn}$.

The phase rule will throw some light on the relationship between metal, nitride and gaseous nitrogen. If we have three phases, liquid metal, solid nitride and a gaseous phase ($p = 3$), and two components, zinc and nitrogen ($N = 2$), then

$$F = N + 2 - p \\ = 2 + 2 - 3 = 1$$

That is to say, there is one degree of freedom. When

the nitride has a certain nitrogen pressure, equilibrium will be attained when this pressure corresponds to a definite temperature, and the concentration will adjust itself simultaneously.

If, however, the nitride is dissolved in the liquid zinc, then the number of phases is reduced to two, and F equals 2. Regarding the temperature constant, the pressure and concentration may change until the solution becomes saturated. Further formation of nitride will then cause the system to revert to monovariance. $F = 1$ is therefore valid only in case the nitride takes part in the reactions as an independent phase.

If, therefore, nitrogen is passed over finely divided zinc at 600 deg., as in the above-mentioned tests, nitride will continue to be formed until the nitrogen pressure of the mixture $Zn_3N_2 + xZn$ equals the partial pressure of the nitrogen in the stream of gas.

Zinc dust from an electric spelter furnace, as well as dust from an electric refining furnace, was next examined for nitrogen. It was shown that the spelter dust contained 0.34 per cent nitride, and the refined zinc dust contained 0.33 per cent nitride. It has been shown in *Chemisches Centralblatt*, 1911, vol. 2, that zinc dust generally contains 0.16 to 0.42 per cent nitride. Consequently it has been demonstrated that zinc reacts with any nitrogen which may be present in the retort, and nitrogen should consequently be kept out of the apparatus as far as possible.

Regarding the influence of sulphur, it may be mentioned that the zinc dust from an electric spelter furnace contained 0.95 per cent S, which was present in the form of sulphide. Prof. J. Vogt has shown that zinc sulphide is appreciably volatile at 1,400 deg. In an electric furnace the temperature may run so high, as the slag produced is ordinarily tapped liquid.

Now, if the zinc ore is poorly roasted, so that the charge contains sulphur, some sulphide will volatilize. It will accompany the gases in a finely divided state, and may provide condensation nuclei which will promote the formation of dust.

SUMMARY

The results thus found may be summarized as follows:

1. The amount of dust (for a given temperature of the condenser) is greater the more dilute the zinc vapor.

2. When condensing zinc, the temperature of the receiver is of paramount importance, since zinc is appreciably volatile above its melting point.

In practical work, it is difficult to keep the temperature exactly at the melting point of the metal, and the tests confirm the idea (Tables II and III, Figs. 2 and 3) that it is better to keep the temperature rather a little above than below the melting point.

3. The zinc vapors should have as short a path as possible from the furnace to the receiver. The longer time the zinc vapors require in order to be condensed the more carbon dioxide will be formed, according to the equation $2CO = CO_2 + C$ and the greater the amount of dust.

4. Even small amounts of water vapor in the gases promote the formation of dust and the precipitation of zinc oxide in the channel leading from the furnace to the condenser.

5. As nitrogen reacts with zinc, the reducing agent should contain as little nitrogen as possible. Moreover, the apparatus should be as tight as possible in order to keep the air out.

6. The various materials going into the charge should contain as little sulphur as possible, as it may cause the formation of zinc sulphide, which may volatilize at electric furnace temperatures. Some zinc sulphide may also remain in the charge, so that in any case some zinc will be lost.

Organization of Employers in Germany*

THE employers in German industry were extensively organized even in pre-war days. The auxiliary service law¹ (*Hilfsdienstgesetz*), enacted at the end of 1916, which had for its scope the greatest possible exploitation of all the economic forces of Germany, was responsible for the creation of additional large employers' organizations. Since the termination of the war, organization of the workers and salaried employees has made phenomenal progress and the solidarity of the workers is pushing the employers toward the utmost limits of financial concessions without securing afterward any compensation by way of increased or improved production. It is therefore not to be wondered at if employers' organizations have increased in numbers during the last two years and show a great tendency to combine in powerful national central organizations (*Reichsverbände*) so as to be able to resist in closed ranks the ever-increasing demands of the worker. Constantly repeated wage fights have created an atmosphere of bitterness, and since the fight has been transferred exclusively into the material domain employers' and workers' organizations face each other with an alarming incapacity for comprehending the true nature of problems for which a solution ought to be searched in common.

DIVISION OF THE ORGANIZATIONS

German employers' organizations may be divided into four groups, according to whether they chiefly concern themselves: (1) With general economic and political problems; (2) with general socio-political problems; (3) with the regulation of special business interests (regulation of production, sales, or prices); or (4) with the safeguarding of the special interests of the employers in their relations with the workers (regulation of working conditions, especially of wages and hours of labor). Some employers' organizations include among their activities several or all of the four tasks enumerated. Employers' organizations are organized by industry groups as national, state, district or local.

STATISTICS ON THE ORGANIZATIONS

The latest official statistics on employers' organizations published by the German statistical office cover the year 1918 and are very incomplete owing to conditions prevailing during the war.

Statistics covering the year 1915 show that 3,683 employers' organizations were in existence in Germany in that year. Of these, 125 were national organizations, 499 were state or district organizations, and 3,059 were local organizations. Of the total number of organizations 1,920 reported a total of 156,938 members and 1,366 organizations reported the number of workers employed by their members, the tabulation of which

*From *Monthly Labor Review*, vol. 12, No. 3, March, 1921, p. 129.

¹See *Monthly Labor Review*, April, 1918, pp. 89-103.

resulted in a total of 4,281,477 workers. By the end of 1918 the number of national employers' organizations had increased to 839, the following industry groups having the largest number: Commerce, 149; metal-working industries, 141; textile industry, 86; clothing industry, 56; quarrying, stonecutting, excavating, etc., 51; chemical, 51; paper, 51.

NATIONAL FEDERATION OF GERMAN INDUSTRY AND UNION OF GERMAN EMPLOYERS' FEDERATION

The strongest national organizations are the National Federation of German Industry (*Reichsverband der Deutschen Industrie*), founded in Jena on Jan. 12, 1919, through the consolidation of several large organizations covering various industry groups and intended as a solidary central organization of German industry for the representation of its political and economic interests, and its counterpart, the Union of German Employers' Federations (*Vereinigung der Deutschen Arbeitgeberverbände*), which deals with all social and socio-political problems of the German industry. One hundred and thirty national federations were affiliated with the latter organization in January, 1920. The number of workers employed by the members of these affiliated organizations is given as exceeding 4,000,000. The union has strongly opposed all attempts of workers' organizations to secure for the workers a share in the management of the establishments and was largely responsible for the mild form given to the German works' council law, believing that increased production is absolutely necessary for the economic reconstruction of Germany and that increased production can be achieved only by an independent employers' class and the development of free initiative by the employers.

At the last annual meeting of the Union of German Employers' Federations (March 11, 1920, at Berlin) its secretary pointed out "that a large number of social problems are awaiting solution, but that the union should for the present center all its activities upon the solution of the wage problem, the adjustment of prices, and consequently also of wages to world's market prices, the building up of a wage system based on the cost of living, the introduction of sliding wage scales, consideration of the size of the family of the worker in the fixing of wages, etc.; that a clearly defined policy of the employers' federations with respect to these problems requires thorough investigation of existing conditions and their effects; that the principal task of the German employers' federations must be energetic co-operation in reconstructing a basis for efficient production. They must create the conditions which make the performance of work possible and must oppose unjustified attempts to disturb and hamper peaceful production. To strengthen and support them therein through the power of combination must now as before be the task and aim of the Union of German Employers' Federations."

OTHER ORGANIZATIONS

The Hansa Union of Trade, Commerce and Industry (*Hansabund für Gewerbe, Handel und Industrie*), one of the most reactionary employers' organizations of Germany, which has always maintained the point of view that the employer must be "master in his own house," has for a long time cherished the idea of forming a superunion of all German employers' organiza-

tions. This idea has in part been realized. According to *Soziale Praxis* (Berlin, July 21, 1920) some of the large national employers' organizations have combined into a Central Committee (*Zentralausschuss*). This central committee has proclaimed as its aim the solidary safeguarding of the common economic and political interests of all German employers and a concerted defense against all movements directed against these interests. A subsequent issue of *Soziale Praxis* (July 28, 1920) states, however, that the formation of this superunion has not been greeted with general acclaim. The fact is that German employers are already much overorganized. For this reason the National Federation of German Industry and the Union of German Employers' Federations have declined to become members of the new Central Committee. These two organizations are much stronger central organizations of employers than the new creation of the ultraconservative Hansabund can ever expect to become.

POWER OF THE GERMAN EMPLOYERS' ORGANIZATIONS

During the present critical industrial and labor situation the German employers' organizations schooled through long experience and welded together in the fire of revolutionary wage movements will give proof of their great power. The Union of German Employers' Federations is strongly prepared for defensive action, as has become evident from a secret circular letter addressed to its members. This circular letter, which somehow came into the hands of some labor organization and was given wide publicity in the labor press, deals with the attitude to be taken by the employers toward the works' council law of Jan. 18, 1920. The letter states that "the plans for a general strike of employers against the enactment of the works' council law have not been carried out, owing to reasons of expediency. It is also not intended to use sabotage against the law. Employers are, however, urgently requested to adopt a strong defensive attitude in the application of the law against all attempts to go beyond the letter of the law made either by the regulations for the enforcement of the law or by the workers. Employers are especially admonished against making concessions in the application of article 62 of the law.³ In the framing of shop regulations (*Arbeitsordnungen*) and in the conclusion of collective agreements employers' federations should not go beyond the bounds of legal obligations." It can only be hoped that this warning will not prevent employers from working in harmony with sensible works' councils, however great the difficulties that are to be overcome while this new German institution is in its experimental stage.

In connection with the subject of employers' organizations it should be mentioned that following the amalgamation of German employers' federations the seventeen existing employers' societies for insurance against strikes formed themselves into one society under the name of German Protective Association Against Strikes (*Deutscher Streikschutz*).

(An article on "Organization of Workers in Germany" will be published in a subsequent issue.)

³Article 62 of the works' council law has the following wording: "A works' council shall not be created, or, if already created, shall be dissolved if, in the nature of the establishment, there are special difficulties in the way of its institution or functioning and if by virtue of a collective agreement declared to be universally binding some other form of representation of the employees of the establishment exists or is to be set up. This form of representation shall take over the rights and duties assigned to the works' council by the present law."

²*Soziale Praxis und Archiv für Volkswohlfahrt*, Berlin, May 5, 1920, p. 728.



GENERAL VIEW OF THE JONES & LAUGHLIN STEEL CO.'S BYPRODUCT COKE PLANT

Byproduct Coke Plant of the Jones & Laughlin Steel Co.

A Summarized Description of the Installation and Operation of a Standard
Koppers Coke Ovens Plant at Hazelwood, Pa., Capable of Coking
Under Normal Conditions 5,000 Tons of Coal Per Day

BY C. R. MEISSNER

THE byproduct coke plant of the Jones & Laughlin Steel Co. of Pittsburgh, which has now been in operation for nearly two years, includes many new developments in coking and byproduct recovery technique, making it one of the most up-to-date and efficient plants in the world.

The new plant comprises 300 ovens, in five batteries of sixty ovens each. Four of these batteries were built and put into operation first, the fifth being added about nine months later. Construction work was begun in May, 1918, and carried to very rapid completion under stress of war-time demands. The first three batteries started pushing coke in June, 1919, a year after ground was broken, and the fourth was started up in the following September. The fifth battery, of the new triangular-flued design, was started in March, 1920.

As normally operated the plant cokes about 5,000 tons of coal per day.

The entire byproduct coke plant was designed, constructed and put into operation by the Koppers Co. of Pittsburgh.

The plant is located along the Monongahela River at Hazelwood, and practically all coal is received direct from the company's mines. The coal as received is crushed to 4 in. at the mines. The roll crushers at the coke plant are designed to reduce to $\frac{3}{4}$ -in. if desired.

OVENS

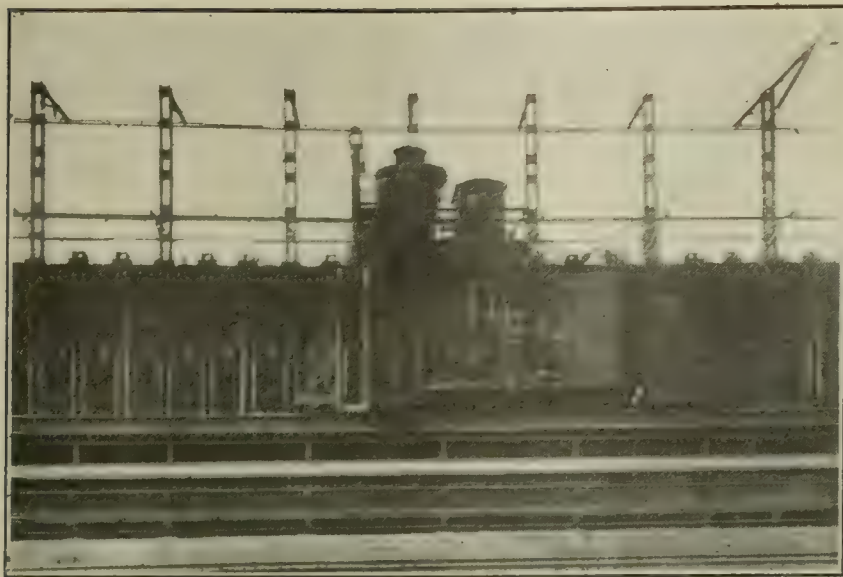
There are three batteries in one row placed parallel with two in the other unit, their discharge sides facing

each other. A 3,000-ton coal bin located over each row supplies the coal to the larry cars. Each of these bins is divided into two compartments to allow for cleaning out or repairs without interruption of coal supply.

The ovens are of the standard Koppers cross-regenerative type. The inside dimensions are: length, 37 ft. between doors; height, 9 ft. 10 $\frac{1}{2}$ in.; width, tapering from 18 $\frac{1}{2}$ to 15 $\frac{1}{2}$ in. from coke discharge sides to pusher side. When coking straight high-volatile coals, it has been found of decided advantage to use a narrower oven chamber than that used for coking mixtures with lower-volatile coals.

The larry cars are built with four separate conical hoppers, above which are placed the measuring cylinders. By this method the ovens are always charged to constant volume regardless of weight, due to fineness of coal or moisture, uniformity and regularity being two requisites of good operation. Each larry car is also weighed as a matter of record. Telescopic, adjustable cylinders or sleeves are provided around each of the larry car hopper chutes, which are operated by a handle in the operator's cab. These are lowered to the oven brickwork during charging to prevent coal spillage around the charging holes. A motor-driven metal swab is provided on each larry car for cleaning out carbonaceous deposits in the gas off-take pipes when necessary.

Steam ejectors, provided in the gas off-takes from each oven, are used during charging to draw the first gas into the collecting main and thus prevent its loss

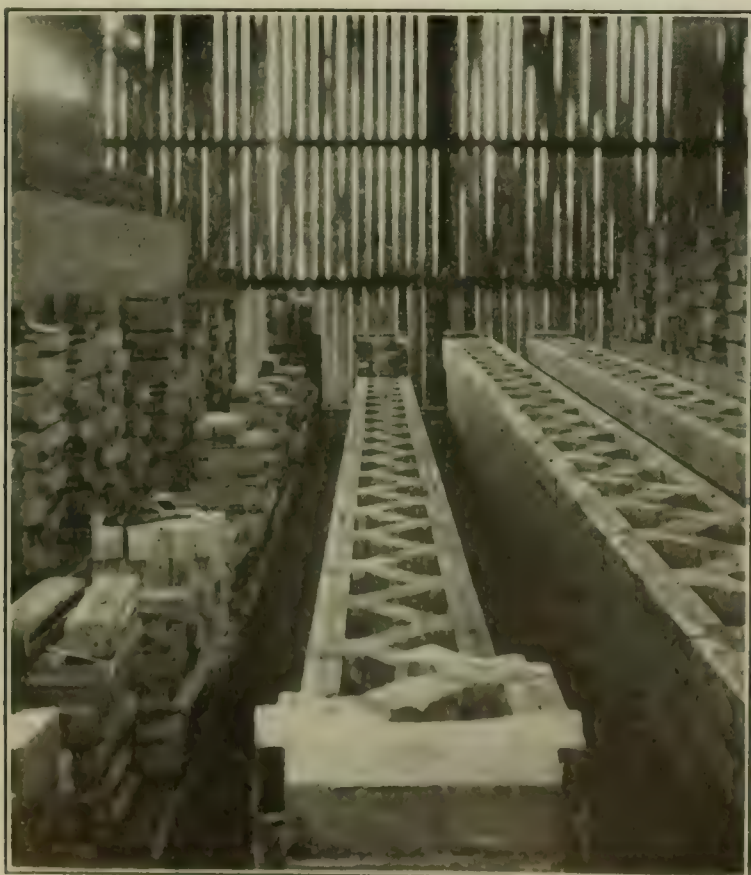


VIEW OF OVENS, SHOWING COAL LARRY, DOOR EXTRACTOR AND COKE GUIDE

to the air through the charging holes, thereby increasing the byproduct yield and making working conditions better for the men.

The first four batteries are built up of standard ovens having the well-known rectangular vertical flue construction in the heating walls. In the fifth battery, however, the heating walls are constructed according to the improved triangular flue design.

In this new type of construction the division walls between the heating flues are made diagonal to the plane of the oven walls, which gives the flues a triangular cross-section. Thus we have two sets of flues in each wall facing in opposite directions toward the adjacent ovens. Similarly each oven has practically its own independent set of heating flues. The overlapping arrangement makes it possible to supply fuel gas from a common header centrally located below the flues; or, in case producer gas is used, through ports from the gas regenerators. There are, however, two separate horizontal flues; one being located at the top of each set of vertical flues for carrying off the products of combustion. Practically independent regulation for each oven is attained by this arrangement. The



BATTERY OF TRIANGULAR FLUE OVENS DURING CONSTRUCTION

accompanying photograph of a battery of triangular flue ovens during construction gives an idea of the flue arrangement. Compared with the rectangular flue construction, this triangular flue development involves no increase in the width of the oven wall, no increase in weight of brickwork and no additional investment per oven.

There are obvious mechanical advantages in this new construction as compared with the rectangular flue type. The triangular bracing gives a much stronger wall. Theoretically this increase in strength as regards lateral pressure is 33 per cent. Actual test models have shown an advantage of 30 per cent. Due to the overlapping arrangement there are forty-four flues in the new wall as compared with thirty in the former type. This tends to give greater uniformity of heating. The faces of the flues adjacent to the oven wall are wider and thus the liner brick are longer, resulting in a 22 per cent decrease in the number of joints in each wall. Less opportunity is thus provided for gas loss outward or air leakage inward and the wear and tear during regular operation are materially reduced.



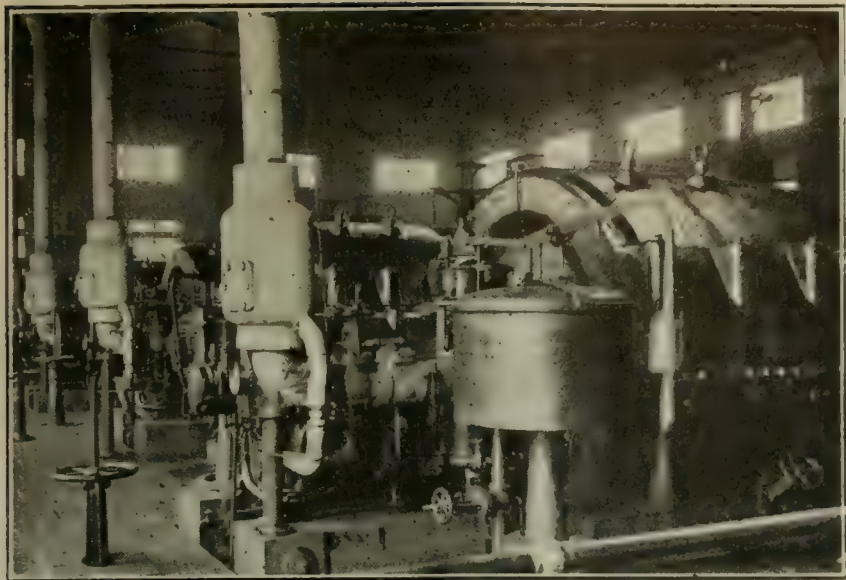
OVENS, QUENCHING CAR, COKE WHARF AND SCREENING STATION

The operation of the triangular flue type of ovens has proved so satisfactory that the Koppers Co. is installing them in several new plants.

COKE HANDLING

At the quenching stations the drainage water is passed through settling basins and recirculated, river water being used to make up for evaporation. More or less fine sediment, mostly coke breeze, settles in the spray pipes and tends to give trouble due to blocking up the holes from the inside. In order to facilitate the removal of this sediment quick opening valves have been provided at both ends of each spray pipe. Regular flushing out obviates all stoppage troubles. The moisture is readily controlled. Hot coke spots are quenched on the wharf by means of hand hose connections.

All coke-handling apparatus is arranged in duplicate between the two rows of batteries. Ample coke wharf space is provided for each unit of batteries. One wharf will hold eight, the other ten oven charges, so any ordinary delays in the coke-handling system or in spotting cars need not disturb the oven-pushing schedule, which is maintained with iron-clad regularity. A small auxiliary wharf is provided to handle run of coke direct to cars over a separate conveying system in case of any serious trouble in the regular system. The two screening stations are separate and independent,



GAS EXHAUSTER WITH REINFORCED CONCRETE CASINGS

loading cars on parallel tracks. The screens are of the bar grizzly type, set at 28 degrees, each made up of forty-eight bars wide and six sets long, spacing $\frac{3}{4}$ in. The bars are 2 ft. long and the spacing is wider at the bottom than at the top of each set. The bars are made wedge-shaped in section, giving an opening flaring out at right angles to the screen surface. This construction prevents coke pieces from wedging between the bars, making the screens self-cleaning. The increased spacing of the bars as they wear out is taken care of by replacements. Coke cars are at present spotted by steam locomotives, the movements of which are regulated by electric signals from screening stations.

GAS-COLLECTING AND COOLING SYSTEM

The gas-collecting and byproduct-recovery system is of the standard Koppers design. The pressure on the collecting mains is maintained at an average of 2 $\frac{1}{2}$ mm. water gage. By carrying this pressure in the collecting mains, the pressure in top of oven is zero, the same as in the top of the heating flues. Butterfly valves controlling this pressure are located in each of the two suction mains from each battery. These valves are controlled by governors, some of the standard Northwestern type and some of the hydraulic type. Pressure variations affect a float in the usual manner, but this float operates a small hydraulic valve mechanism, which in turn controls the water flow to the operating piston cylinder. Operation is very smooth, positive and also very sensitive. Butterfly dampers are used in the gas off-take goosenecks to cut off the ovens from the collecting main. They are very easy to operate, light deposits of carbon making them fit gas tight, thus proving very satisfactory.

The collecting and suction mains are flushed with a mixture of 40 per cent tar and 60 per cent liquor, this mixture being quite closely controllable by a suitable arrangement of valves and piping at the flushing or hot drain tank. Such a mixture has been found most satisfactory for maintaining clean mains and for cooling the gas. Gas reaches the primary coolers at about 75 deg. C. After the coolers, it is carried at 28 deg. to 30 deg. C. Lower temperatures than this tend to throw down more light oils into the tar than is desirable.

CONCRETE EXHAUSTERS AND BOOSTERS

Due to the shortage of steel during the war period in which the plant was built and to the difficulty in obtaining deliveries, it was necessary to economize on metal where possible. To avoid several months' delay in

securing casings for the centrifugal gas exhausters and boosters, they were constructed of reinforced concrete. They resemble the steel shells in all outward appearances. The base is cast integrally with the foundation. Cast-steel flanges are cast in to make connection with similar flanges on the upper section and to carry the bearing boxes. The top sections are entirely of concrete cast in one piece with steel flanges and eye bolts complete. These machines are giving entire satisfaction under all plant operating conditions. Concrete has previously been used for mine fan casings, but this is believed to be its first trial for high-speed centrifugals, pumping raw gas. The concrete turbo blowers were constructed on the ground by the Koppers Co. under direction of General Electric Co. engineers.

BYPRODUCT RECOVERY APPARATUS

The P. & A. tar extractors are equipped with Tagliabue controls to maintain a constant gas pressure differential by raising or lowering the level of the tar seal. A differential pressure of 6-in. water is normally maintained. As the centrifugal exhausters remove about 75 per cent of the tar remaining in the gas after the primary coolers, the tar extractors function in the removal of the last traces of tar fog. The reheaters are not regularly used but only as required by saturator conditions. This is due to the use of 66 deg. Bé. sulphuric acid. The heat of reaction is sufficient to maintain the bath at a proper operating temperature to evaporate water used in washing salt, etc.

The saturators are of the Koppers large elliptical design with two ejectors and two drain tables feeding to three centrifugal driers. Dried salt is wheeled in buggies and after weighing on a suspended platform scale is dumped into a pit. From this it is periodically removed by an overhead electric traveling crane and bucket and dumped into the stock pile.

TAR-FLUSHING SYSTEM AND AMMONIA STILL WASTE

All condensate from the primary coolers, exhausters, tar extractors, etc., is run directly into the suction of the flushing pumps instead of into the hot drain tank, to be pumped back over the collecting mains. This is done to allow some redistillation of the light oils by the hot gas in the mains, thus cutting down the amount going into the tar and allowing a larger recovery by the light-oil scrubbers. All return flushing from the collecting and suction main goes direct to the hot drain tank. Motor-driven centrifugal tar and liquor pumps are used



INTERIOR OF BYPRODUCT BUILDING, SHOWING AMMONIUM SULPHATE APPARATUS

regularly. A small boom derrick with clamshell bucket is provided for cleaning out the hot drain tank and still waste sump, being located between the two.

The lime sludge from the sump is being successfully used by mixing with the mud used for luting the oven doors. It is said to improve materially the consistency of this mud and at the same time dispense with the loam requirements.

LIGHT-OIL RECOVERY PLANT

There are two final coolers 80 ft. high and 14 ft. in diameter, having the same interior construction as the scrubbers, being fitted with wooden hurdles. The four scrubbers are 100 ft. in height and 18 ft. in diameter, and are placed in parallel sets of two each. The gas is evenly divided through the two sets of apparatus.

DISTRIBUTION OF GAS

The final cleaned gas after leaving the light-oil scrubbers goes to a 40,000-cu.ft. holder. The surplus gas is used in heating furnaces, soaking pits, etc., to replace natural gas formerly used. Total and surplus gas is measured by Venturi meters which give very close and satisfactory results. When the mills do not require the gas, as on Saturday afternoon and Sunday, it is burned in the boiler house or bled to the atmosphere in extreme cases.

BOILER HOUSE

The boiler house contains eight B. & W. 500-hp. boilers equipped with Coxe stokers and Dietrich flat suspended arches. Coke breeze is burned normally, and practically all of the plant production of this material is thus utilized. Breeze is dumped from hopper cars to a pit and thence handled by an overhead crane to the feeder bins at the boilers. Ashes are dumped from hand trucks into an adjacent pit and handled by the same crane to cars for removal.

BENZENE PLANT

The benzene plant embodies many improvements. Heat exchangers, vapor to oil, are mounted directly on

capacity. There are three crude and four pure stills, the only difference being in the greater height of the rectifying columns on the latter. Motor fuel, pure benzene and toluene are run off as the market dictates.

ACID-REGENERATING PLANT

The crude fractions are washed in a separate building located at some distance from the benzene plant. The two agitators are set high in a steel framework and sludge is drained directly into four acid-regenerating pots located below and to one side, but well above the yard level. These pots are of the tilting type with stationary sand-sealed covers. The final spongy sludge mass is dumped directly into large wooden boxes set on a flat car. These boxes are equipped with steel hooks so they can be lifted and emptied by a locomotive crane.

Synopsis of Recent Chemical & Metallurgical Literature

The Edible Vegetable Oil Industry.—A concise outline of the edible vegetable oil industry by H. Tefft was published in the April issue of *Canadian Chemistry and Metallurgy*, p. 102.

Vegetable oils may be divided into two classes, domestic and Oriental. The domestic oils (produced on the North American continent) include cottonseed, linseed, peanut, castor, corn and sunflower. The chief Oriental oils are coconut, palm, palm-kernel, soya-bean, rape-seed and peanut. The Philippine and South Pacific Islands and the Malay Archipelago are the big producers of copra and coconut oil. Palm oil and palm-kernel oil come chiefly from Africa; soya-bean, rape-seed and peanut oils from China.

These oils may also be classified as edible or commercial. Divided in this manner, the commercial oils used for manufacturing some inedible product such as paint would be linseed, castor and rape-seed. The edible oils would include cottonseed, peanut, corn, sunflower, coconut, palm, palm-kernel and soya-bean. Some of the oils are in both classes.

There are three general methods of obtaining the edible oils—extraction, expeller pressing and hydraulic pressing, or combinations of these methods. The exact procedure varies according to the individual characteristics of the oil. In the case of peanut oil, the peanuts after being shelled, blanched and degermed are given a preliminary pressing in an expeller press, the product being a virgin oil which is capable of being used for edible purposes without further treatment. The cake from the expeller press is then ground, cooked and put through a hydraulic press to obtain the remaining oil.

For refining the crude oils, the method almost universally employed is to agitate the oil with a solution of caustic soda, allow the resulting soap to settle, and siphon off the supernatant oil. This procedure neutralizes the acid in the oil, coagulates the albuminous material and, in settling, drags down what meal or other foreign matter there may be in the oil. A certain amount of the original color is removed at the same time. After being siphoned off, this neutralized oil is clarified by further settling and is then mixed with some bleaching agent such as fullers earth or fitt-char and pumped through a filter press. The oil is then run into a deodorizer and blown with steam at a high temperature. For salad oils, a mild-flavored oil is refrigerated to separate stearine, which is then removed by filtration.

Modifications of the caustic refining treatment include the Chisholm process, in which sodium silicate is added to the caustic soda, and the Baskerville process, using cotton linters with the caustic, a percentage of soda ash being added before removing the foots in a filter press. The foots



BENZENE BUILDING

top of the light-oil stills in a vertical position. The superheaters are of the high, upright, cylindrical type. All light-oil and benzene vapor coolers and condensers are of the open coil with outside water spray type. They are located outdoors directly over the wash oil coolers of the same type, thus conserving water.

The crude and pure stills are each of 15,000 gal.

or settlings from the refining process consist of neutralized fatty acids, coagulated albuminous matter, dirt and other impurities, precipitated coloring matter, saponified oil, and unsaponified oil entrained in the foots. Formerly, foots were either pumped to a tank car or cut with sulphuric acid to form "black grease." In either case, their destination was the soapmaker. Recently it has been found that by diluting the foots with water and passing them through a Sharples supercentrifugal, a certain proportion of the entrained unsaponified oil can be recovered. This process is one of the most important improvements in the old method of refining that has been developed in recent years.

The hydrogenation process has also had a wonderful influence upon this industry. For one thing, it has made the soap manufacturer independent of the supply of harder fats, as he can buy softer oils and harden them according to his needs.

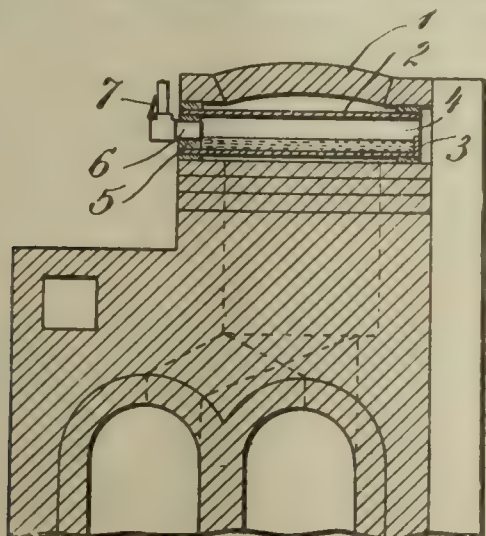
There are unlimited opportunities for research in this field. The action of fullers earth and caustic soda, the disagreeable flavors and odors in the oils, the exact mechanisms of the various reactions which take place—all these require careful study. Often an oil is received at the refinery which defies all efforts to obtain concordant results either in the laboratory or the factory, in spite of the greatest care in handling. There are apparently some variable factors which cannot be brought under control at present because they are not thoroughly understood.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

French Process Zinc Oxide.—In the production of French oxide by the retort volatilizing process it is the common practice in the art to charge the retorts with broken up slabs of zinc, which must be melted and brought to the volatilizing temperature before the oxide production can take place. The production of French oxide in this way is an intermittent operation, each charge being worked off before the next charge is introduced into the retort. As a result the retorts can be operated at their maximum capacity during only a part of the time. This intermittent method of operation requires frequent cleaning of the retorts, while the retorts themselves not infrequently crack

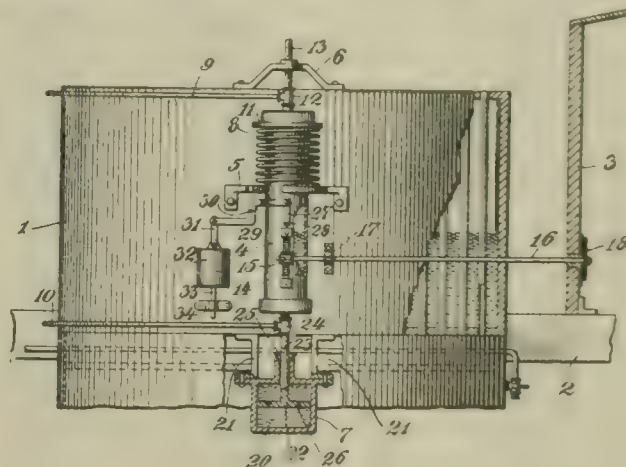


or fail and must be replaced, thus further decreasing the output of the furnace and increasing the labor and expense of operation. So also such intermittent operation of the retorts is wasteful of fuel for the reason that the retorts must be heated during the time interval between the end of one operation and the beginning of the next, as well as during the preliminary period of melting the zinc

and heating it to the required temperature, and also during the entire working-off operation, during the latter part of which the retort is operated at a greatly reduced capacity owing to the progressively decreasing amount of molten zinc remaining therein.

In order to make possible continuous operation JAMES A. SINGMASTER of Palmerton, Pa., proposes to maintain an approximately constant amount of zinc in each retort by adding molten zinc from time to time. For this purpose an auxiliary melting furnace is supplied with metal from the spelter furnaces. A later improvement by WALTER L. COURSEN is to cast the zinc in small rods, which are placed in the retorts at intervals. In either case the level of molten metal in the retorts is kept practically constant so that even when lead is present the retort may be operated for a long time before the concentration of lead becomes great enough to cause trouble. The accompanying illustration represents a vertical transverse section of a retort furnace. The retorts 2 (of which there are twenty in each furnace) have the usual dam 3 at one end and the usual opening 4 above it and are closed at the other end by a closure or luting 5, through which extends the pipe 6. The retorts are heated externally to a temperature above the volatilization point of zinc but below that of lead, iron, etc., and the retorts are kept filled with a reducing gas, such as clean producer gas, introduced through the pipe 6. The introduction of this gas prevents premature oxidation of the zinc vapor and also assists in sweeping out the zinc vapor as fast as formed. The zinc vapor and the producer gas combine with the oxygen of the air at the mouth of the retort, and the oxide thus produced is collected in the usual way. For use with the present inventions doors 7 are provided in the ends of the pipes 6. Through these the molten zinc or rods may be added to the retorts. (1,372,462 and 1,372,486; assigned to the New Jersey Zinc Co.; March 22, 1921.)

Apparatus for Indicating the Height of Liquids in Receptacles.—Referring to the figure, the gaging device comprises a weighing cylinder 4 supported in position adja-



cent the boiler 1 by suitable brackets 5 and 6, and a dash-pot 7. The weighing cylinder 4 is yieldingly mounted upon a calibrated spring 8 and has communication with the interior of the tank by means of the pipes 9 and 10, which are of sufficient length to extend around the tank to a point diametrically opposite the position of the weighing cylinder. The pipes 9 and 10 by reason of their length flex readily and avoid exerting any appreciable restraint against the free vertical movement of the weighing cylinder under conditions of operation. The calibrated spring 8 surrounds the weighing cylinder 4 and is interposed between the bracket 5, which is made fast to the exterior of the tank 1 and a flange 11 formed on the top cap of the cylinder 4, so that the weight of the cylinder and its contents will be carried by the spring, the whole exerting a compressive tension against the spring. Extending from a union 12, which affords communication between the pipe 9 and cylinder 4, is a guide rod 13 loosely fitting within the bracket 6, which is riveted or otherwise secured to the tank forming an aligning means which confines the movement of the weighing cylinder to the vertical.

It will be understood from the description thus far that the liquid supplied to the tank 1 will flow without restraint

through pipe 10 into the weighing cylinder 4 and will rise therein to an equal level, causing the weighing cylinder to descend against the tension of the calibrated spring 8. In order to indicate the level of the liquid entering the weighing cylinder 4, and hence the level of the liquid within the tank 1, the following instrumentalities are used. Upon the side of the weighing cylinder 4 is arranged a rack 14; co-operating with the rack is a pinion 15 mounted upon a shaft 16, the latter being guided by a bearing 17. This shaft has mounted upon its extremity an indicating hand 18, which co-operates with a dial 19, which is suitably graduated. It will be obvious that as the weighing cylinder 4 moves in either direction this motion is communicated to the hand 18, causing the latter to vary accordingly upon the dial. By suitably proportioning the parts such as increasing the size of the pinion 15 the extent of movement of the hand 18 over the dial can be governed.

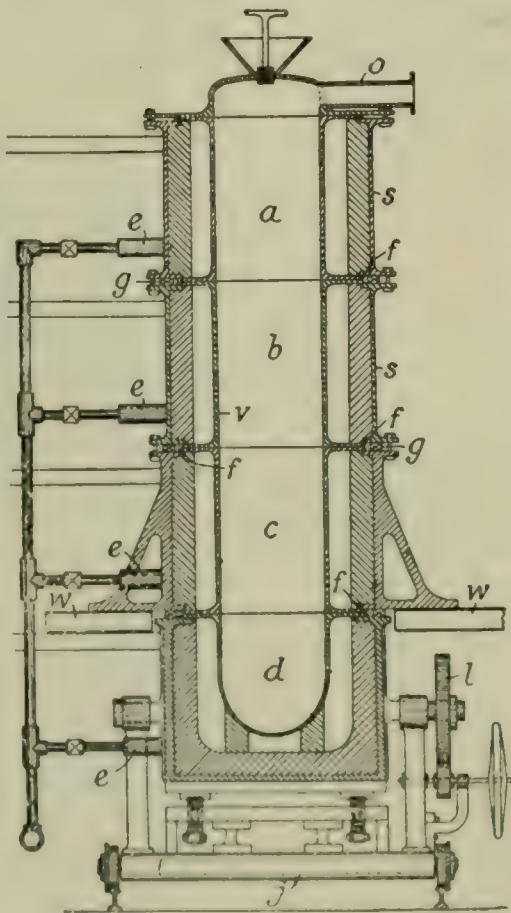
The sensitiveness may be increased by the use of a counterweight which balances the weight of the cylinder. One means of accomplishing this result consists in using a link 27 pivoted to the weighing cylinder 4 at 28, to which link is connected a lever 29 pivotedly supported at 30. The opposite extremity of this lever is connected to a link 31 which supports a counterweight 32, having a projecting extremity 33 guided in a guide-bearing 34. (1,367,689; JOSEPH C. FULLER, of Sewaren, N. J.; Feb. 8, 1921.)

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Tungsten.—Tungsten powder is obtained from sodium or potassium tungstate or both by mixing the tungstate with a chloride, preferably ammonium chloride, and a reducing agent such as wood, charcoal, anthracite or sawdust, and heating the mixture in the form of briquets or otherwise to 1,000-1,500 deg. C.

for about fifteen hours. The product is either cooled out of contact with air or is quenched in water. Any soluble tungstates formed may be precipitated with lime and calcium chloride and the calcium tungstate added to a subsequent charge. The furnace shown comprises a casing *s* and a retort *v* arranged in sections and heated by burners *e*, the joints between the sections being provided with asbestos packing *f* and spring washers *g*. The upper sections *a*, *b*, *c* are mounted on a platform *w* and the bottom section *d* in bearings on a carriage *j*, tilting means *l* being provided. As the charge is heated, it melts and sinks into the section *d*, ammonia which is evolved escaping through an opening *o* and being recovered for re-use. The chamber *d* is then disconnected and removed and the heating completed under a separate hood. According to the provisional specification, fluorides may be used instead of or in addition to chlorides. (Br. Pat. 155,600, C. J. HEAD, London; Feb. 23, 1921.)



thioglycollic acid dissolved in caustic soda. By addition of alcohol, silver thioglycollate of sodium, $\text{AgS-CH}_2\text{-COONa}$, is precipitated as a yellow powder, which is soluble in water and is of value in treating gonococci diseases. (Br. Pat. 156,103; not yet accepted; CHEMISCHE FABRIK FLORA, Zurich, Switzerland. March 2, 1921.)

Assimilable Phosphates.—Phosphates are rendered assimilable as a manure by grinding them with a large quantity of water to which has preferably been added a small amount of acid or alkali. The finely divided phosphate becomes hydrated and assumes a colloidal-like form which after drying is equal in value to water-soluble phosphates. The addition of 0.1 to 3 per cent of sulphuric, nitric or phosphoric acid is sufficient to accelerate this transformation considerably. The process is facilitated by conducting it under pressure or by heating to about 90 to 95 deg. C., or by adding protective colloids such as tannin, salts of lysalbinic acid, or the alkali salts of humic acid. Bone-meal and guano may be subjected to the same process. In an example slag phosphate is first ground in a phosphate mill and is then disintegrated in the presence of six times its amount of water. The resulting suspension is weakly acidified with a gaseous or liquid acid and allowed to separate into two layers. The bottom layer of phosphate mud is withdrawn, filtered and dried; preferably by blowing with hot air or by heating with waste gases. (Br. Pat. 154,124; not yet accepted; H. PLAUSON, Hamburg, and J. A. VIELLE, Westminster. March 2, 1921.)

Zinc Sulphide—Lithopone.—Zinc polysulphide is obtained by precipitation of a zinc salt of an organic or inorganic acid such as zinc chloride with an alkali or alkaline earth polysulphide such as a barium polysulphide, while maintaining an excess of the zinc salt. The zinc chloride may be obtained by treating zinc sulphate with barium chloride, and the barium sulphate is reduced to sulphide, dissolved, and converted into any polysulphide by treatment with the requisite quantity of sulphur. Lithopone is obtained by precipitating zinc sulphate with barium polysulphide in presence of a soluble zinc salt or other than the sulphate. The precipitated zinc polysulphide is completely washed and dried and is heated first at about 300 deg. C. until any oxide present is converted into sulphide, the sulphur dioxide being removed, and then to about 700 deg. C. The heating is effected in a clay crucible and a current of inert gas such as nitrogen may be passed through. The sulphur expelled may be collected and used for making more barium polysulphide. (Br. Pat. 155,824; not yet accepted; FABRIQUES DE PRODUITS CHIMIQUES DE THANN ET DE MULHOUSE, Thann, France. March 2, 1921.)

Nitrocellulose Compositions.—Nitrocellulose is dissolved in non-volatile liquid tricresyl esters of phosphoric or thiophosphoric acid, or in halogen substitution products of these esters. The solution, with the addition of fillers and coloring matter, may be combined with one or more layers of fabric to form driving belts, floor coverings, etc., or may be molded under pressure into various forms for insulating and other purposes. A typical composition contains 20 to 25 per cent nitrocellulose, 28 to 35 per cent phosphoric acid tricresyl ester, 15 to 20 per cent chalk or fossil earth, 2 to 5 per cent English red, and 35 to 15 per cent finely ground sawdust. (Br. Pat. 156,096; not yet accepted; C. CLAESSEN, Berlin, March 2, 1921.)

Acetic Acid.—In the catalytic oxidation of liquid acetaldehyde to acetic acid the formation of peracetic acid is inhibited by using as catalysts salts containing water of crystallization—e.g., hydrated salts, particularly the acetates, of nickel, cobalt, manganese, chromium or copper, alkali and alkaline earth hydrated salts, and alums. Salts specifically mentioned are ferrous sulphate, sodium acetate, potassium cobalt sulphate, potassium ferrisulphate and manganous sulphate. According to the example, oxygen or air is passed into acetaldehyde containing finely divided ferrous sulphate ($\text{FeSO}_4 \cdot 7\text{H}_2\text{O}$), the resulting acetic acid separated from the salt and then distilled, preferably in vacuo. The remaining ferric sulphate can be used afresh after it has been reduced and crystallized. (Br. Pat. 156,146; not yet accepted; H. PLAUSON, Hamburg, and J. A. VIELLE, Westminster. March 2, 1921.)

Thioglycollates.—An aqueous solution of thioglycollic acid is treated successively with an aqueous solution of a silver salt and one of caustic soda; or the silver solution, for example silver nitrate or fluoride, may be added to the

Current Events

in the Chemical and Metallurgical Industries

Knox Dye Amendment Passes Senate

The Knox amendment continuing the control of the War Trade Board over imports of dyes was embodied in the emergency tariff bill in exactly the form as approved by the committee and the bill itself was passed May 11 by a vote of 63 to 28. The measure now goes to conference, where the differences between the Senate and House bills will be adjusted. It is practically certain that the House conferees will accept the Knox amendment. Senator Moses of New Hampshire, chief opponent of the amendment, declares that its adoption means that the licensing of dye imports not only will extend during the six months' life of the emergency tariff, but will be written into the permanent tariff bill as well.

SENATOR MOSES CONDEMNS THE MEASURE

Senator Moses condemned the whole emergency tariff measure as "unscientific, unjust and sure to defeat the hopes of those who have advocated it." Embargo and licensing systems were condemned by the New Hampshire Senator as being un-Republican, un-Democratic and un-American. He said the amendment "puts hundreds of business men to the disadvantage of exposing the secrets of their business to some petty agent of the War Trade Board, which continues to function, though war long since has ceased." He condemned the dye industries for spending large sums in pushing the amendment when they "were hammering at the gates of Congress with the plaintive cry that they could not live out the winter." In that connection Senator Moses went into some detail as to the expenditures which he alleges were made by the American Dyes Institute in its effort to secure this legislation. He declared that Morris R. Poucher "is the Dyes Institute, is the du Pont company, is the Textile Alliance and it is now proposed to make him the doorway to the War Trade Board."

"In these various capacities," continued Senator Moses, "the way will be paved to him to know not only the details of the business of every dye manufacturer in the United States, but to secure an accurate line on the consumer as well—to whom he may dictate what he may and may not use. The dye consumers of the country may as well understand in the beginning that the entire dyestuffs business of the United States is to be turned over to Mr. Poucher and to those whom he represents and that they will determine who shall or shall not continue in business, whether it be manufacturing, importing or consuming."

Senator Moses pointed out that the word "dyestuffs" is new so far as American statutes are concerned. Since the word has received no legal interpretation, he expects that it will be interpreted to include not only the coal-tar colors but the natural dyes, such as logwood, fustic, natural indigo, prussian blue and the like.

SENATOR KNOX REPLIES

Senator Knox, speaking on the floor of the Senate in defense of his amendment, declared that he had been amused by the arguments of Senator Moses, which he characterized as being prejudiced. "It is not my purpose," said Senator Knox, "to approach the consideration of the amendment from the standpoint of a profit and loss account of a Dolly Varden calico mill in New England, but from the standpoint of the roster of the dead of the great war." He stated that he would omit from his arguments the economic reasons for protecting the dye industry and would confine himself solely to the need for establishing a great chemical industry because of its importance for the national defense.

When the war began gas shells constituted an insignificant proportion of projectiles, Senator Knox pointed out, yet at the time of the Germans' last retreat it was found

that fully 50 per cent of their projectiles were filled with gas rather than with high explosives. He quoted extensively from General Fries to bring out the importance of chemical warfare and the certainty that it will be employed in any future conflicts. He also embodied in his remarks certain observations of Colonel Phillippe Bunau-Varilla in speaking of the pre-war blindness of the French people in not meeting the German advance in organic chemistry, so as to be able to cope with them in the production of chemical armament.

Senator Knox had printed in the *Congressional Record*, as an adjunct to his speech, practically the entire address delivered by General Fries at the recent Chemical Warfare Service annual dinner. He also included, as a part of his remarks, a memorandum written by General Fries to General Leonard Wood in which was pointed out how easy it would be for Japan, in the event of war with that country, to take the Philippines with the aid of gas.

In the course of his remarks, Senator Knox called attention to the fact that in 1914 there were seven manufacturers of dyes in the United States. In 1920 there were 184 dye manufacturers in this country, which fact he used as an argument to show that the industry is not being monopolized by a few. He explained that necessarily some of these institutions must be great and must be enormously capitalized, since "when great things are being done in the world, it requires great instrumentalities to accomplish them."

General Staff College Hears of Chemical Warfare

That the General Staff of the Army is coming to regard chemical warfare with greater sympathy may be judged by the fact that General Amos A. Fries on May 11 appeared before the General Staff College and delivered an exhaustive address on the underlying fundamental principles of chemical warfare. General Fries' remarks covered thirty-one typewritten pages. In the course of his address he declared that chemical warfare is the most scientific of all methods of fighting and is the most universally applicable of all the methods of making war. The use of gas, he said, is just as fundamental as was the introduction of gunpowder.

"The World War opened the eyes of England, France and Japan, as well as those of the United States," said General Fries in the course of his address. "Each of them today is struggling to build up a great chemical industry as the very foundation of successful war." At another point in his speech General Fries said:

"A part of the strategy of peace is the card indexing of the man power of a nation divided into special groups. In one great group must come those who have a knowledge of chemistry and the chemical industries. That must be so worked out that if war should come on a moment's notice, within twenty-four hours thereafter every chemist could be given his job, jobs extending from the firing line to the research laboratory. And that is the task of the Chemical Warfare Service."

General Fries reiterated a point he frequently has made that there never has been a case in history where a powerful weapon ever has been abandoned once its effectiveness had been proved. For that reason, he said, "our Government today is giving most serious heed to the need of building up a great chemical industry in the United States. We have the raw materials. We need only the factories and the trained men that go with them. We need of course, in addition to the development of the coal-tar industry, a production of heavy chemicals such as chlorine, sulphuric acid and the like, all of which, however, are bound together by community interest in peace as well as in war."

Engineering Council Urges Patent Office Relief

Wholesale resignations are crippling the United States Patent Office to the point of disorganization and are creating conditions that threaten American industrial enterprise and invention, it was declared in a statement issued by the American Engineering Council of the Federated American Engineering Societies.

The Council, through its patents committee, of which Edwin J. Prindle, of New York City, is chairman, asserted that the situation had become almost intolerable and quoted the new Commissioner of Patents, Thomas E. Robertson, as saying that remedial legislation at the present session of Congress is necessary if results approaching disruption were to be prevented.

The Council appealed for support of pending patent legislation, which provides sufficient increases in salaries to check the exodus of employees from the Patent Office to private employment. In a little over one year, it was stated, 110 of the force of examiners numbering 437 have resigned. During the first three weeks of the Harding administration six highly trained experts quit to accept salaries two or three times as great on the outside.

In the past year, according to figures furnished by Commissioner Robertson, 142 of the 560 clerical workers have left the service. There are thirty clerks in the Patent Office who receive only \$60 a month. They would get \$1,100 a year under the new salary bill.

The Council also made public a statement from Major A. M. Holcombe, former chief of the patent section, General Staff, United States Army, urging engineers to aid patent legislation and saying that patents play an increasingly important part in proportion to the degree of specialization in industry.

Chairman Prindle stated it was the unqualified opinion of the important engineering, research and manufacturing associations of the United States that the scientific and industrial interests of the country were being jeopardized by Patent Office conditions. The National Research Council, the American Chemical Society and the National Association of Manufacturers were cited by him as among the organizations favoring Patent Office relief.

"With our patent system working normally," he said, "many inventions will be produced each year which in the aggregate will add so much to the income of our country that the returns from income taxes will be much larger with the Patent Office properly supported. To deny the Patent Office relief is not economy, but waste. The European countries, taught by the war, are already strengthening their patent systems. America must not lag."

Extensions by Anaconda Company

Anaconda's annual report for the year 1920 contains the following information on new experimentation, construction and operation of new departments:

ANACONDA

Very little construction work was done at Anaconda during the year 1920, the principal items being the completion of the 50-ton phosphate plant, which was begun in the latter part of 1919, and the completion of the arsenic refining plant, work on which was begun at the same time. Both of these plants were operated in a very satisfactory manner.

The 50-ton phosphate plant treated approximately 1,500 tons per month of rock and produced about 900 tons per month of treble superphosphate, containing about 47 per cent available phosphoric acid. This plant is a pilot plant intended for developing the process of producing high-grade phosphate and demonstrating the marketability of the product. Plans are under way for the construction of a large commercial plant to treat 400 to 450 tons of rock per day, together with the necessary sulphuric acid plant.

The new arsenic-refining plant, the remodeling of which was completed during the year, contains two refining furnaces each capable of producing about 200 tons per month of refined arsenic. Toward the end of the year a baghouse was constructed to recover the fume from the gases leaving the arsenic plant. The entire system operated in a most satisfactory manner.

A small experimental plant for the production of liquid sulphur dioxide and an experimental precipitator for the precipitation of copper from sulphate solutions by means of liquid sulphur dioxide were completed and successfully operated during the year.

GREAT FALLS

A very considerable advance was made during the year in connection with the treatment of zinc plant residue and baghouse fume, by making the fume and the residue into briquets and smelting the same in one of the old copper blast furnaces, which was remodeled for this purpose.

At the rolling mill a double six-die wire drawing machine, a nine-die wire drawing machine and a seven-wire strander were added to the plant.

At the ferromanganese plant considerable work was done during the year in the way of reconstructing the furnaces as they wore out. Two of the furnaces were rebuilt along new and improved lines and the electrode holders were very much improved. The plant for the last half of the year operated very satisfactorily, but as there was a decided falling off in the demand for ferromanganese in the middle of December the operation of the Great Falls plant was discontinued.

EAST CHICAGO

The electrolytic white lead plant of the Anaconda Lead Products Co., located at East Chicago, Ind., was put in operation on Jan. 25, 1920, and immediately, as is usually the case in new process work, weaknesses in equipment and plant design developed, which from time to time were remedied and will be completely overcome in the near future. The cellroom of the plant developed a greater tonnage than was expected, thereby throwing out of balance the filtering, drying and barreling departments.

The process operated satisfactorily, the grade of the product being excellent, establishing a new standard of whiteness for white lead. Construction and operation of the plant were seriously hampered by a scarcity of labor, which was remedied only toward the close of the year. The plant made an output of eighteen tons of white lead per day during the last month of the year.

POTRERILLOS

The experimental mill of the Andes Copper Mining Co. at Potrerillos was started Jan. 25, 1920. Various alterations were made to permit of thorough tests on the oxide ores by a leaching process, to be followed by sulphur dioxide precipitation and iron cementation. The leaching experiments carried on during the year indicated a consistent extraction of 92 per cent of the copper content in the oxide ores treated.

The sulphur dioxide plant has been shipped to South America and should be in operation early in the year 1921. In the meantime tests on similar ores have been made at Anaconda, Mont. These experiments have fully corroborated the results obtained originally in the 1-ton plant at Anaconda and warrant the expectation of a very satisfactory recovery from the ores treated.

Due to shortage of fuel, the mill was shut down in September, 1920, but will be started up early in the year 1921.

Mme. Curie to Visit Washington

Mme. Curie arrived in New York City on the Olympic May 11 and was entertained at luncheon by New York chemists on May 17. She plans to visit Washington, where, on the afternoon of May 20, President Harding will present her with a gram of radium which has been purchased as a gift to her by the women of the United States. On the same evening a meeting in her honor will be held at the National Museum, where Prof. R. A. Millikan will speak on the subject of "Radium." The following two days will be spent in visits and entertainment in Washington, including dinners in honor of Mme. Curie at the French Embassy and Polish Legation, a trip to Mount Vernon, attendance at the formal opening of the cryogenic laboratories of the Bureau of Mines and a visit to the Bureau of Standards.

Annual Meeting, Society of Chemical Industry

The following message from Sir William J. Pope, president of the Society of Chemical Industry, was published in the April 15 issue of the *Journal* of the society:

As has already been announced, the next annual meeting of the Society of Chemical Industry will be held in Canada, in response to a very hearty invitation extended by the Montreal Section; the formal meeting extends from Aug. 29 to 31, but our Canadian friends have expressed the wish that the party from Europe will arrive a few days earlier so that they may be shown some parts of Canada not included in the extensive official program now being compiled. It will thus be convenient if as many of the visitors as possible will travel with me by the Melita, which leaves Liverpool on Friday, Aug. 12, and arrives at Montreal on or after Aug. 22.

At the close of the business meeting on Aug. 31, the members will leave Montreal by a special train for a four days' triangular tour of eastern Canada, during which visits will be paid to the paper and pulp works at Grand Mere, the largest in Canada, to the carbide and synthetic acetic acid factories at Shawinigan, and possibly to the aluminum and magnesium electrolytic plants. Sept. 2 will be spent at Ottawa and the next two days at Toronto. A boat trip across the lake has been arranged in connection with a visit to Niagara and to the chemical works and fruit farms on the Canadian side of the river. Sept. 6 will be spent in an inspection of the electrochemical works on the American side of the Niagara Falls, and the party will then proceed by train to New York.

From Sept. 7 to 10 the party will co-operate in a joint meeting of the Society of Chemical Industry and its American Section and the American Chemical Society; it will visit the great Chemical Exposition which opens at New York on Sept. 12, and which will certainly be one of the most important exhibitions of the chemical industry which has ever been held.

During the critical period through which all branches of the chemical industry are at present passing, when old markets are falling away and must be replaced by new ones, it is more than ever essential that British industrial chemists should seize every opportunity of gaining acquaintance with the conditions which prevail in the British Dominions and abroad; only by personal visits and by the establishment of new friendships and fresh business relationships can our members hope to be able to raise our chemical industries to the position indicated for them by the history and the geographical environment of these islands. Our Canadian and American friends have intimated their desire to furnish uncommonly extensive facilities for the inspection of works concerned with every branch of chemical industry, and it is certain that similar facilities cannot be granted to private individuals traveling alone apart from an official party such as is now being formed. The Council therefore desires to urge the members of our society to make every effort to accept the generous invitation extended to us by our transatlantic friends; we are convinced that the maximum benefit to our society and to the chemical industries of Great Britain, of Canada and of the United States can only be derived by the attendance of a large British party at the coming annual meeting.

New Chemistry Building at Buffalo

The Greater University of Buffalo, Buffalo, N. Y., will soon break ground for the construction of its proposed new chemistry building on Main St., contract for which was awarded recently to the J. W. Cowper Co., Fidelity Building. The structure will be three-story and basement, of Colonial style architecture; the facade will be of Indiana limestone with smooth light buff trim. The building will be constructed in the form of an H, with wings at the north and south ends, facing the campus.

A complete metallurgical laboratory will be located in the basement, supplemented by a dental metallurgical laboratory and electrochemical laboratory. The lobby on the main entrance floor will be used as a museum; in the north wing on this floor will be an organic laboratory, 48 x 96 ft., while the south wing will be used as a reading room, library and recitation room; at the front of the building on this floor will be the offices for the professors, smaller labora-

tories and supply rooms. On the second floor, the north wing will be used as an organic chemistry laboratory, and the south wing arranged for a microscopic laboratory, recitation room and lecture hall. Three large class rooms will also be located on this floor. The north wing on the third floor will be given over to a post-graduate laboratory and quantitative laboratory; in the south wing two other laboratories will be situated. The front of the building on this floor will be used for an analytical laboratory, with adjoining water and gas analysis laboratories and electrolysis department.

The building will have a total of approximately 17,000 sq.ft. on each floor, and has been designed to accommodate about 1,200 students. It is estimated to cost about \$400,000.

Development Work of the Bureau of Chemistry

The office of Development Work has recently been created in the Bureau of Chemistry of the United States Department of Agriculture to assist in the industrialization and commercialization of chemical processes and discoveries worked out in the laboratories of the bureau. The engineers in this branch will endeavor to design mechanical equipment to place the processes on a plant production basis and determine the manufacturing cost and market value of the products. The chemical discoveries relate to the utilization of waste agricultural materials for new purposes and to the deriving of new substances from farm products. One of the projects undertaken has been the production of sirup from sweet potatoes. The process as worked out in the laboratory has been very satisfactory and the engineers in the Development Division are now endeavoring to obtain data to assist in the establishing of a sweet potato sirup production industry if the scheme is commercially feasible.

Another project to be undertaken in the near future has to do with deriving furfural, cellulose flour and two grades of adhesive from corn cobs. Other lines of work following up closely the methods determined in the laboratory will be undertaken. The industrial contact for the bureau will be handled through this new division and the engineers will be called upon to maintain satisfactory industrial relations with the business interests of the United States.

In connection with this development work the United States Civil Service Commission will receive applications until June 21 for positions of associate development engineer at salaries from \$2,500 to \$3,600 a year, assistant development engineer at salaries from \$1,800 to \$2,500 a year, and junior development engineer at salaries from \$1,440 to \$1,800 a year. Appointees at annual compensation of \$2,500 or less, whose services are satisfactory, will be allowed the increase granted by Congress of \$20 a month.

Applicants will not be required to report at any place for examination, but will be rated upon their education, training, and experience, as shown by their own statements and by corroborative evidence, and upon published writings or theses submitted with their applications. They must qualify in at least one of eleven specified engineering branches.

The requirements for entrance to these examinations and other information in full, together with application blanks, may be obtained by communicating with the United States Civil Service Commission, Washington, D. C., or the secretary of the local board of United States civil service examiners at the post office or custom house in any city.

C.W.S. to Test Gas Bombs in Naval Aerial Warfare

In connection with the tests of aerial bombs to be conducted off the Atlantic coast June 21 the Chemical Warfare Service is planning to experiment on the effectiveness of poison gas bombs. Non-explosive bombs filled with brombenzylcyanide will be dropped on a ship carrying a crew provided with gas masks. It has been pointed out that the ventilating system of all warships is based on a suction system drawing air through tubes to every part of the vessel. This system would be the chief ally of an enemy gas attack, sucking the deadly gases into every nook and corner of the vessel.

New Jersey Chemical Society Meeting

In an address on "Scientific Preparedness," delivered before the New Jersey Chemical Society May 9, Prof. Marston Taylor Bogert pointed out the profound influence which the use of poison gas was bound to have upon the methods of conducting future wars. Since chemical warfare can be waged with materials prepared from such seemingly innocent sources as the chlorine obtained from salt brines, coke, ethyl alcohol from the fermentation of carbohydrates, and the nitrogen of the air, the problem of chemical disarmament is by no means a simple one. Considered from the defensive point of view the safest policy would seem to be one involving unceasing research and study on the methods of chemical warfare and the assurance of a permanent domestic dye industry through appropriate legislation.

At the conclusion of Prof. Bogert's speech a short business meeting was held. A resolution was adopted urging the passage of the emergency tariff measure with the Knox amendment covering dyes and chemicals. Dr. F. W. Zons reported that the final touches were being put on the Year Book. Arrangements have been made by the committee on chemical industry for a visit to the Procter & Gamble plant at Port Ivory, Staten Island, on Saturday, May 21. Members expecting to attend were requested by Dr. Traub to be at the Elizabethport-Staten Island ferry not later than 9:30 a.m. Following the election of new members C. L. Bryden announced that the society now had 704 members.

NICKEL

The technical program was continued by John F. Thompson, of the technical department, International Nickel Co. He outlined briefly the chemical and physical properties and uses of nickel and its more important alloys, such as Monel metal. A consideration of the applications of nickel compounds, however, brings out the interesting fact that with the exception of electroplating the demand is very slight. The property of forming two sets of compounds having valences of 2 and 3 respectively is utilized in one form of storage battery and some processes for the manufacture of nickel catalyzers depend upon nickel compounds. Research directed toward widening the field of application of these compounds has developed some interesting points. One of the most promising seems to be the use of nickelic hydroxide as a pigment for printing ink. It has an excellent bluish undertone and makes an ink which prints well. Furthermore, it can be bleached easily so that the recovery of newsprint is facilitated.

R. L. Suhl, also of the International Nickel Co., commented on the prevalent idea that the price of nickel compounds is too high to warrant use as indicated. He said that the price was due largely to the small output and that with increased demand the economies of larger production would result in a substantial lowering of the price.

Executive Committee of T.A.P.P.I. Holds Meeting

The first meeting held by the executive committee of the Technical Association of the Pulp and Paper Industry since the election of George E. Williamson as president took place at the Strathmore Inn, Woronoco, Mass., on Thursday, May 5, and lasted over Friday. There was a full attendance of members.

MUCH CONSTRUCTIVE WORK TRANSACTED

It is safe to say that at no previous meeting of the executive committee of T.A.P.P.I. has so much work of a constructive character been transacted. Plans of a service committee for the conduct of group meetings of the association were adopted and arrangements made for the fall meeting of the association to be held under the joint direction of T.A.P.P.I. and the American Pulp and Paper Mill Superintendents' Association at Washington, D. C.; York and York Haven, Pa., and Philadelphia, Oct. 18, 19 and 20, 1921. Fred A. Curtis, of the Paper Section, U. S. Bureau of Standards, Washington, was named general manager of the meeting for T.A.P.P.I. and he will be assisted by Grellet N. Collins, of Philadelphia, and others. Owing

to an expected attendance of upward of 500 members and an already extended program of mill visitations, etc., it was found necessary to curtail the entertainment features to some extent. It was arranged that trips to York, York Haven and Wilmington be made optional for Wednesday, Oct. 19. This curtails the session in Washington to one day, Tuesday, Oct. 18, but members could arrange to reach Washington on Monday, Oct. 17, and spend the day in seeing the sights of the capital.

NEW STANDING COMMITTEES NAMED

Other business transacted by the executive committee included the appointment of standing committees of the association for the ensuing year, the adoption of a budget and passing on estimates of income and expenditures. On a request by the Cost Association of the Paper Industry for an investigation of depreciation in values of machinery and apparatus a special committee of the association will be named for the purpose.

ELECTION OF MEMBERS

New members have been admitted by the executive committee during and since the annual meeting as follows: Charles L. Cockroft, night foreman, Everett Pulp & Paper Co., Lowell, Wash.; Richard H. DeMott, manager, industrial development department, SKF Industries, 165 Broadway, New York; Robert S. Finney, secretary and general manager, McNamee Kaolin Co., 60 Broadway, New York; Charles L. Harpham, manager of manufacturing, F. C. Huyck & Sons, Albany, N. Y.; Harry M. Hooker, sales manager, Hooker Electrochemical Co., 25 Pine St., New York; Benjamin K. Hotchkiss, sales department, Hooker Electrochemical Co., 25 Pine St., New York; Harold G. Ingraham, construction engineer, Marathon Paper Mills Co., Rothschild, Wis.; Dr. Edwin A. Rees, chemist, F. C. Huyck & Sons, Albany, N. Y.; John O. Ross, president and general manager, J. O. Ross Engineering Corporation, 30 East Forty-second St., New York.

GENEROUS CONTRIBUTION TO VOCATIONAL EDUCATION FUND

A generous contribution to the funds of the Vocational Education Committee is announced, the Champion Fibre Co., Canton, N. C., having recently sent in its check for \$500. This sum comes at a time when it is greatly needed for the completion of the work undertaken by the Joint Vocational Education Committee of the Pulp and Paper Industry of the United States and Canada, and it is hoped that the good example of the Champion Fibre Co. will be followed by other firms that have not been previously heard from.

Chemical Club of Philadelphia After More Members

The Chemical Club of Philadelphia is arranging a campaign for increased membership. At present there are more than fifty members, representing about thirty chemical companies in the city. Recently elected officers for the coming year are: J. H. Stutt, du Pont Co., president; F. S. Havens, Atlantic Products Corp., vice-president; W. J. Thorn, Innis, Speiden & Co., treasurer; W. H. Davis, Harshaw, Fuller & Goodwin Co., secretary.

Obituary

C. H. CLARKE, president of the Clarke Chemical Co., Denver, Col., died recently at his home in that city.

AMBROSE MONELL, president of the International Nickel Co. for fifteen years and a metallurgist of note, died on May 2 at Beacon, N. Y., where he was undergoing a rest cure in an endeavor to recover from nervous prostration which had endured for several months. He leaves a widow, two sons and two daughters. Mr. Monell was born in New York City in 1874, and was graduated from the School of Mines, Columbia University, in 1896. He was then metallurgical engineer and assistant to the president, Carnegie

Steel Co., during which time he patented the steel process which bears his name. His idea was to adapt the Talbot continuous open-hearth process to a stationary furnace without retaining a heavy bath of molten metal at all times. As now practiced by the Carnegie Steel Co., molten pig iron is poured into a furnace containing white hot scrap, whereupon the impurities are rapidly oxidized and join with the lime and ore on the furnace bottom. Most of the slag boils out a special slag notch, or is skimmed off. What is known as the "lime boil" lasts two or three hours longer. After an hour more for adjusting the carbon content the steel is tapped. As head of the International Nickel Co., Mr. Monell was signally successful. His name has become widely known by the exploitation of Monel metal, an excellent natural alloy produced directly from the company's Canadian ore. These sulphide ores are roasted, and smelted into matte, a mixture of copper, nickel and iron sulphides. The iron sulphide is then eliminated by blowing the molten matte in a bessemer converter, and the resulting copper-nickel sulphide reduced with charcoal. When America entered the World War, Mr. Monell was commissioned Colonel in the aviation service and immediately went to France to organize the flying service on that side. He commanded at one time the day and night bombing groups. As a result of the intense strain under which he labored, his health broke down, never to be recovered.

Personal

A. J. BARNEBL, JR., formerly with the Dorr Co., is chief mechanical engineer for the K. B. Pulverizer Co., New York City, which is designing equipment for pulverizing coal.

L. H. CHAMBERLAIN has been appointed Western sales engineer for the Schutte & Koerting Co., with offices at 72 New Montgomery St., San Francisco.

B. DUNGLINSON, chemical engineer of the American Chemical & Sugar Machinery Co., has transferred his activities from the Philadelphia district to the Chicago office, with headquarters at 1725 Transportation Building.

AARON FRIEDMAN, formerly with Cooper & Cooper, Inc., is now with the New Process Metals Corporation of Newark, N. J. He will erect and superintend a plant for the manufacture of metallic cerium and other rare-earth metals.

O. H. KOCH, one of the members of American Engineering Council's executive board, has just completed visits to member societies in New Orleans, Birmingham and Nashville. He reports that they are much interested in the activities of the Federated American Engineering Societies.

E. C. LANE, chemist at the San Francisco laboratory of the U. S. Bureau of Mines, has left for an extended Eastern trip. He will spend several months in the Mid-Continent and Eastern oil fields and visit the stations of the bureau at Bartlesville and Pittsburgh, and also the Washington office, returning to San Francisco during the summer.

C. W. MILLER, president of the Davison Chemical Co., Baltimore, Md., has returned from a trip to the pyrites properties of the company in the West Indies.

L. W. WALLACE, the executive secretary of the Federated American Engineering Societies, has returned to his office in Washington after a visit to Milwaukee, Detroit and Chicago. At Milwaukee he addressed the Society of Industrial Engineers on industrial leadership. At Detroit he spoke at the annual banquet of the local engineering societies. In Chicago he attended the meeting of American Engineering Council's committee dealing with the licensing of engineers. This committee, in view of recent legislation, has made certain changes in its model bill. These changes will be laid before the executive board of the Council at its June meeting.

A. B. WILSON has resumed his former position as metallographer with the Titanium Alloy Manufacturing Co. and is engaged in work in connection with the use of ferro-carbon-titanium in steel.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, May 16, 1921.

The heavy chemical market is strengthening up markedly, in spite of several declines in some items. Confidence throughout the trade is increasing after the long period of depression and it looks as though the pendulum is about to swing back. Business, however, is still far from normal, but the general attitude is much more hopeful, as steadiness is increasing throughout the general list. Even *caustic potash*, which has been consistently the weakest commodity in the market, is showing signs of firmness. The stand taken by leading manufacturers of the country's big basic products in reference to labor is a sign of decreased inflation of producing costs and assures healthier markets a little later in the year. The announcement of a lowering of discount rates by Federal Reserve banks in various parts of the country is significant that frozen credits are being thawed out. This is one of the brightest features that has confronted industry since the beginning of the year. It is also apparent that a reduction in freight rates will shortly be made and, altogether, developments are working toward a satisfactory end from a business point of view.

GENERAL CHEMICALS

Importations of foreign chemicals and the desire of foreign interests to compete in the American market are features of great concern to American producers. Higher prices were named for imported *nitrite of soda* and the market closed in a firm condition with the passage of the emergency tariff bill. This undoubtedly will prevent the keen state of competition which has existed between domestic and imported nitrite. Prices are decidedly firm on resale *caustic potash*, with the imported material, 88-92 per cent, offered at 6c. per lb. Consumers are taking a moderate amount of this material at the low prices and it is understood that the soap trade has taken large quantities. Prominent dealers offered *acetate of soda* for immediate shipment on the basis of 4½c. per lb. f.o.b. works. It is intimated that the figure might be shaded on a firm bid for a round lot. The present movement is quiet and small lot operations feature the market. Resale stock of *bichromate of soda* was quoted at 8c. per lb. in several directions ex-store N. Y., and while odd lots can still be purchased at 7½c., it is doubtful if very much business could be placed below the outside figure. Inquiries are said to be confined mostly to 5 and 10 lot quantities. Second-hand prices on *caustic soda* are reported at \$3.60@3.65 per 100 lb. ex-warehouse and \$3.75 f.a.s. steamer. The inquiry is irregular, with small lots attracting the most attention. Producers state they are placing a fair amount of business with the consuming trades and quoted the former range of 3½@3¼c. per lb., basis 60 per cent, f.o.b. works. Higher prices for *nitrite of soda* were named on spot and the market covered a range from 6½@7c. per lb. The advance was not accompanied by any radical activity. Consumers are taking small lots on the advance but did not appear eager to extend commitments. Imported *prussiate of soda* is showing strength in the open market and most sellers are not inclined to shade 12½c., while 13c. was named in several quarters. Offerings were not heavy but seemed sufficient to meet the current extent of inquiries. Occasional sales of light *soda ash* in bags went through at \$2.10 per 100 lb. Barrels were held at \$2.40@2.50 ex-store N. Y. The scarcity of offerings is keeping the market in a firm position. Producers report sales at \$1.62½@1.72½, basis 48 per cent, f.o.b. works in single bags. *Dense ash* is held at 10c. per 100 lb. premium. An arrival of a few 100-ton lots of ash was noted from Liverpool. Sellers of the imported material asserted that all April shipments were made and that May delivery is moving steadily.

Spot sales of *formaldehyde* were reported at 14½c. per lb. by second hands. Quotations are heard from 14@15c. per lb. according to seller. Buyers are taking moderate quantities of this chemical for miscellaneous consuming requirements. The undertone of the *glycerine* market rules steady regardless of the small volume of trading. Sellers' views on the dynamite are 15@15½c. per lb., while c.p. glycerine was held at 17@17½c. The *alcohol* market is still in a disturbing state and competition is keeping prices soft. Supplies of *ethyl alcohol* are easy and prices range from \$4.65@ \$5.25 per gal., according to quantity. Small lots of *denatured* moved in moderate volume and sellers are asking from 32@48c. per gal., depending on quantity and formula. There has been little change in *methanol* prices, which range from 75c.@\$1.15 per gal., depending on grade. Factors in *fluoride of soda* report sales at former levels, with small lot sales continuing to feature the market. Quotations range from 12@13c. per lb. The market on *bleaching powder* is very unsettled in the absence of any marked demand and prices among resellers are very hard to place. Offerings f.o.b. works from second hands have been heard all the way down to \$2.15 per 100 lb. Makers' quotations are given as \$2.75 per 100 lb., but this figure has little meaning in the present market. Makers of *lead acetate* have kept their prices at former levels and are quoting the white crystals at 13@13½c. per lb. and the brown variety at 11½@12½c. per lb. Producers of gray *sal ammoniac* have reduced their prices and are now quoting on a parity with the imported material at 7½@8½c. per lb. Imported white granular is quoted at 6½@7½c. per lb. American makers of white *sal ammoniac* are holding at 10@10½c. per lb.

COAL-TAR PRODUCTS

On Wednesday, May 11, the Senate passed the emergency tariff and anti-dumping bill, retaining all amendments recommended by the Finance Committee, but rejecting those individually proposed. The vote was 63 to 28. It is expected to become law practically unchanged. There is no doubt now among leading interests that the long period of uncertainty that has been such a drawback to the coal-tar industry will automatically pass with the enforcement of this new legislation. The volume of trading during the past week was of little larger proportion and the inquiry in one quarter and another was reported as more active. Full-time operation is noted in several mills where the four days a week schedule has been in force since last November. The lower bank rate is accepted as a good sign and if efforts now being made to secure financial assistance from the banking authorities are at all successful, a steady improvement in foreign business is expected. Dyestuffs have been more actively traded in during the period and principal factors are firm in their views on prices. Swiss and German dyes have been arriving quite regularly and occasionally small lots are available in resale quarters. Intermediates have held quite steady with a few moving more actively, while some of the less important have shown little evidence of any improvement.

Reports from some quarters on *para-amidophenol* reflect an improving demand, although there is little in the line of buying for future needs. Supplies are readily available and prices steady with the base at \$1.60@ \$1.70 per lb., and the HCl at \$1.75@ \$1.80 per lb. *Aniline oil* varies according to seller, ranging from 20@25c. per lb. It is possible to do 32c. per lb. on *beta naphthol*, although producers' figures are 42@45c. *Dimethylaniline* is quiet and only small quantities are called for with prices at 42@55c. per lb., depending on seller and quantity. Supplies of *diphenylamine* are easy, but prices are steady at 60@70c. per lb., with trading in fair volume. The consuming demand for *metaphenylenediamine* is fairly good and prices are steady at \$1.15@ \$1.25 per lb. Factors in most quarters report a regular supply of *toluidine* available while the demand is limited to small routine movement with prices ranging from \$1.25@ \$1.35 per lb. Trading in *toluene* was shown only in small lots during the week. There has been no change in the price level at 28@31c. per gal., depending on quantity, although second hands might shade down to 27c. on firm business. The market for *xylene* shows little change from

day to day, with a slight routine consuming demand. Supplies of the pure are quoted at 40@45c. per gal.

VEGETABLE OILS

Trading in *cottonseed oil* lacked snap and the undertone was rather heavy considering the favorable turn of events in Europe. Grains, provisions and cotton moved upward, but this caused hardly a ripple in the cottonseed oil trade. Export inquiry was dull, with domestic demand also quiet. The crude material was a shade easier at the mill, sales passing at \$5@ \$5.05 per 100 lb. The inquiry for *linseed oil* was reported as fair, consumers showing some interest in both nearby and July-September contracts. The undertone was firmer and while crushers no longer offered raw oil for nearby delivery at 64c. per gal., it was intimated that firm bids might still be accepted on carlot orders. Crushers were asking from 65@67c. per gal. for May-June shipment, with July-August oil commanding 66@68c., according to sellers. The market for *chinawood oil* closed higher at 12@12½c. per lb. in barrels, spot delivery. May shipment oil was held at 10¼@11c., with June quoted at 10½c. per lb. The Coast market for prompt shipment oil was quite strong at 11c. asked. Demand for *coconut oil* was less active, bids being below the market and no important sales going through. On the Coast Manila oil for May shipment was offered at 8½c. per lb., sellers' tanks, although some holders were still asking 8¾c. Copra inquiry was fairly active, but the asking price was considered too high. Bids were noted for Ceylon copra at 5½c. and Manila at 5c. per lb., c.i.f. N. Y. Crude *corn oil* in Chicago was firm, closing at 5½c. per lb. sellers' tanks, nearby delivery. Southern mills were asking from 6@6½c. per lb. for domestic crude *peanut oil* in buyers' tanks. The demand was quiet. Oriental oil was held at 6¼c., sellers' tanks, f.o.b. Coast.

WAXES

Offerings of *carnauba wax* were fairly liberal and with the primary markets unsettled, prices here were barely steady at the recently reduced rates. Demand was quiet throughout the week. *Flor* was held at 60c. per lb., with the No. 1 at 58@59c. On the lower grades there was scattered interest in futures, but spot quotations were generally maintained at 17@17½c. per lb. for the No. 3 North Country. The crude oil situation had little or no effect upon the market for *paraffine wax*. Export demand covering forward contracts was comparatively quiet and with some selling pressure noted here prices were irregular. Domestic inquiry also was reported slow. Crude white scale wax, 122-124 deg. melting point, was offered in carlots at 2¼c. per lb. in some directions and 2½c. on firm business. Match wax closed at 3¼@4c. per lb. Refined paraffine, 118-120 deg. melting point, was offered at 3¼c. per lb., while 130-132 closed barely steady at 5@5½c. per lb.

The Iron and Steel Market

PITTSBURGH, May 13, 1921.

As indicated in last week's report, it has become clear that the iron and steel trade is in no better condition than a month ago, and the continued failure of any definite improvement to develop now suggests that on the whole the condition must be regarded as worse. The proverbially dull summer season being now not far distant, the prospect is slim for any real improvement to occur in the near future. For some time past the common prediction in steel trade circles has been that there would be no important improvement before September or October, and that prediction holds good, with the appendage that conditions are likely to be somewhat worse meanwhile.

Using some estimates in conjunction with the monthly report of the American Iron and Steel Institute showing the production of steel ingots in April of the companies that make monthly reports, it may be concluded that in April the independent steel producers in general operated at about 22 per cent of capacity, and this with an operation of about 41 per cent by the Steel Corporation makes an operation for the whole industry of about 31 per cent of the estimated capacity of 52,500,000 tons of ingots per annum. The independents had operated at about 30 per cent in January and February, rising to about 32 per cent in March. The

Steel Corporation's operations had declined from a 90 per cent rate in January, so that the two parties are now closer together.

There is no indication that operations have been any heavier in the past week than the average of April, there being rather room for the conclusion that there has been a slight decrease. The lead of the Steel Corporation over the independents seems likely to be maintained. While the corporation loses each month in its unfilled obligations—by 439,541 tons in the case of April—its constantly lowering rate of operation has made it that month by month the remaining unfilled tonnage would last a longer time. Thus at a 40 per cent operation the unfilled tonnage of 5,845,224 tons shown at the end of April would last a trifle over ten months. The independents have very little contract tonnage on books, as they had high prices last year and neither solicited nor were offered contracts for extended periods, so that they must now depend upon business picked up from time to time.

TEST OF STEEL PRICES

It is now a month since the steel market was equalized by the independents advancing their prices on most commodities and by the Steel Corporation reducing its prices. The new prices have been maintained to date, in a way, but it is the common remark that the prices have not been seriously tested as yet. It is predicted that the real test, whether the independents will all adhere to these prices, will come during the next thirty days; in other words, that if the prices last until the fore part of June they will hold through the summer. A new situation might be presented in the fall.

There are occasional reports of price irregularities, usually ascribable to a particularly attractive tonnage of business being offered. Thus an oil company is said to have been quoted \$3 a keg on 4,200 kegs of nails, the regular price being \$3.25, while the Ford Motor Co. is alleged to have bought all or a large part of a requirement of 4,000 tons of hot-rolled strips at 2.40c., the regular quotation being 2.75c. On ordinary lots of the various finished steel products there do not seem to be any cut prices being quoted at present.

While the steel market is regarded as being altogether stagnant it should be remembered that the industry has so grown that what was formerly a large tonnage is now a small tonnage relative to capacity. At the 31 per cent operation the steel industry appears to have shown for April there is represented about 250,000 net tons a week of the regular finished steel products, and that is really not a small tonnage for a hard times consumption, when the flow of steel into large construction work is very largely arrested. A 30 per cent operation today is equivalent to a 109 per cent operation of the capacity existing in 1903 or 1902, when the steel industry was regarded as being very large.

PIG IRON

The decline in pig iron prices continues, but at a relatively slow rate, there being only an occasional yielding, and then by a fraction of a dollar. When the market began to decline after reaching its peak at the end of last August the declines were recorded in steps of several dollars a ton at a time. On a 2,000-ton sale of basic pig iron by a merchant-furnace interest in the valleys \$22 furnace has just been done, this representing a reversion of the control to the merchant furnaces, sales for several weeks preceding having been by steel works interests, at \$22.50, the merchant furnaces holding aloof. Bessemer is offered at \$24 valley, as against the previous nominal quotation of \$25. Foundry iron is offered at \$23.50 valley, a decline of 50c. in the week. At these prices pig iron cannot have much farther to go, and as a matter of fact pig iron prices in general are a slightly greater percentage below their Industrial Board levels than are finished steel prices, although the great advance that has occurred in freight rates since the Industrial Board adjustment bears more heavily upon pig iron relatively than upon steel.

Connellsville furnace coke could probably be bought at \$3.25, a price that leaves little if any occasion for the consumers to demand a further liquidation.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

Acetic anhydride.....	lb.		\$0.43	\$0.45	
Acetone.....	lb.	\$0.12	\$0.12	.13	.15
Acid, acetic, 28 per cent.....	100 lbs.	2.50	2.75	3.00	3.25
Acetic, 56 per cent.....	100 lbs.	4.00	4.25	4.50	5.50
Acetic, glacial, 99½ per cent, carboys,	100 lbs.	9.35	9.40	9.50	10.00
Boric, crystals.....	lb.	.13	.14	.14	.15
Boric, powder.....	lb.	.15	.15	.16	.17
Citric.....	lb.			.45	.46
Hydrochloric.....	100 lb.	1.50	1.65	1.75	2.00
Hydrofluoric, 52 per cent.....	lb.	.13	.13	.14	.14
Lactic, 44 per cent tech.....	lb.	.10	.11	.11	.12
Lactic, 22 per cent tech.....	lb.	.04½	.05½	.06	.07
Molybdic, C. P.....	lb.	4.00	4.50	4.50	5.00
Muriatic, 20 deg. (see hydrochloric).....	lb.			.07	.07½
Nitric, 40 deg.....	lb.	.06½	.06½	.07	.08½
Nitric, 42 deg.....	lb.	.07½	.07½	.07½	.08½
Oxalic, crystals.....	lb.	.17	.18	.18½	.20
Phosphoric, Ortho, 50 per cent solution.....	lb.	.17	.17½	.18	.19
Picric.....	lb.	.20	.25	.27	.35
Pyrogallic, resublimed.....	lb.			1.90	2.15
Sulphuric, 60 deg., tank cars.....	ton			12.00	13.00
Sulphuric, 60 deg., drums.....	ton			14.00	15.00
Sulphuric, 66 deg., tank cars.....	ton	18.00	20.00		
Sulphuric, 66 deg., drums.....	ton	22.00	22.50	23.00	23.50
Sulphuric, 66 deg., carboys.....	ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars.....	ton	23.00	24.00		
Sulphuric, fuming, 20 per cent (oleum) drums.....	ton	25.00	26.00	26.50	27.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....	ton	32.00	35.00	40.00	
Tannic, U. S. P.....	lb.			.90	1.00
Tannic (tech.).....	lb.	.50	.52	.54	.57
Tartaric, crystals.....	lb.			.31	.35
Tungstic, per lb. of WO.....	lb.			1.30	1.40
Alcohol, Ethyl.....	gal.			4.65	5.25
Alcohol, Methyl (see methanol).....	gal.				
Alcohol, denatured, 188 proof.....	gal.			.32	.38
Alcohol, denatured, 190 proof.....	gal.			.40	.45
Alum, ammonia lump.....	lb.	.04	.04½	.04	.04½
Alum, potash lump.....	lb.	.04	.04½	.04½	.05
Alum, chrome lump.....	lb.	.13	.13	.14	.14½
Aluminum sulphate, commercial.....	lb.	.02½	.02½	.02½	.03
Aluminum sulphate, iron free.....	lb.	.03	.03½	.03	.04
Aqua ammonia, 26 deg., drums (750 lb.).....	lb.	.07½	.07½	.08	.08½
Ammonia, anhydrous, cyl. (100-150 lb.).....	lb.	.30	.32	.33	.35
Ammonium carbonate, powder.....	lb.	.08	.08½	.09	.10
Ammonium chloride, granular (white sal ammoniac) (nominal).....	lb.	.06½	.06½	.07	.07½
Ammonium chloride, granular (gray sal ammoniac).....	lb.	.07½	.08	.08½	.08½
Ammonium nitrate.....	lb.	.08	.08½	.09	.10
Ammonium sulphate.....	100 lb.	2.50	2.75	2.80	2.90
Amylacetate.....	gal.			4.00	4.25
Amylacetate (tech.).....	gal.			2.50	3.00
Arsenic oxide, (white arsenic) powdered.....	lb.	.07½	.08	.08½	.08½
Arsenic, sulphide, powdered (red arsenic).....	lb.	.12	.12½	.13	.14
Barium chloride.....	ton	58.00	59.00	60.00	65.00
Barium dioxide (peroxide).....	lb.	.19	.20	.21	.22
Barium nitrate.....	lb.	.10	.10½	.10	.11
Barium sulphate (precip.) (blanc fixe).....	lb.	.04½	.05	.05½	.06
Bleaching powder (see calc. hypochlorite).....					
Blue vitriol (see copper sulphate).....					
Borax (see sodium borate).....					
Brimstone (see sulphur, roll).....					
Bromine.....	lb.	.40	.41	.42	.45
Calcium acetate.....	100 lbs.	2.00	2.05		
Calcium carbide.....	lb.	.05	.05½	.05½	.05½
Calcium chloride, fused, lump.....	ton	27.00	29.00	30.00	32.00
Calcium chloride, granulated.....	lb.	.01½	.01½	.02	.02½
Calcium hypochlorite (bleach/g powder).....	100 lb.	2.25	2.40	2.50	2.75
Calcium peroxide.....	lb.			1.25	1.50
Calcium phosphate, tribasic.....	lb.			.15	.16
Camphor.....	lb.			.63	.68
Carbon bisulphide.....	lb.	.07	.07½	.07½	.08
Carbon tetrachloride, drums.....	lb.	.10	.10½	.11	.12
Carbonyl chloride (phosgene).....	lb.			.75	1.00
Caustic potash (see potassium hydroxide).....					
Caustic soda (see sodium hydroxide).....					
Chlorine, gas, liquid-cylinders (100 lb.).....	lb.	.08	.09	.09	.10
Chloroform.....	lb.			.38	.40
Cobalt oxide.....	lb.			3.00	3.10
Copperas (see iron sulphate).....					
Copper carbonate, green precipitate.....	lb.	.20	.21	.22	.23
Copper cyanide.....	lb.			.50	.62
Copper sulphate, crystals.....	lb.	.05½	.05½	.05½	.06
Cream of tartar (see potassium bitartrate).....					
Epsom salt (see magnesium sulphate).....					
Ethyl Acetate Com. 85%.....	gal.			.90	1.00
Ethyl Acetate pure (acetic ether 98% to 100%).....					
Formaldehyde, 40 per cent.....	lb.	.14	.14½	.14	.15
Fusel oil, ref.....	gal.			3.00	3.25
Fusel oil, crude.....	gal.			1.75	2.00
Glauber's salt (see sodium sulphate).....					
Glycerine, C. P. drums extra.....	lb.			.17	.17½
Iodine, resublimed.....	lb.			3.75	3.85
Iron oxide, red.....	lb.			.10	.20
Iron sulphate (copperas).....	100 lb.	.75	1.00	1.10	1.25
Lead acetate.....	lb.			.11	.13½
Lead arsenate, pas c.....	lb.	.09	.09½	.10	.11
Lead nitrate.....	lb.			.15	.20
Litharge.....	lb.	.08	.09	.09½	.10
Lithium carbonate.....	lb.			1.25	
Magnesium carbonate, technical.....	lb.	.10	.11	.11½	.12
Magnesium sulphate, U. S. P.....	100 lb.	2.75	3.00		
Magnesium sulphate, technical.....	100 lb.			1.10	2.25
Methanol, 95%.....	gal.			.75	.77
Methanol, 97%.....	gal.			.78	.82
Nickel salt, double.....	lb.			.14	.14½
Nickel salt, single.....	lb.			.15	.15½
Phosgene (see carbonyl chloride).....					
Phosphorus, red.....	lb.	.45	.46	.47	.50
Phosphorus, yellow.....	lb.			.35	.37
Potassium bichromate.....	lb.	.11½	.12	.12½	.12½

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar) lb.	\$ \$	\$0.30 - \$0.35
Potassium bromide, granular lb.		.16 - .25
Potassium carbonate, U. S. P. lb.	.35 - .40	.45 - .50
Potassium carbonate, crude lb.	.06 - .06	.06 - .07
Potassium chlorate, crystals lb.	.08 - .10	.10 - .14
Potassium cyanide lb.		.30 - .32
Potassium hydroxide (caustic potash) lb.	.06 - .06	.06 - .08
Potassium muriate ton	50.00 - 50.50	
Potassium iodide lb.		2.75 - 3.00
Potassium nitrate lb.	.09 - .09	.10 - .12
Potassium permanganate lb.	.32 - .33	.34 - .35
Potassium prussiate, red lb.	.33 - .35	.36 - .38
Potassium prussiate, yellow lb.	.27 - .27	.28 - .29
Potassium sulphate (powdered) per unit		1.75 - 1.80
Rochelle salts (see sodium potas tartrate)		
Salammoniac (see ammonium chloride)		
Salt soda (see sodium carbonate)		
Salt cake ton		30.00 - 35.00
Silver cyanide oz.		1.30 - 1.35
Silver nitrate oz.		.41 - .42
Soda ash, light 100 lb.	2.10 - 2.15	2.25 - 2.50
Soda ash, dense 100 lb.	2.20 - 2.30	2.40 - 2.75
Sodium acetate lb.	.04 - .04	.05 - .05
Sodium bicarbonate 100 lb.	2.35 - 2.50	2.60 - 2.85
Sodium bichromate lb.	.07 - .08	.08 - .08
Sodium bisulphate (nitre cake) ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphite powdered, U.S.P. lb.	.05 - .05	.05 - .06
Sodium borate (borax) lb.	.06 - .06	.07 - .07
Sodium carbonate (sal soda) 100 lb.	2.00 - 2.10	2.15 - 2.50
Sodium chlorate lb.	.07 - .07	.08 - .08
Sodium cyanide lb.	.22 - .24	.25 - .30
Sodium fluoride lb.	.12 - .12	.13 - .14
Sodium hydroxide (caustic soda) 100 lb.	3.60 - 3.75	3.80 - 4.00
Sodium hyposulphite lb.		.03 - .04
Sodium nitrate 100 lb.	2.90 -	3.00 -
Sodium nitrite lb.	.06 - .07	.08 - .10
Sodium peroxide, powdered lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic lb.	.04 - .04	.05 - .05
Sodium potassium tartrate (Rochelle salts) lb.		.27 - .28
Sodium prussiate, yellow lb.	.12 - .12	.13 - .14
Sodium silicate, solution (40 deg.) lb.	1.25 - 1.35	1.40 - 1.50
Sodium silicate, solution (60 deg.) lb.	.02 - .03	.03 - .03
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.05 - .05	.06 - .06
Sodium sulphite, crystals lb.	.03 - .04	.04 - .04
Strontium nitrate, powdered lb.	.15 - .15	.16 - .17
Sulphur chl ride, red lb.	.07 - .07	.07 - .08
Sulphur, crude ton	20.00 - 22.00	
Sulphur dioxide, liquid, cylinders extra lb.	.08 - .08	.09 - .10
Sulphur (sublimed), flour 100 lb.		2.25 - 3.10
Sulphur, roll (brimstone) 100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent lb.	.18 - .19	
Tin oxide lb.		.40 - .42
Zinc carbonate, precipitate lb.	.16 - .18	.19 - .20
Zinc chloride, gran. lb.	.11 - .11	.11 - .12
Zinc cyanide lb.	.45 - .49	.50 - .60
Zinc dust lb.	.12 - .13	.13 - .14
Zinc oxide, XX lb.	.08 - .09	.09 - .10
Zinc sulphate lb.	.03 - .03	.04 - .05

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude lb.	\$1.10 - \$1.15
Alpha-naphthol, refined lb.	1.25 - 1.30
Alpha-naphthylamine lb.	.35 - .40
Aniline oil, drums extra lb.	.20 - .25
Aniline salts lb.	.26 - .29
Anthracene, 80% in drums (100 lb.) lb.	.85 - 1.00
Benzaldehyde U.S.P. lb.	1.00 - 1.50
Benzidine, base lb.	.85 - .90
Benzidine sulphate lb.	.75 - .80
Benzoic acid, U.S.P. lb.	.65 - .70
Benzoate of soda, U.S.P. lb.	.65 - .70
Benzene, pure, water-white, in drums (100 gal.) gal.	.27 - .32
Benzene, 90%, in drums (100 gal.) gal.	.25 - .28
Benzyl chloride, 95-97%, refined lb.	.28 - .30
Benzyl chloride, tech. lb.	.20 - .25
Beta-naphthol benzoate lb.	3.50 - 4.00
Beta-naphthol, sublimed lb.	.70 - .75
Beta-naphthol, tech. lb.	.32 - .45
Beta-naphthylamine, sublimed lb.	2.00 - 2.25
Cresol, U. S. P., in drums (100 lb.) lb.	.16 - .18
Ortho-cresol, in drums (100 lb.) lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums gal.	.70 - .80
Cresylic acid, 95-97%, dark, in drums gal.	.65 - .70
Cresylic acid, 50%, first quality, drums gal.	.45 - .50
Dichlorobenzene lb.	.07 - .08
Diethylaniline lb.	1.20 - 1.25
Dimethylaniline lb.	.42 - .55
Dinitrobenzene lb.	.30 - .32
Dinitrochlorobenzene lb.	.20 - .30
Dinitronaphthalene lb.	.30 - .40
Dinitrophenol lb.	.35 - .40
Dinitrotoluene lb.	.25 - .27
Dip oil, 25%, tar acids, ear lots, in drums gal.	.40 - .45
Diphenylamine lb.	.60 - .70
H-acid lb.	1.30 - 1.50
Meta-phenylenediamine lb.	1.15 - 1.20
Monoethylaniline lb.	.12 - .14
Monoethylaniline lb.	1.75 - 1.85
Naphthalene crushed, in bbls. (250 lb.) lb.	.08 - .08
Naphthalene, flake lb.	.08 - .09
Naphthalene, balls lb.	.09 - .10
Naphthalonic acid, crude lb.	.70 - .75
Nitrobenzene lb.	.12 - .15
Nitro-naphthalene lb.	.30 - .35
Nitro-toluene lb.	.16 - .18
Ortho-amidophenol lb.	3.15 - 3.40
Ortho-dichlor-benzene lb.	.15 - .20
Ortho-nitro-phenol lb.	.75 - .80
Ortho-nitro-toluene lb.	.17 - .20
Ortho-toluidine lb.	.20 - .25
Para-amidophenol, base lb.	1.60 - 1.70
Para-amidophenol, HCl lb.	1.75 - 1.80

Para-dichlorobenzene lb.	.15 - .20
Paranitroaniline lb.	.85 - 1.05
Para-nitrotoluene lb.	.85 - 1.00
Para-phenylenediamine lb.	1.95 - 2.00
Para-toluidine lb.	1.25 - 1.60
Phthalic anhydride lb.	.50 - .60
Phenol, U. S. P., drums (dest.), (240 lb.) lb.	.12 - .14
Pyridine gal.	2.00 - 3.50
Resorcinol, technical lb.	1.75 - 1.85
Resorcinol, pure lb.	2.25 - 2.30
Salicylic acid, tech., in bbls. (110 lb.) lb.	.21 - .23
Salicylic acid, U. S. P. lb.	.22 - .24
Salol lb.	.85 - .95
Solvent naphtha, water-white, in drums, 100 gal. gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal. gal.	.14 - .16
Sulphanilic acid, crude lb.	.30 - .35
Tolidine lb.	1.25 - 1.35
Toluidine, mixed lb.	.40 - .45
Toluene, in tank cars gal.	.25 - .28
Toluene, in drums gal.	.28 - .31
Xylidines, drums, 100 gal. lb.	.40 - .45
Xylene, pure, in drums gal.	.40 - .45
Xylene, pure, in tank cars gal.	.45 - .45
Xylene, commercial, in drums, 100 gal. gal.	.33 - .35
Xylene, commercial, in tank cars gal.	.30 -

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark lb.	\$0.23 - \$0.25
Beeswax, refined, light lb.	.25 - .27
Beeswax, white pure lb.	.45 - .47
Carnauba, Flora lb.	.60 - .61
Carnauba, No. 2, North Country lb.	.28 - .30
Carnauba, No. 3, North Country lb.	.17 - .17
Japan lb.	.18 - .18
Montan, crude lb.	.07 - .08
Paraffine waxes, crude match wax (white) 105-110 m.p. lb.	.03 - .04
Paraffine waxes, crude, scale 124-126 m.p. lb.	.03 - .04
Paraffine waxes, refined, 118-120 m.p. lb.	.03 - .04
Paraffine waxes, refined, 125 m.p. lb.	.04 - .04
Paraffine waxes, refined, 128-130 m.p. lb.	.04 - .05
Paraffine waxes, refined, 133-135 m.p. lb.	.06 - .06
Paraffine waxes, refined, 135-137 m.p. lb.	.06 - .06
Stearic acid, single pressed lb.	.09 - .09
Stearic acid, double pressed lb.	.10 - .10
Stearic acid, triple pressed lb.	.11 - .11

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl. 280 lb.	\$5.50 -
Rosin E-I 280 lb.	6.30 - 6.40
Rosin K-N 280 lb.	6.50 - 6.70
Rosin W. G.-W. W. 280 lb.	6.80 -
Wood rosin, bbl. 280 lb.	6.25 -
Spirits of turpentine gal.	.70 -
Wood turpentine, steam dist. gal.	.68 -
Wood turpentine, dest. dist. gal.	.66 -
Pine tar pitch, bbl. 200 lb.	 - 7.00
Tar, kiln burned, bbl. (500 lb.) bbl.	 - 12.50
Retort tar, bbl. 500 lb.	 - 12.50
Rosin oil, first run gal.	.40 -
Rosin oil, second run gal.	.44 -
Rosin oil, third run gal.	.47 -
Pine oil, steam dist., sp.gr. 0.930-0.940 gal.	 - \$1.80
Pine oil, pure, dest. dist. gal.	1.50 -
Pine tar oil, ref., sp.gr. 1.025-1.035 gal.	 - .46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla. gal.	 - .35
Pine tar oil, double ref., sp.gr. 0.965-0.990 gal.	 - .75
Pine tar, ref., thin, sp.gr. 1.080-1.960 gal.	 - .35
Turpentine, crude, sp. gr. 0.900-0.970 gal.	 - 1.20
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990 gal.	 - .35
Pinewood creosote, ref. gal.	 - .52

Solvents

73-76 deg., steel bbls. (85 lb.) gal.	\$0.41 -
70-72 deg., steel bbls. (85 lb.) gal.	 - .39
68-70 deg., steel bbls. (85 lb.) gal.	 - .38
V. M. and P. naphtha, steel bbls. (85 lb.) gal.	 - .30

Crude Rubber

Para-Upriver fine lb.	\$0.17 - .17
Upriver coarse lb.	.11 - .12
Upriver caucho ball lb.	.14 - .14
Plantation—First latex crepe lb.	.18 - .17
Ribbed smoked sheets lb.	.16 -
Brown crepe, thin, clean lb.	.15 -
Amber crepe No. 1 lb.	.17 -

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls. lb.	\$0.09 - \$0.09
Castor oil, AA, in bbls. lb.	.10 - .10
China wood oil, in bbls. (f.o.b. Pac. coast) lb.	.11 - .10
Cocanut oil, Ceylon grade, in bbls. lb.	.10 - .10
Cocanut oil, Cochon grade, in bbls. lb.	.11 - .11
Corn oil, crude, in bbls. lb.	.07 - .08
Cottonseed oil, crude (f. o. b. mill) lb.	.05 - .05
Cottonseed oil, summer yellow lb.	.07 -
Cottonseed oil, winter yellow lb.	.07 -
Linseed oil, raw, car lots (domestic) gal.	.65 - .66
Linseed oil, raw, tank cars (domestic) gal.	.58 -
Linseed oil, in 5-bbl lots (domestic) gal.	.68 - .69

Olive oil, Denatured.....	gal.	\$1.40	—	\$1.60
Palm, Lagos.....	lb.	.07½	—	.07½
Palm, Niger.....	lb.	.05½	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.06	—	.06½
Peanut oil, refined, in bbls.....	lb.	.10	—	.10½
Rapeseed oil, refined in bbls.....	gal.	.86	—	.88
Rapeseed oil, blown, in bbls.....	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07½	—	.....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.04½	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.42	—	\$0.43
Yellow bleached menhaden.....	gal.	.45	—	.....
White bleached menhaden.....	gal.	.48	—	.....
Blown menhaden.....	gal.	.80	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	10.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	10.00	—	.....
Blanc fixe, dry.....	lb.	.05	—	.05½
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.16
Chalk, domestic, extra light.....	lb.	.05	—	.05½
Chalk, domestic, light.....	lb.	.04½	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04½	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	25.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07½	—	.08
Graphite, Ceylon chip.....	lb.	.06	—	.06½
Graphite, high grade amorphous crude.....	lb.	.02½	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.57	—	.....
Shellac, orange superfine.....	lb.	.60	—	.....
Shellac, A. C. garnet.....	lb.	.46	—	.....
Shellac, T. N.....	lb.	.50	—	.....
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	14.00	—	15.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	35.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	1,000	160	.....
Carborundum refractory brick, 9-in.	1,000	1250.00	.....
Chrome brick, f.o.b. Eastern shipping points.....	net ton	80-100	.....
Chrome cement, 40-45% Cr ₂ O ₃	net ton	45-50	.....
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	.....	55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	55-60	.....
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	45-50	.....
Magnesite brick, 9-in. straight.....	net ton	90	.....
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	105	.....
Magnesite brick, soaps and splits.....	net ton	120	.....
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	45-55	.....
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	45-55	.....
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	45-55	.....

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.15	—	.16
Ferrochrome per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.16	—	.17
Ferromanganese, 76-80% Mn, domestic.....	gross ton	82.00	—	85.00
Ferromanganese, 76-80% Mn, English.....	gross ton	82.00	—	85.00
Spiegeleisen, 18-22% Mn.....	gross ton	32.00	—	35.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50	—	.....
Ferrosilicon, 10-15%.....	gross ton	50.00	—	55.00
Ferrosilicon, 50%.....	gross ton	80.00	—	85.00
Ferrosilicon, 75%.....	gross ton	145.00	—	150.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45	—	.50
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	.....
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00	—	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$8.00	—	\$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	45	—	50
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	45	—	50
Coke, foundry, f.o.b. ovens.....	net ton	4.50	—	5.00
Coke, furnace, f.o.b. ovens.....	net ton	3.25	—	3.75
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00	—	16.00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	15.00	—	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00	—	22.50
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.01½
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.25	—	.30
Manganese ore, chemical (MnO ₂).....	gross ton	60.00	—	65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00	—	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.14	—	.14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.14	—	.14
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.13
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.25	—	3.50
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.25	—	3.50
Uranium ore (carnotite) per lb. of U ₂ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₂ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	.....
Zircon, washed, iron free.....	lb.	.03	—	.....

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.75-13.00
Aluminum, 98 to 99 per cent.....	28.00-28.5
Antimony, wholesale lots, Chinese and Japanese.....	5½ @ 5½
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	0.35
Monel metal ingots.....	0.38
Monel metal, sheet bars.....	0.40
Tin, 5-ton lots, Straits.....	33.00
Lead, New York, spot.....	5.00 @ 5.20
Lead, E. St. Louis, spot.....	4.90 @ 5.00
Zinc, spot, New York.....	5.40
Zinc, spot, E. St. Louis.....	4.90

OTHER METALS

Silver (commercial).....	oz.	\$ 60½
Cadmium.....	lb.	1.00-1.10
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.60
Cobalt.....	lb.	4.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00-75.00
Iridium.....	oz.	250.00 @ 300.00
Palladium.....	oz.	65.00 @ 70.00
Mercury.....	.75 lb.	46.00-47.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per Lb.

Copper sheets, hot rolled.....	20.50-20.75
Copper bottoms.....	28.00-28.25
Copper rods.....	19.25-20.00
High brass wire.....	18.25
High brass rods.....	15.25
Low brass wire.....	20.25
Low brass rods.....	20.25
Brazed brass tubing.....	29.00
Brazed bronze tubing.....	34.25
Seamless copper tubing.....	22.00
Seamless high brass tubing.....	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	8.50 @ 9.00	18.50	10.00	10.50
Copper, heavy and wire.....	8.00 @ 8.25	16.50	9.50	9.50
Copper, light and bottoms.....	7.00 @ 7.50	14.50	9.00	8.50
Lead, heavy.....	3.25 @ 3.50	7.25	4.00	4.00
Lead, tea.....	2.15 @ 2.30	5.25	3.00	3.00
Brass, heavy.....	4.25 @ 4.50	9.50	7.00	10.00
Brass, light.....	3.00 @ 3.25	8.00	5.00	5.50
No. 1 yellow brass turnings.....	4.00 @ 4.25	9.50	5.50	6.00
Zinc.....	2.00 @ 2.50	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.50	\$3.23	\$3.23
Soft steel bars.....	2.50	3.00	3.13
Soft steel bar shapes.....	2.50	3.13	3.13
Soft steel bands.....	2.85	3.83	3.78
Plates, ½ to 1 in. thick.....	2.50	3.30	3.23

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

LOS ANGELES—The American Aluminum Products Co., 717 Van Nuys Bldg., recently incorporated, has acquired property aggregating about 5 acres at Burbank, near Los Angeles, a site for the erection of a new plant, to consist of a number of 1-story buildings. Preliminary plans are under way. William E. Dursten is president and Elwell D. Moore representative.

PASADENA—The Kahler Sprinkler & Brass Mfg. Co., 367 South Fair Oaks Ave., will build a 1-story addition to its plant to be equipped as a brass foundry.

RICHMOND—Charles J. Hurrell, New Hampton, Ind., is negotiating with the local Chamber of Commerce for a site for the erection of a new plant for the manufacture of window glass. Mr. Hurrell at one time operated a plant at Sacramento, Cal., but later sold the property. E. M. Downer and H. A. Johnston of the Chamber of Commerce are handling the details of the proposition.

REDWOOD CITY—The American Manganese Products Co. is reported to have purchased the local plant of the Aniline Dye Works, and will continue to operate the property.

WEST BERKELEY—John Lucas & Co., Inc., 322 Race St., Philadelphia, Pa., has acquired the local plant of the Glidden Co., manufacturer of paint, known as the Heath-Milligan unit, and will use the property for a branch plant for the manufacture of paint, varnish, etc.

SAN MATEO—The Minerals & By-Products Co., Denver, Col., is negotiating with the local Chamber of Commerce for a suitable site for the erection of a new plant. J. J. McGrath is president of the Chamber of Commerce and Daniel C. Imboden manager.

Connecticut

NORWALK—Charles H. Harris, president of Charles H. Harris, Inc., is planning for the erection of a new plant on property recently acquired on Main St., for the manufacture of glass for automobile windshield service. It will be 1-story, brick, and is estimated to cost about \$65,000.

NEW HAVEN—The National Folding Box Co. has taken bids for the erection of a new building at its plant on James St. Westcott & Mapes, Inc., New Haven, is engineer.

Delaware

WILMINGTON—The Hercules Powder Co. has received permission from the United States District Court to acquire the physical properties and assets of the Aetna Explosives Co.

Florida

WAUCHULA—W. G. DeVane, Trilby, Fla., and associates are planning for the erection of a new local fertilizer manufacturing plant to cost about \$30,000 with equipment. J. B. Foreman, Vinnea, Ga., is also interested in the project.

CANAL POINT—The Florida Sugar & Food Products Co. has acquired property consisting of about 700 acres of land, and plans for the erection of a large sugar mill.

Illinois

CHICAGO—The Aetna Porcelain Enameling Co., 4701 Augusta St., has broken ground for the erection of a 1-story plant addition to cost about \$10,000, to be located at Augusta St. and Kilpatrick Ave.

Indiana

INDIANAPOLIS—The Standard Oil Co. of Indiana has plans under way for the erection of a new oil refinery at Glenrock. Pressure stills will be installed to handle

the residue from the plant of the Mutual Refining & Producing Co., which is also arranging for plant enlargements. The latter company is a subsidiary of the Elk Basin Consolidated Petroleum Co.

Maryland

FROSTBURG—The Big Savage Fire Brick Co. is planning for the rebuilding of its power plant and other buildings, recently destroyed by fire, with loss estimated at about \$25,000.

FREDERICK—The O. J. Keller Lime Co. has commenced the construction of a new plant for the production of hydrated lime. The machinery will be arranged with individual motor drive. A lime storage building will also be erected. Richard K. Meade & Co., 13 East Fayette St., Baltimore, Md., are engineers for the work.

BALTIMORE—The new local plant of the American Sugar Refining Co., 117 Wall St., New York, now in course of construction, will require about 12 months to bring to completion. It will occupy a site of about 20 acres of land in the heart of the city, and is estimated to cost in excess of \$5,000,000.

BALTIMORE—The American Foundry & Mfg. Co., South St., is planning for the erection of an addition to its foundry; a machine shop will also be built. The extensions are estimated to cost about \$40,000. The company recently increased its capital to \$200,000. John E. Shell, Jr., is manager.

Missouri

KNOB NOSTER—The Johnson County Brick Co., recently reorganized with a capital of \$125,000, is planning for additions in its plant to increase the capacity from 30,000 to 50,000 bricks per day. A number of new kilns will be constructed at the plant, and considerable new machinery installed in the different operating departments. W. J. Mayes is president, and Frank L. Mayes treasurer.

RICHARDS—William E. Willis and W. J. Smiley of this place are organizing a company to build a new oil-refining plant in the vicinity of Springfield, Mo., with initial daily capacity of about 500 bbl. The plant will be erected on the unit type, and is estimated to cost about \$100,000.

SPRINGFIELD—The Forster Mfg. Co., recently incorporated with a capital of \$300,000, is planning for the erection of a new plant for the manufacture of cleaners, polishes and kindred products. The initial daily capacity will be about 15 tons of material. T. E. Forster, Neosho, Mo., is president, and D. D. Neblett secretary and treasurer.

New Jersey

WASHINGTON—The Washington Porcelain Co., manufacturer of electrical porcelain products, has completed the erection of two additions to its plant for increased operations, 50x96 ft. and 20x50 ft. respectively.

NEWARK—The Schenck & Schliete Co., Nesbitt St., manufacturer of paper boxes and containers, has leased a portion of the Quimby Bldg. at 21-39 Division St., totaling about 30,000 sq. ft. of floor space, for the establishment of a new plant.

NEWARK—The Reeves Mfg. Co. has broken ground for the erection of a new 2-story brass foundry at 318-26 Passaic St. to cost about \$12,000. Arthur D. Reeve heads the company. Fitzsimmons & Richards, 207 Market St., are architects.

New York

BROOKLYN—Constant A. Benoit, operating a chemical manufacturing plant on Jerome Ave., has made application to the Board of Appeals for permission to build a new 3-story plant at 1702-18 Avenue Y, corner East Seventeenth St., for the manufacture of colors, enamels, varnishes and kindred products.

BROOKLYN—The Basic Chemical Corporation of America, 77 Seventh Ave., has leased property at 847 Union St. for a period of 5 years for a manufacturing plant.

LONG ISLAND CITY—Mayer & Lowenstein, Vernon Ave. near Bodine St., manufacturer of varnishes, etc., have awarded a contract to M. J. Irwin & Sons, 19 Hulst St., for the erection of a 1-story addition to cost about \$17,000.

NEW YORK—The Cuba Cane Sugar Corp., 117 Wall St., is planning for the erection of a new sugar mill in eastern Cuba, with initial capacity of about 250,000 bags. At a later date extensions will be erected to double this output. The company is now operating 17 estates in Cuba.

NEW YORK—The Talc Products Co., 7 Hanover St., manufacturer of talc, soapstone, etc., is planning for the erection of a new mill in the vicinity of its present plant at Glendon, N. C. The proposed plant will have an initial capacity of about 100 tons of material daily. The company will also open up additional mining properties in this section.

NEW YORK—The International Petroleum Co., 120 B'way, has acquired an island in the Harbor of Barranquilla, Colombia, S. A., on the Magdalena River, as a site for the erection of a new oil refinery, to have a daily capacity of about 25,000 bbl., and which output will be increased at an early date. The company is now building a refining plant about 400 miles up the Magdalena River, to have an initial capacity of 2,000 bbl. per day. It is expected to have this latter plant ready for service at an early date.

Ohio

CINCINNATI—The Rossa-Ratliff Chemical Co. has leased a 5-story building for the establishment of a new plant, replacing its works recently destroyed by fire.

Oklahoma

OKMULGEE—The Okmulgee Brick Co. is perfecting plans for the erection of a new local plant for the manufacture of paving brick and other burned clay products. R. E. Buckles is engineer.

Pennsylvania

PHILADELPHIA—The Crew Levick Co., 111 North Broad St., operating local oil refineries with total capacity of about 80,000 bbl. per month, has arranged for a bond issue of \$1,500,000, a portion of the proceeds to be used for extensions, betterments and general operations. The company is a subsidiary of the Cities Service Co., 60 Wall St., New York.

SCRANTON—Fire May 5 destroyed the plant of the Diamond Paint & Oil Co., Seventh St., with loss estimated at about \$125,000. It is said that the factory will be rebuilt.

Utah

MARYSVALE—The Industrial Potash Corp., Rockford, Ill., recently organized with a capital of \$30,000,000, has plans under way for the erection of a large plant at Marysvale, for the manufacture of potash, fertilizer specialties and affiliated products. Potassium sulphate will be a primary feature of production. The new plant will have a capacity of about 10,000 tons of material per day, and with the development of raw material properties in this section is estimated to cost about \$1,000,000. The company is headed by Jacob H. Krause and Ross P. Beckstrom, Rockford; and Floyd Bergland, Marysvale. It is represented by Louis Grollman, 111 West Monroe St., Chicago, Ill.

Virginia

HOPEWELL—The Hopewell Chemical Co., recently organized with a capital of \$500,000, will soon commence production at its local plant for the manufacture of sodium sulphate and kindred specialties. A new building will be erected at an early date for increased capacity. The residue from nitre lakes near Roanoke, Va., will be used at the plant.

AQUIT STATION—The Fer-Sul Chemical Corp., has had plans prepared by the National Laboratories, 1313 H St., N. W., Washington, D. C., for the erection of a new plant for the production of sulphuric acid; the initial works will have a capacity of about 65 tons.

Washington

SPOKANE—The Western Soap Co., Ltd., has preliminary plans under way for the erection of a new plant at Sinto and Ash Sts. It will be 3-story, 92x100 ft., and is estimated to cost about \$100,000 with machinery. Frank E. Irvine is president and manager.

Capital Increases, Etc.

THE QUEEN CITY BRICK & TILE Co., Cumberland, Md., manufacturer of brick, tile and other ceramic products, has filed notice of increase in capital from \$100,000 to \$200,000.

THE COSMO CHEMICAL Co., Muncie, Ind., has filed notice of dissolution under state laws.

THE UNITED ZINC SMELTING CORP., Eddyville, N. Y., has filed notice of increase in active capital from \$3,000,000 to \$4,000,000, with \$1,000,000 in preferred stock and 60,000 shares of common stock, no par value.

THE VIRGINIA ORES CORP., Lynchburg, Va., has filed notice of increase in capital from \$750,000 to \$1,500,000. S. S. Johnson is vice-president.

THE DECATUR BRASS WORKS, Decatur, Ill., has increased its capital from \$100,000 to \$200,000.

THE BOLIVAR CLAY PRODUCTS Co., Pittsburgh, Pa., has filed notice of increase in capital from \$100,000 to \$225,000.

New Companies

THE LIBERTY LEATHER CORP., Boston, Mass., has been incorporated with a capital of \$150,000 to manufacture leather products. William J. Fallon, Sr., is president; and William J. Fallon, Jr., 938 South St., Roslindale, Mass., treasurer.

THE WONDER CHEMICAL Co., Trenton, N. J., has been incorporated with a capital of \$100,000 to manufacture chemicals and chemical byproducts. The incorporators are Filippo Benedetti and Melchior F. Morton, Trenton.

THE PARAGON REFINING Co. OF NEW YORK, Buffalo, N. Y., has been incorporated with a capital of \$100,000 to manufacture petroleum and other oil products. The incorporators are A. S. Matthews, I. C. Taber and C. A. Ulsh. Kent, Cummings & Means, Dun Bldg., represent the company.

THE ILLINOIS-WISCONSIN CONCRETE PIPE & TILE Co., 112 West Adams St., Chicago, Ill., has been incorporated with a capital of \$50,000 to manufacture concrete products. The incorporators are George B. Harker, A. S. Sorenson and W. C. Whitcomb.

THE LITTLE TAMPICO PETROLEUM Co., Los Angeles, Cal., has been incorporated with a capital of \$1,000,000 to manufacture petroleum products. The incorporators are William A. Meyer, H. H. Everett and Frederick Haas. I. Henry Harris, 1127 Title Insurance Bldg., represent the company.

THE O-JOY CHEMICAL Co., Syracuse, N. Y., has been incorporated with a capital of \$25,000 to manufacture chemicals and chemical byproducts. The incorporators are F. L. Hogan, G. B. Stearns and H. B. Ansell, Burney Bldg.

THE WESTGARD SAW Co., 252 Empire Bldg., Seattle, Wash., has been incorporated with a capital of \$100,000 to manufacture circular saws with high-speed steel insertible teeth. A. D. Cross is secretary and treasurer.

THE SILENT PRODUCTS Co., Elizabeth, N. J., has been incorporated with a capital of \$125,000 to manufacture chemical specialties. The incorporators are Philip P. Scherer, Augustus J. and Welcome W. Bender, 208 Broad St.

THE SOLVENT PRODUCTS Co., Boston, Mass., has been incorporated with a capital of 400 shares of stock, no par value, to manufacture soap, dyestuffs, etc. Charles R. LaRose is president, and Edward W. Dougher, 21 Hyland St., Dorchester, Mass., treasurer.

THE HUDSON CEMENT PRODUCTS CORP., White Plains, N. Y., has been incorporated with a capital of \$200,000 to manufacture cement products. The incorporators are A. D'Elie, L. E. Karle and W. G. Brown, Woolworth Bldg., New York.

THE LYNX SANITARY Co., 116 Market St., Newark, N. J., has filed notice of organization to manufacture chemical products, disinfectants, etc. Lincoln Arndt, 336 Belmont Ave., heads the company.

THE QUAKER CITY LEATHER Co., Philadelphia, Pa., has been incorporated with a capital of \$25,000 to manufacture leather products. C. W. Toebe, 6448 Woodbine Ave., is treasurer.

THE SARDONYX MFG. Co., Dallas, Tex., has been incorporated with a capital of \$50,000 to manufacture soaps and kindred products. The incorporators are J. E. Bryant, E. Morley Page, Dallas; and William H. Herring, Houston, Tex.

THE PENN PAPER Co., Erie, Pa., has been incorporated with a capital of \$50,000 to manufacture and deal in paper products. John F. Young, 604 East Twenty-first St., is treasurer.

THE SPRINGFIELD BRONZE Co., Springfield, Mass., has been incorporated with a capital of \$50,000 to manufacture brass and bronze products. Joseph R. Gould, 125 Ohio Ave., West, is president and treasurer; Robert S. Kneeland and Leonard Johnston are directors.

THE COLONIAL BRICK Co., Calvert Bldg., Baltimore, Md., has been incorporated with a capital of \$50,000 to manufacture brick and other burned clay products. The incorporators are William F. Bell, Edward T. Reisler and Albin Widoff.

THE M. FRENVILLE Co., New York, N. Y., has been incorporated with a capital of \$50,000 to manufacture leather products. The incorporators are M. Frenville, W. J. Delaney and L. G. Bernard. Price & Nathan, 19 Cedar St., represent the company.

THE J. BACH SPECIALTY Co., Secaucus, N. J., has been incorporated with a capital of \$5,000 to manufacture chemicals and chemical byproducts. The incorporators are William Williams, George J. and Jacob Bach, 1170 Paterson Plank Rd.

THE CLIMAX OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are J. L. Hines, H. L. Hazzard, Pasadena, Cal.; and Ernest Richter, Pomona, Cal.

THE INTERSTATE ALUMINUM TRADING CORP., New York, N. Y., has been incorporated with a capital of \$100,000 to manufacture aluminum and other metal products. The incorporators are M. F. Cooperman, S. Kramer and S. Reiter. Davis, Donohue & Deitz, 140 Nassau St., represent the company.

THE TUFHEAD NOVELTY MFG. Co., Bridgeport, Conn., has been incorporated with a capital of \$50,000 to manufacture varnishes, lacquers and kindred products. The incorporators are M. D. Stowe, G. L. Kelley and William Chapman, Bridgeport.

THE FARMERS' MUTUAL PHOSPHATE Co., Nashville, Tenn., has been incorporated with a capital of \$600,000 to manufacture fertilizer products. W. R. Roach, A. Warden and John M. Petty are the incorporators.

THE FEDERAL REFINING CORP., New York, N. Y., has been incorporated under Delaware laws with a capital of \$3,000,000 to manufacture petroleum products. Arthur W. Britton, 65 Cedar St., represents the company.

THE STEINHARDT LEATHER Co., Newark, N. J., has been incorporated with a capital of \$50,000 to manufacture leather products. The incorporators are Lawrence J. Steinhart, 203 McWhorter St.; Andrew Clark and Nathan Bilder.

THE WHITE-KNIGHT CORP., 5 North La Salle St., Chicago, Ill., has been incorporated with a capital of \$250,000 to manufacture metal products. The incorporators are C. L. Sonen, H. Mulvaney and J. D. Maher.

THE HUNTINGTON-PACIFIC PETROLEUM Co., Los Angeles, Cal., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are J. W. LaFrangé and W. A. Davidson, Los Angeles; and James E. Jeter, Glendale, Cal.

THE KANSAUTAUQUA OIL Co. OF BUFFALO, Buffalo, N. Y., has been incorporated with a capital of \$150,000 to manufacture refined oils. The incorporators are J. Volk and W. Stein. Harding & Harding, Buffalo, represent the company.

THE COMBINED MOSAIC & STAINED GLASS CORP., New York, N. Y., has been incorporated with a capital of \$100,000 to manufacture mosaics and other ceramic products. The incorporators are M. Elson, M. A. Barrett and M. Gries. W. E. Foster, 60 B'way, represents the company.

THE MOTOR OIL & REFINING Co., Chickasha, Okla., has been incorporated with a capital of \$50,000 to manufacture refined oil products. The incorporators are R. C. Parks, Duncan, Okla.; R. N. Stroup and B. B. Wofford, Grandfield, Okla.

THE NEW FEDERAL LEAD & ZINC Co., Miami, Okla., has been incorporated with a capital of \$100,000 to manufacture lead, zinc and kindred metal products. The incorporators are W. V. French, A. W. Yakish and J. P. Whatley, all of Nowata, Okla.

THE UNITED CHEMICAL PRODUCTS Co., 500 Temple St., Los Angeles, Cal., has filed notice of organization to manufacture chemicals and chemical byproducts. Thomas Barrabee, 1806 Taberman St., heads the company.

THE ILLINOIS PETROLEUM Co., 217 South Lincoln St., Chicago, Ill., has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture petroleum products. The incorporators are F. Letherstrom, Milton D. Smith and Brewster G. Spink.

THE FULTON LABORATORIES, New York, N. Y., has been incorporated with a capital of \$5,000 to manufacture chemical products. The incorporators are R. J. Pielisch, H. G. Kogen and T. R. Cardenas. Gordon, Winston & Goddard, 799 B'way, represent the company.

THE MARTRESE CORP., New York, N. Y., has been incorporated with a capital of \$10,000 to manufacture refined oil products. The incorporators are E. Moesch, V. A. Roberts and A. W. Palmer, 27 Cedar Street.

New Publications

AMERICAN INDUSTRY IN WAR is the title of the report of the War Industries Board by Bernard M. Baruch.

THE ASSAY OF COAL FOR CARBONIZATION PURPOSES: A NEW LABORATORY METHOD, by Thomas Gray and James G. King; Tech. Paper 1 of the Fuel Research Board, Department of Scientific and Industrial Research, London.

HELIUM: ITS HISTORY, PROPERTIES AND COMMERCIAL DEVELOPMENT, by Richard B. Moore. Reprinted from the *Journal of the Franklin Institute*, February, 1921, by the J. B. Lippincott Co.

POWDERED COAL APPLICATION TO FOUR 2640-HP. BOILERS. Presented before the Mechanical Section, Engineers Society of Western Pennsylvania, Pittsburgh, Pa., by H. D. Savage, reprinted by the Combustion Engineering Corp. and given with its compliments.

USE OF PULVERIZED COAL UNDER CENTRAL STATION BOILERS, by John Anderson, chief engineer of power plants, Milwaukee Electric Railway & Light Co., which has been reprinted and issued by the Combustion Engineering Corp., New York, with its compliments.

THE COOLING OF QUENCHING OIL IN THE HEAT-TREATMENT OF STEEL, by Kenneth B. Millett. Compliments of the Griscom-Russell Co., New York.

NEW BUREAU OF MINES PUBLICATIONS: Bull. 195, Underground Conditions in Oil Fields, by A. W. Ambrose; Bull. 198, Regulation of Explosives in the United States, with Special Reference to the Administration of the Explosives Act of Oct. 6, 1917, by the Bureau of Mines, by Charles E. Munroe; Bull. 205, Flotation Tests of Idaho Ores, by Clarence A. Wright, James G. Parmelee and James T. Norton (this report was prepared in co-operation with the School of Mines, University of Idaho, and the Idaho State Bureau of Mines and Geology; Tech. Paper 228, The Relative Safety of Brass Copper and Steel Gauzes in Miners' Flame Safety-Lamps, by L. C. Hiley and A. B. Hooker; Tech. Paper 246, Water-Gas Apparatus and the Use of Central District Coal as Generator Fuel, by William W. Odell (Illinois Coal Mining Investigations Co-operative Agreement); Tech. Paper 254, The Analysis of Sulphur Forms in Coal, by Alfred R. Powell; Tech. Paper 270, The Detection and Estimation of Platinum in Ores, by C. W. Davis; Tech. Paper 272, Permeation of Oxygen-Breathing Apparatus by Gases and Vapors, by A. C. Fieldner, S. H. Katz and S. P. Kinney; Tech. Paper 280, Accidents at Metallurgical Works in the United States During the Calendar Year 1919, by William W. Adams.

NEW BUREAU OF STANDARDS PUBLICATIONS: Sci. Paper 408, Effect of the Rate of Cooling on the Magnetic and Other Properties of an Annealed Eutectoid Carbon Steel, by C. Nusbaum and W. L. Cheney; Sci. Paper 409, A New Method for the Measurement of Photographic Filter Factors, by Raymond Davis; Tech. Paper 183, Notes on Small Flow Meters for Air, Especially Orifice Meters, by Edgar Buckingham; Tech. Paper 185, Experiments on Copper Crusher Cylinders, by Alexander I. Krynskiy.

NEW UNITED STATES GEOLOGICAL SURVEY PUBLICATIONS: I: 9, Manganese and Manganiferous Ores in 1919, by H. A. C. Jenison (Mineral Resources of the U. S., 1919, Part 1), published April 6, 1921; I: 10, Quicksilver in 1919, by F. L. Ransome, with a supplementary bibliography by Isabel P. Evans (Mineral Resources of the U. S., 1919, Part I), published April 2, 1921; I: 11, Gold, Silver, Copper, Lead and Zinc in California and Oregon in 1919, Mines

Report, by Charles G. Yale (Mineral Resources of the U. S., 1919, Part I), published April 20, 1921; I: 30, Tungsten in 1918, by Frank L. Hess (Mineral Resources of the U. S., 1918, Part I), published March 21, 1921; II: 13, Phosphate Rock in 1919, by Ralph W. Stone (Mineral Resources of the U. S., 1919, Part II), published Feb. 25, 1921; II: 14, Magnesite in 1919, by Charles G. Yale and Ralph W. Stone (Mineral Resources of the U. S., 1919, Part II), published March 7, 1921; II: 15, Sand-Lime Brick in 1919, by Jefferson Middleton (Mineral Resources of the U. S., 1919, Part II), published March 5, 1921; II: 16, Salt Bromine and Calcium Chloride in 1919, by Herbert Insley (Mineral Resources of the U. S., 1919, Part II), published March 26, 1921; II: 17, Fuller's Earth in 1919, by Jefferson Middleton (Mineral Resources of the U. S., 1919, Part II), published March 9, 1921; II: 18, Talc and Soapstone in 1919, by J. S. Diller (Mineral Resources of the U. S., 1919, Part II), published April 14, 1921; II: 19, Mica in 1919, by Herbert Insley (Mineral Resources of the U. S., 1919, Part II), published March 28, 1921; II: 35, Coal in 1918, by C. E. Leshner (Mineral Resources of the U. S., 1918, Part II), published Dec. 6, 1920; II: 37, Coke in 1918, by C. E. Leshner and F. G. Tryon (Mineral Resources of the U. S., 1918, Part II), published April 22, 1921.

Manufacturers' Catalogs

W. W. SLY MFG. Co., Cleveland, O., has issued a new folder, No. 80, describing dust-collecting problems as solved by Sly dust arresters. The company is manufacturing a general line of apparatus for collecting industrial dusts and several of the installations which have been made are attractively illustrated in this publication.

THE BREGEAT CORP. OF AMERICA, New York City, has published a booklet on "The Bregeat Process for the Recovery of Volatile Solvents."

THE METAL & THERMIT CORP., New York City, has issued a booklet entitled "Instruction for the Use of Thermit Welding in Railroad Shops."

THE BOONTON RUBBER MFG. Co., Boonton, N. J., calls attention to a new catalog on "Boonton Bakelite," which is molded material for electrical insulations and for mechanical, chemical and other purposes. Many interesting illustrations are given.

THE JEFFREY MFG. Co., Columbus, O., has received from the press Catalog 257, on Jeffrey Standardized Scraper Conveyors. It features both single and double strand conveyors designed to handle all kinds of loose products in manufacturing and mining industries, power plants, retail coal yards, canning plants, sugar mills and practically all other industries. Instruction, specifications and dimensions are given. Copies will be sent to interested persons upon request.

EDWARD R. LADEW Co., New York, has recently issued two catalogs. "The Proof Book" is a compilation of evidence of the dependability of Hoyt leather belting in service, with a brief discussion of some of the fundamentals of belting economy. The illustrations are from actual installation, showing Hoyt belts in service over various periods up to forty-four years, together with illustrations of a variety of difficult drives. "Ladew Leather Belting" is an 80-page catalog describing the manufacture of Hoyt leather belting from the rough hide to the finished product. Belting rules and tables are given, with a data sheet for analysis of belt drives for highest economy. Belting accessories are also included.

FRANK D. CHASE, INC., Chicago, Ill., announces two new catalogs. "Industry" is the title of one which contains a number of interesting articles, among which there is one by Frank D. Chase on "The Employer's Analysis of an Engineer." "Factories that Fit" is the title of the other publication. The purpose of the book is to convey the Chase conception of sound engineering design in factory construction. Many illustrations are given which show examples of the company's work.

THE PYROELECTRIC INSTRUMENT Co., Trenton, N. J., has issued a price list of apparatus for electrometric and colorimetric determinations of hydrogen ion concentrations.

THE WHITING CORP., Harvey, Ill., has issued catalog 156, on Ladle. The catalog is well illustrated.

THE J. L. MOTT IRON WORKS, New York City, has issued three new catalogs. No. 3-A deals with Metal Melting Pots and Fur-

naces, coal, gas and oil; No. 5 deals with Stills, Vacuum Pans and Condensers; No. 10 is on Acid Eggs, Blow Cases and Filters. Each booklet is well illustrated.

THE THWING INSTRUMENT Co., Philadelphia, Pa., calls attention to Bulletin 19, which treats of Type A thermoelectric pyrometers, both indicating and recording, which are particularly adapted for chemical and metallurgical industries. The booklet is illustrated.

THE DUST RECOVERING & CONVEYING SYSTEM, Cleveland, O., has issued bulletins 12 and 501, the first of which outlines the development of dust-collecting equipment and the second of pneumatic conveying equipment. Bulletin 12 is well illustrated, showing the simplest equipment used in dust recovery together with the Dracco Perfecto, the latest type of dust recovery installation. Bulletin 501 shows the simple practice in pneumatic conveying where some dust may escape through the pump, where air is filtered after passing the pump, where coarse and fine contents are discharged separately and where coarse and fine contents are discharged together. The receiver can be arranged in this system to meet any discharge requirements.

GEORGE J. HAGAN Co., Pittsburgh, Pa., is issuing a new gas producer bulletin describing the Hagan hand-stoked producer and also pointing out the service which the company can render in connection with producer installations, together with interesting illustrations and blue prints. This company has also issued Bulletin LF 101 on Liquid Fuel Burners for open-hearth and other regenerative furnaces. Descriptions and illustrations are given together with blue prints.

THE HARDINGE Co., New York, announces the publication of the sixth of its series of Grinding Data Bulletins. This bulletin presents interesting data on the operation of the large sized Hardinge mills in the mining field, not only where the stage reduction is the custom, but also where the single stage method is in use. The whole series of bulletins embodies information on Hardinge mills and other types of grinders.

THE MINE & SMELTER SUPPLY Co., New York, Denver, Salt Lake City and El Paso, has published Bulletin 64 descriptive of Wilfley concentrating tables. In addition to the generally understood use of these devices in ore treatment, they are recommended for such purposes as the recovery of metallics from refuse in brass foundries and for the washing of inferior coal.

THE YOUNGSTOWN BOILER & TANK Co., Youngstown, O., has issued a 19-page bulletin illustrating and describing Youngstown tanks and showing how standardized size save money. Much other valuable information for tank users is contained in this bulletin.

C. F. PEASE Co., of 813 North Franklin St., Chicago, has issued an attractive new catalog, S-41, for the engineers' surveyors field and office supplies.

W. E. PRINDLE Co., engineer, Columbus, O., in a new catalog illustrates and describes the design and construction of the Prindle driers. In these driers the application of the drying agent, whether it be direct heat, indirect heat or steam-heated air, have been worked out so as to give the best results. Types 10 to 15 inclusive are illustrated and described. General construction of the driers is described together with the guarantee, replacement patents and a note to prospective customers as to what data are required to give quotations, etc.

THE GRISCOM-RUSSELL Co., New York, has issued several new bulletins. G-R Regenerative Compressor is the title of Bulletin 350, which describes and illustrates a unique patented apparatus just placed on the market. This apparatus is designed for installation on Reilly evaporators, self-sealing, and its use during period of reduced evaporator capacity is said to permit evaporator operation at an efficiency much greater than can be secured by the evaporator operating alone, single effect. Bulletin 315 describes the G-R multiscreen filter, a redesign of the Reilly water filter and grease extractor. Bulletin 330 covers the Reilly evaporators, self-sealing, for marine service.

THE CUTLER-HAMMER MFG., Co., Milwaukee, Wis., calls attention to a number of new leaflets and booklets. A four-page leaflet, entitled "C-H Iron-Clad Solenoid," describes electric solenoids for operating brakes, clutches, valves and similar devices where a straight line motion is desired. Electrically operated brakes are described and illustrated in a 16-page booklet, which is known as Publication 850. Publications 875 and 876 are of interest to men of the gas industry. The former is a 12-

page booklet descriptive of the Thomas meter, which is used for measuring large quantities of commercial gases and air, while the latter describes the Thomas calorimeter, which gives graphical records of the total heating values of gases.

THE CHICAGO PNEUMATIC TOOL Co., New York, calls attention to two new publications. Bulletin 639 illustrates and describes BQ-46 hammer drill and Bulletin 607 contains a comprehensive description and several interesting applications of the Chicago pneumatic oil-engine-driven compressors. These machines are built in both stationary and portable types. A comparison of their operating cost versus steam-driven compressors appears on pages 20 and 21.

THE VANADIUM CORP. OF AMERICA, New York, has issued an attractive catalog on Vanadium, in war and peace. The booklet describes and illustrates the many uses of vanadium products.

DE LAVAL STEAM TURBINE Co., Trenton, N. J., has just published "Ten Years Progress in Water Works Pumps." The first half of the book is devoted to a discussion of the economy of different types of pumping units and to a description of notable installations of turbine-driven centrifugal pumps in municipal pumping plants, while the second part of the book takes up the testing of steam turbines and centrifugal pumps and the measurement of head and discharge, which should be of interest to engineers generally. The book will be distributed free of charge to interested persons.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN IRON AND STEEL INSTITUTE will hold its nineteenth general meeting in the Hotel Commodore, New York, on Friday, May 27. There will be three sessions: A forenoon session beginning at 10 o'clock daylight saving time (9 a.m. Eastern time); an afternoon session at 2; and a banquet in the evening at 7.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS will hold its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12, in the Eighth Coast Artillery Armory, New York City.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-eighth annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., the week beginning June 20.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 342 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

The following chemical societies will meet at Rumford Hall, Chemists' Club, New York City, as follows: May 20, Society of Chemical Industry; June 10, American Chemical Society.

CHEMICAL & METALLURGICAL ENGINEERING

H. C. PARMELEE
Editor
ELLWOOD HENDRICK
Consulting Editor
ERNEST E. THUM
Associate Editor
WALLACE SAVAGE
Assistant Editor

A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

ALAN G. WIEGAND
R. S. MCKEIDE
CHARLES N. HILBERT
Assistant Editors
CHESTER H. JONES
Industrial Editor
J. S. NEGRU
Managing Editor

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Number 21

Home Valuation Of Imports

THE framers of the new tariff are seriously considering the advisability of assessing ad valorem duties on American rather than foreign valuation. Although a radical departure from present practice, the proposal is generally looked upon with favor as a practical solution of the difficulties arising out of undervaluation, the chaotic condition of foreign exchange and the widely different production costs in this country and abroad. The foreign market value has been the basis for our ad valorem duties for practically a century and naturally the Government officials are reluctant to sanction a change which might upset the existing routine of customs administration.

It is pointed out, however, that there are many serious objections to our present system. The difficulties in obtaining foreign costs have made it necessary to rely more and more on the purchase price as stated in the importer's invoice. The differences in the costs of production in the various foreign countries have caused the assessment of different duties on the same article when imported from a number of sources. This, it is held, is a discrimination against countries in which costs are high and at the same time a direct concession to the foreign producer with low costs, from whom the domestic manufacturer is most desirous of being protected.

A concrete instance was brought to the attention of the Ways and Means Committee not long ago by HENRY HOWARD, the representative of the Manufacturing Chemists Association. He stated that a certain medicinal of German manufacture was being offered in the United States for 68 cents per pound on which a duty of 25 per cent ad valorem had been paid. This would indicate that the selling price in Germany was in the neighborhood of 55 cents, while at the same time the article was selling in England for \$1.50 per pound. Our duty on the British product would amount to 37.5 cents, or practically three times that imposed on the German. Another objection results from the difference in many countries between consumption and export prices.

Under the existing law duties are assessed on the "actual market value and wholesale price of the merchandise at the time of exportation to the United States, in the principal markets of the country whence the same has been imported" notwithstanding the fact that the imported goods are often purchased at substantially higher export prices.

These objections would be met in a large measure by the adoption of American valuation. In the first place, the value on which the duty is to be assessed would be determined in this country, where our Government has jurisdiction and ample authority, if need be, to compel

the disclosure of the necessary information. Second, under the American valuation plan, all countries would be on a parity with respect to the duties paid. It is claimed that the ultimate consumer will not be burdened through its operation, because in the United States the prices demanded by the high-cost countries operate to fix the prices and the low-cost countries are directly benefited. An indirect advantage, which was pointed out by Mr. HOOVER in his recent testimony before the committee, is that data obtained in the administration of home valuation can be put to the direct benefit of the public by utilizing the information for more accurate indexes of price movements.

Opposition to home valuation has come principally from importing interests which realize that its adoption will tend materially to increase the general level, that is, the amount of ad valorem duties. Others have opposed the plan because of the difficulties in its administration. If the principle is adopted it must be decided whether values are to be fixed at the port of importation or in the principal market or markets of the country, whether the time for appraisement is to be the date of the exportation or of the importation, and finally and what is perhaps of most importance, whether the values determined are to be the prices of imported merchandise or of similar or identical American products.

The action of the Congress will be awaited with interest, for the plan of home valuation, if adopted, must largely depend for its success on the solution of these administrative problems.

Madame Curie Honored By New York Chemists

THE luncheon by the chemists of New York to Mme. CURIE was a very distinguished affair. There were upward of 600 persons present, and it had the quality of an important social event. OSCAR, the *maitre d'hôtel* of the Waldorf-Astoria, had a special conference with the chef, who, for the love of France, gave the preparation his most particular attention, and Dr. EDGAR FAHS SMITH presided. That should be enough to satisfy any potentate! There were four speeches, every one to the point, and every one of the sort that made those present wish for more. Dean PEGRAM of Columbia spoke as a physicist, Dr. MOORE of the Bureau of Mines spoke as a chemist, and Dr. WOOD of the Crocker Cancer Research Institute at Columbia spoke as a physician. Dr. SMITH's introduction was a prose poem, and in conclusion when he introduced the Queen of Science and the musicians played the Polish national anthem it was just a little emotional. Mme. CURIE has been the recipient of many honors since her arrival on our shores, but none, we opine, has been more distinguished and delightful than this.

Occupational Diseases in The Chemical Industries

AT THE Rochester meeting of the American Chemical Society Prof. CHARLES BASKERVILLE of New York presented his report as chairman of the committee on occupational diseases. It contained a great deal of instructive information and was characteristic of all work undertaken by Dr. BASKERVILLE in that it was thorough, well arranged and competently prepared.

The reduction of occupational diseases in the chemical industries during the past year has been due chiefly to the decline in business. Fewer men have been employed. Then, too, the rush and disorder of war time were especially provocative of neglect of details that under ordinary conditions would be severely criticized. For this reason it is noticeable that complaints against chemical works as causing nuisance or injury increased materially as soon as the Armistice was signed. It is recorded, however, that there has been a distinct improvement on the part of chemical manufacturers to safeguard and protect their workers.

The change in the name of methyl alcohol to methanol has been largely adopted, and the committee believes this has had a decided effect in decreasing its use as a beverage. To the uncultivated lay mind alcohol is alcohol, no matter what its front name may be, and when the possessor of such a lay mind wants a drink any old alcohol will do. There occurred lately an incident that bears this out. A miner entered an apothecary's establishment in western Pennsylvania and called for a certain bath alcohol that is advertised as efficacious for the purpose specified, but not to be taken internally. The apothecary asked the miner what he wanted it for. "I want it to drink," he replied, and the apothecary refused to sell it to him. Now the miner had a real thirst, and he knew better; he was going to beat this prohibition business anyway. So shortly afterward a tramp came in with the price to pay for a bottle of the same stuff, and he explained that he wanted to rub it on his knee, which he had sprained. He effected the purchase and, once outside the store, he handed it over to the miner, who immediately pulled the cork and took a grand swig at it. He was really thirsty. But in less than three minutes' time that miner was doubled up over a fence and in the throes of repentance. The denaturant was not deadly; for a time the miner wished it was; but it was only painful. A citizen of that type would not hesitate to drink methyl or propyl or butyl or any other alcohol so long as it bears the alcohol label; on the other hand he would not think of drinking methanol, because that is merely a chemical.

Gas masks are coming into use in industries, but the canisters must be prepared with special adsorbents, depending on the objectionable material present in the air. In some Mexican oil camps gases have killed men and mules and the ordinary gas masks prove useless. The principal trouble was caused by the H_2S , and the difficulty was met by the employment of helmets like those used by divers. There was trouble, however, in inducing the men to wear them.

Tuberculosis appears to be practically non-existent among workers in sulphur dioxide.

Skin troubles were observed to follow wearing khaki cloth produced by certain factories. It is suggested that the presence of some unchanged dinitrobenzene may have caused the trouble, which was met by washing the consequent eczema with a 2 per cent phenol solution.

A disease called "the purples" has been attributed to benzene fumes. This decreases the volume of white corpuscles in the blood so as to destroy the power of coagulation. The patient then bleeds from the mucous membrane and bleeds beneath the skin until death results.

An excellent emollient to protect the skin of users of dope and varnish is recorded taken from Circular 91, Educational Bureau, Paint Manufacturers' Association and National Varnish Manufacturers' Association in the U. S. It consists of lanolin, petrolatum, stearine and glycerine in equal parts by weight, and its use is recommended before starting to work and at the end of a shift, especially when coating compositions containing large amounts of organic solvents or thinners are used. In an important report by Dr. G. A. WELSH, medical officer to H. M. Factory at Gretna, picric acid is recommended as a dressing for acid burns.

In conclusion Dr. BASKERVILLE reported that with the assistance of W. H. PEARCE, librarian of the chemistry department of the College of the City of New York, abstracts of the current literature are now being compiled and that this matter will be available to members of the American Chemical Society.

Suggesting an Exhibit for The American Ceramic Society

IN AN article on "The Condition and Prospects of the British Ceramic Industry," by J. A. AUDLEY, published Jan. 31 in the *Journal of the Society of Chemical Industry*, the author says:

"There is still a demand for fancy goods, but not for inferior yet expensive ware which may be ranged in that class. As the world shortage of supplies gradually becomes satisfied and as international trade relations with Russia, Germany and other countries get restored, the vegetable and mineral exports from those places will have a powerful effect on the prices of similar commodities in America. This in turn will affect the prices of pottery, etc., purchased in America, from this country and elsewhere. It would therefore be wise for manufacturers . . . to concentrate their efforts on lines that are likely to be in continual demand, avoiding particular articles which will not be able to compete with cheaper, similar goods from other countries."

This advice to concentrate on quality in salable goods is sound, but salable goods is a broad term. Generally speaking, however, it means not only durable wares but those that are conceived and designed and wrought in good taste. It is quality that fixes good prices at first, after economic conditions are stabilized, and then, when industry at large meets the problem of quality, it is design which brings good prices and leadership in the market.

We venture the belief that American ceramic manufacturers can take time by the forelock in this respect, and make a step in advance of all others by a little judicious planning. Whether the industry is sufficiently developed here to have a great annual exposition or not we do not pretend to say, but we think it is. It might be initiated in connection with the meetings of the American Ceramic Society, just as the exhibits of the Steel Treathers and Foundrymen are arranged.

In the matter of design, so far as tableware and ornaments are concerned, we suggest that it would be wise to step out of the beaten track a little. The crockery and department store buyers think they know what they can sell and what has the reputation of being in

fashion, but that does not bring ideas into the business. Buyers are among the least imaginative of citizens. So we have a proposition to make; one that may be useless under present conditions, but our mind is open in this respect somewhat in the Scotch sense. We believe the National Academy, co-operating with the Art Division of the American Ceramic Society, would willingly appoint a jury of sculptors and painters to pass on the design of tableware and the like, and to award prizes for the best of each class. Then all such material as had been approved would have a certain *cachet*; it would be known to be in good taste. The exhibit should be broad in scope and include tapestry and face brick, art tiles, faience and all branches of ceramic industry in which expression of good taste in form and color make appeal to those who have the capacity to enjoy it.

Of course it is true that uncultured persons often have the most reprehensible likings and they buy dreadful stuff. The less we know the more certain we are, usually, that we possess that elusive quality which is the very gospel of culture. But most of us, no matter how ignorant we are, are rather sensitive in this respect, and we do not like to be classed among the ignorant. We like to have it said of us that we appreciate the right thing. The prize plates and dishes and also those that are approved would have in this approval a kind of good taste insurance. It might cost considerable for publicity to spread the idea abroad that wares approved by a jury of the National Academy of Design were being made and sold, but we think it would take with the public. The ambition for good taste and culture is so keen as to be no less than pathetic among our people. This would be a way to meet that desire and to get the market.

Science

Vs. Politics

TO UNDERTAKE to compete for the interest of the national professional politician by means of science might at first thought seem foolhardy. Yet science, or more particularly chemistry, is in real need of attention by our national legislators and it appears to be getting increasing attention, consideration and support.

One of the most encouraging signs of this development is the fact that the National Research Council was able to present in the Caucus Room of the Office Building of the House of Representatives the exhibit which has been on display for a short time in the headquarters of the Council. It is a most striking display of the relationship among fundamental science, chemical technology and important industrial developments of our nation. It touches upon problems of the dye industry, explosives manufacture, chemical warfare, nitrogen fixation, coking and byproducts and numerous other related and interrelated industries.

To set forth such an idea before our national legislators in their own office building is particularly fortunate. Perhaps as a result of this the Congressman may feel more at home with and realize more clearly his responsibility to the problems of chemical legislation which confront him. That he has afforded temporary relief to our chemical industries through the Knox amendment on the emergency tariff legislation is not enough, fine as that support may be. There still remain large and pressing questions for answer. It is well that a demonstration of some phases of this large problem can be brought so conveniently before him.

Inconsistencies in

Prices and Wages

WE ARE in the midst of an industrial depression and we are all anxious to see the way out. We have had other industrial depressions, many of them, in the United States, and we have always got out. Not a few books have been written about industrial depressions, and in their historical sections they generally undertake to show the cause of each depression and the cause of its ending. Usually the explanation appeals to the reader. Those who have personal recollection of industrial depressions have a different conception from that presented by the books. Their recollection is that while during a depression the causes thereof were perhaps correctly assigned, the influences that should be expected to end them were not clearly seen. The industrial prophets would tell the public how and when the patient was going to get well. The patient would get well but the causes of his getting well would prove different from those mentioned in the predictions.

It is now being said in some quarters that the present industrial depression is different from those of the past in that now men know precisely what they are waiting for. This may be true and it may not be true, but it is certain that men think they know. They assert and believe that they are waiting for lower commodity prices and lower wage costs, the latter item involving both the rate of payment per day or week and the quantity of service rendered in the day or week.

Assuming then that we are in the midst of a readjustment in prices and wages the completion of which will bring industrial activity and prosperity, the notable phenomenon today is the inconsistency between prices of different commodities and between wage rates for different classes of employment. We see common labor in the iron and steel industry paid as low as 30 or 33 cents an hour, in some cases without overtime payment for hours in excess of eight in the day, against 46 cents an hour in 1920 with time and a half for hours in excess of eight, while we see the artisans in the building trades in many communities demanding wages substantially as high as those paid in 1920 and generally ranging above a dollar an hour.

As to prices, the monthly presentments of the Bureau of Labor Statistics at Washington are presumably authoritative. The weighting of the various commodities to form an index number of "all commodities" at wholesale is partly a matter of judgment, and that need not concern us in this connection. The April index number, just announced, is 154, the 1913 average being 100. It is the inconsistencies between the groups of commodities that are pertinent to the present argument. With 1913 as 100 we have for last month:

Farm products	115
Food, etc.	141
Cloths and clothing.....	186
Fuel and lighting.....	199
Metals and metal products.....	138
Building materials	203
Chemicals and drugs.....	168
Housefurnishing goods	274
Miscellaneous	154
All commodities	154

The people are faced with the condition that housefurnishing goods are 274 while farm products are 115, and that building materials are 203 while metals and metal products are 138. The public is puzzled. Those of the public who are farmers are indisposed to buy at 203 or 274 when they have to sell at 115. The need for readjustment is more pressing than ever.

Readers' Views and Comments

Melting Non-Ferrous Metals

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your March 23 issue M. A. Combs writes a very illuminating article upon the use of gas as fuel in furnaces for melting non-ferrous metals. In this article Mr. Combs, to his own satisfaction, neatly disposes of coke-, coal-, oil- or electrically-heated furnaces for the purpose mentioned, but the figures which he gives were obviously either selected for the purpose in hand or Mr. Combs was unfortunate, or fortunate, depending upon the viewpoint, in obtaining figures from plants employing very poor practice.

Mr. Combs states that "a furnace of 1,000-lb. capacity is used with gas as a fuel in foundries for red and yellow brass in smelting with wonderful results," then goes on to state that such a furnace required forty-two minutes to melt 1,100 lb. of metal, burning 310 cu.ft. of gas per 100 lb., which, figured at \$1.20 per 1,000 cu.ft., costs 37.2c. Also that on yellow brass, using such a furnace, the dross amounted to 3.74 per cent.

By comparison it is interesting to note that in a half dozen plants with which the writer is familiar, using electric furnaces, 2,000-lb. charges of a similar alloy are melted in less than forty minutes with a metallic loss less than 1 per cent and a cost for electric power less than 17c. per 100 lb. of metal melted.

Mr. Combs' statement is noted that in "comparing gas against electricity for melting furnaces the most striking advantage of gas after its economy is the flexibility of the furnace." The writer is familiar with a certain electric furnace installation in which one 2,000-lb. furnace has been used for melting pure copper, brass and bronze alloys, aluminum bronze and gray iron. It is not, however, contended that this wide diversity of alloys could be melted without a change in the refractory lining and I believe that any metallurgist or practical foundryman will readily agree that it would be suicidal to attempt to melt any difficult composition of copper or aluminum alloy on the same hearth as had previously been employed for melting high-lead or high-zinc alloys.

Herewith is offered a melting-cost-sheet taken from the books of a large manufacturer of brass and bronze castings using two rocking electric furnaces for the past thirty months:

STATEMENT OF ACTUAL MELTING COST

(As submitted by a manufacturing company using rocking electric furnaces during 1919-1920)

		Cost per Ton
Alloy melted: 85 per cent copper, 5 per cent tin, 5 per cent lead, 5 per cent zinc		
Power: 280 kw.-hr. per ton of metal melted at 1½c. per kw.-hr.		\$4.20
Electrodes: 3½ lb. per ton at 25c. per lb.		.88
Linings: 1,000 heats at \$200.		20
Labor: One man at \$6 per day	\$6.00	
½ man at \$5 per day	2.50	
	\$8.50	
\$8.50 over 6 tons		1.42
Incidentals: General maintenance, supplies, etc.		.50
		\$7.20
Metal loss:		
0.5 per cent, or 10 lb., per ton at 20c. per lb.		2.00
Total melting cost per ton, 2,000 lb.		\$9.20
Total melting cost per cwt.	\$0.46	

It will be noted that the total cost of melting the alloy shown is 46c. per cwt., which I believe shows sufficient saving over the figures given by Mr. Combs for coal, oil or gas to prove conclusively that the users of

the furnaces which he discusses should immediately take steps, as so many modern industrial plants are doing, to replace their present extravagant melting equipment with the electric furnace.

E. L. CROSBY.

Detroit, Mich.

Effect of Manganese on Malleable Iron

To the Editor of Chemical & Metallurgical Engineering

Sir:—A few words of comment regarding the subject matter of Dr. Leuenberger's article on the effect of manganese on malleable iron, abstracted on page 751 of your issue for April 27, seem worth while.

The abstractor seems to have lost sight of the fact that the work bears no direct relation to the properties of malleable cast iron as made in this country. Both the original German article and your abstract indicate this quite clearly, although the evidence is probably not obvious to those not intimately acquainted with American malleable cast iron.

The table of analyses indicates carbon contents which would under American conditions of annealing result in extremely low tensile strengths. Furthermore, under these annealing conditions, which depend upon the separation of the carbon in the free state and not on its removal, the physical properties of the resultant product would be infinitely more affected by the variations in carbon content than by any moderate variations in manganese. Thus iron with an original carbon content of 3.18 would have a tensile strength of perhaps 38,000 to 40,000 lb. per sq.in., and iron with a carbon content of 2.6 would have a tensile strength of possibly 48,000 lb. per sq.in.

The silicon values quoted are so low that a graphitizing anneal would be practically prevented. The sulphur values are approximately in line with American practice, but both the physical properties and the extremely energetic heat-treatment by which these properties are attained indicate that the annealing has been done by decarburizing and not by graphitizing.

With the American graphitizing anneal those irons having a manganese content of 0.66 and above in the investigator's table would hardly have shown any ductility at all. In fact the results would have been approximately as indicated in the data for the first heat-treatment reported upon. The fact that the ductility increased with subsequent heat-treatments and the strength decreased is an evidence of the further removal of the continued carbon by oxidation. This letter is, therefore, prompted by a desire to point out that those interested in American malleable cast iron should not rashly apply Leuenberger's data to American conditions, as in that manner untold confusion and no useful improvement would result. This confusion between the American and the European practice has already been a source of much vexation in this country, and a further obscuring of the matter is much to be deplored.

May I refer to a series of articles now appearing in the *Iron Trade Review* on American malleable cast iron for a more extended discussion of the difference in principles and practice between American and European malleable plants?

H. A. SCHWARTZ,

Manager of Research,
National Malleable Castings Co.

Cleveland, Ohio.

F. M. Feiker to Join Department of Commerce

F. M. FEIKER, vice-president and chairman of the editorial board of the McGraw-Hill Co., has been appointed assistant to the Secretary of Commerce, with duties and relations of greatest significance to business publications.

Briefly Mr. Hoover has divided the bureaus of the Department of Commerce into two parts. Assistant Secretary Huston will supervise the bureaus relating to navigation and fisheries, while Mr. Hoover will give his personal attention to the bureaus of Foreign and Domestic Commerce, Standards and Census. Mr. Feiker will directly assist Mr. Hoover in the expansion of these bureaus as aids to business.

The immediate problem is to find out what kind of facts and figures industry needs from the Government by means of a series of conferences with the representative men of industry. Having organized the department to function according to the requirements, the next problem is to devise an adequate system of clearing the collected data back to business. It will be apparent at once that with Mr. Feiker's background of engineering training; his viewpoint on the needs of industry and his sense of publicity, he will be in a position to render unusual service in the furtherance of Mr. Hoover's plans.

It is Mr. Hoover's purpose to develop the Department of Commerce so that it will have the same relation to business that the Department of Agriculture now has to the farmer. In other words, he feels that its function is to aid industry, not to regulate or control it. Considering his intimate knowledge of foreign conditions, his masterful grasp of economic principles, and his present official position, a most optimistic view of the developments in prospect is justifiable.

It is well known to those who have been close to the Department of Commerce that Mr. Hoover has been looking all over the country to find a man suitable for the work he has in mind. The invitation, which came to Mr. Feiker first over the long-distance telephone from Washington, was a distinct surprise. The full importance of the position and the opportunities which it offers were not made clear until Mr. Feiker had an opportunity to have a full discussion of the proposed work with Mr. Hoover. It is significant that Mr. Hoover has a keen appreciation of the fundamental service rendered by the business press. Considering the fact that he is the first engineer to have a place in the Cabinet or the Department of Commerce, it is evident that engi-

neers and engineering thought are destined to play a more important part in the business of the country than ever before. Many other developments are making clear that the engineer is taking a new place in the world and industry.

Mr. Feiker is a graduate in electrical engineering of the Worcester (Mass.) Polytechnic Institute, class of 1904. Following his graduation he assisted in special research work in high-tension transmission and generation at Worcester. From 1906 to 1907 he served the General Electric Co. at Schenectady, N. Y., as technical journalist, and in the latter year went with the *System* magazine at Chicago, shortly afterward developing the idea of *Factory* magazine, of which he became managing editor. In 1912 he was appointed chairman of the editorial board of all the A. W. Shaw

publications. He left Chicago in 1915 to join the McGraw organization in New York as editor of *Electrical World*. In the year following he established *Electrical Merchandising*, to supplement and extend the service of *Electrical World* to the industry. In 1919 he was made editorial director of the McGraw-Hill Co., and in January, 1920, was elected vice-president and chairman of the board of editors of its eleven publications.

Mr. Feiker is a member of the American Institute of Electrical Engineers, the American Society of Mechanical Engineers, the American Association of Engineers, the National Electric Light Association, the Illuminating Engineering Society and other technical societies, and is prominent in the committee work of these associations. During 1920 he served as chairman of the Editorial Conference of the New York Business Publishers Association.

He is a member of the Engineers' Club of New York, the City Club, the University Club of Chicago and the Cosmos Club.

Mr. Feiker will not sever his connection with the McGraw-Hill Co., but will be given an indefinite leave of absence.

In a statement of the purposes of his new work, Mr. Feiker said: "I hope to be able to assist Mr. Hoover in the development of the statistical and research branches of the Government in such a way as to provide information and help for the needs of the average business man and the small manufacturer who have neither the opportunity nor the capital to get the information individually. The Government's functions in the collection of fundamental data and trade information can be put to their service in a definite and practical way. I am keenly interested in Mr. Hoover's broad plans to develop the Department as an aid to industry."



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FRED M. FEIKER

Bureau of Mines Cryogenic Laboratory Dedication

THE new Cryogenic Laboratory of the U. S. Bureau of Mines was dedicated by Mme. Curie as a part of the celebration of the visit of this famous scientist to Washington. Addresses were delivered upon this occasion by Secretary Fall, the Director of the Bureau and Dr. R. B. Moore, chief chemist, in charge of the laboratory. Mme. Curie, in addition to delivering the dedicatory address, also pressed the button which set in motion the machinery for the first formal operation of the equipment in the new laboratory. Participating in the affair were the Mme. Curie Reception Committee of Washington, various Government officials and representatives of the Army, Navy and scientific departments of the federal establishments interested.

The new laboratory, which is to be operated under the appropriations of the military departments by allotment by the Helium Board, is to take up the work required for determination of scientific data of fundamental interest, especially in connection with the operation of Government helium plants. The earlier history of this work and the description of the new laboratory equipment is given by the bureau in the following language.

NEED FOR THE RESEARCH LABORATORY

When the helium plants were started in 1918, owing to the pressure in connection with all war undertakings there was no time nor opportunity to do any research work on a small or semi-commercial scale. It was necessary to design and build the plants as rapidly as possible and to do whatever experimentation was required in the plants themselves. Shortly after the two experimental units at Fort Worth were operating, the advisability of research work in connection with the undertaking was plainly seen, and some vapor pressure work was started at the Bureau of Standards under a co-operative arrangement with the Bureau of Mines and the Army and Navy. Last year arrangements were made with Dr. Harvey N. Davis, of Harvard University, and Dr. F. G. Keyes, of Massachusetts Institute of Technology, to do further work along this line, and this is now in progress. There is, however, a distinct addition in having a thoroughly equipped laboratory which is available at all times for research work in connection with the plants and this has been accomplished through the establishment this year in the Bureau of Mines at Washington of a Cryogenic Laboratory. The funds were allotted to the Bureau of Mines last June through the interest of Commander A. K. Atkins, of the Navy, and Colonel C. DeF. Chandler and Lieutenant R. S. Olmstead, of the Army Air Service, and at the present time Lieutenant Commander S. M. Kraus and Major P. E. Van Nostrans are acting for the Navy and Army respectively under the co-operative agreement with the Bureau of Mines.

EQUIPMENT

The equipment is now installed in the new Department of Interior Building at Washington. It consists of two 4-stage Norwalk air compressors, rated at 75 cu.ft. of free air per min. each, compressed to 3,500 lb. per sq.in. at 135 r.p.m. These compressors are driven by two 50-hp. variable speed, 220-volt d.c. motors. These compressors will be used for making liquid air and for obtaining the necessary refrigeration for other purposes. From 15 to 20 liters per hour of liquid air can be obtained. In addition there is one three-stage submarine

type compressor, rated at 28.87 cu.ft. of free gas per min. at 150 r.p.m., compressed to 3,000 lb. per sq.in., and driven by a 15-hp. variable speed, 220-volt d.c. motor; also one three-stage submarine type compressor, rated at 16 cu.ft. of free gas per min. The first one will be used for liquefying hydrogen and the second for a liquid helium cycle. All the compressors have unloading valves so that the capacities can be varied within wide limits.

There are two 300-cu.ft. and one 200-cu.ft. gas holders for holding hydrogen and helium; four smaller holders for storing gas samples; a machine shop equipped with 13-in. engine lathe, bench lathe, shaper, two drill presses, grinders, pipe tools, etc. There are also available one Air Reduction low temperature expansion engine, air and hydrogen liquefiers, and the necessary physical and chemical apparatus to go with the above equipment.

The object of the laboratory is twofold. Its first and main object is to obtain scientific data that will be of use in the operation of the helium plants so as to get more efficient operation and reduce the cost of helium production. Its second and subsidiary use is to furnish facilities to a limited number of American scientists who may be interested in using the laboratory for special low-temperature work, particularly along lines that will not be covered by the technical men of the Bureau of Mines.

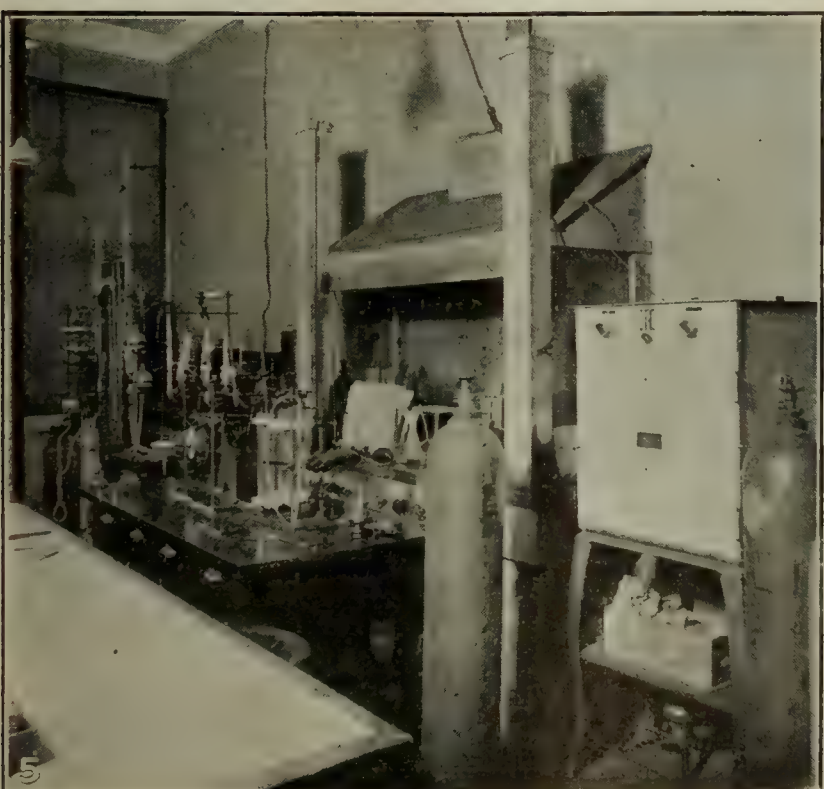
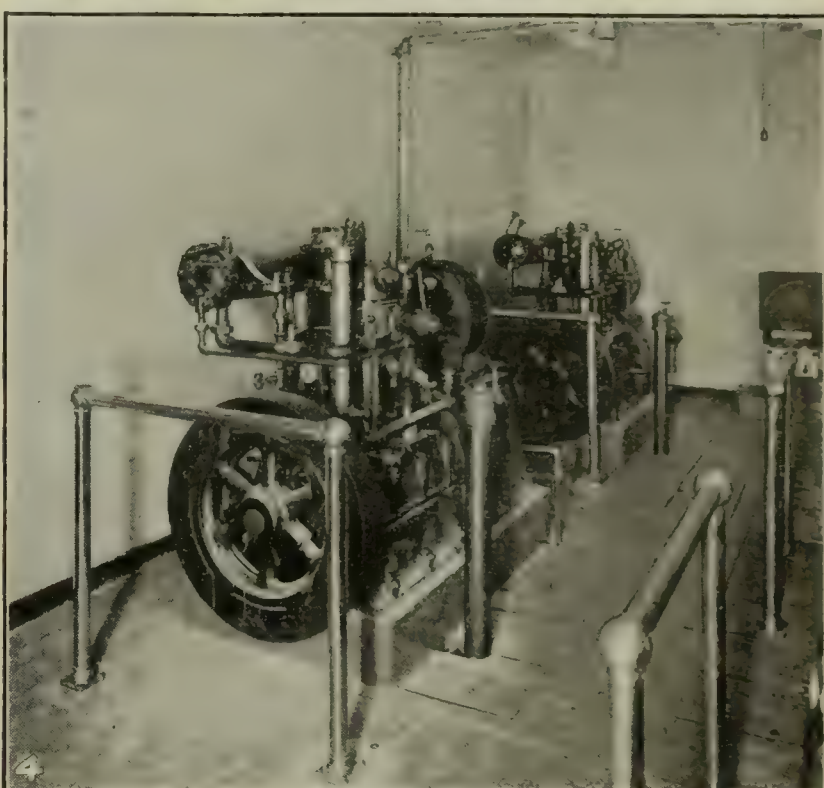
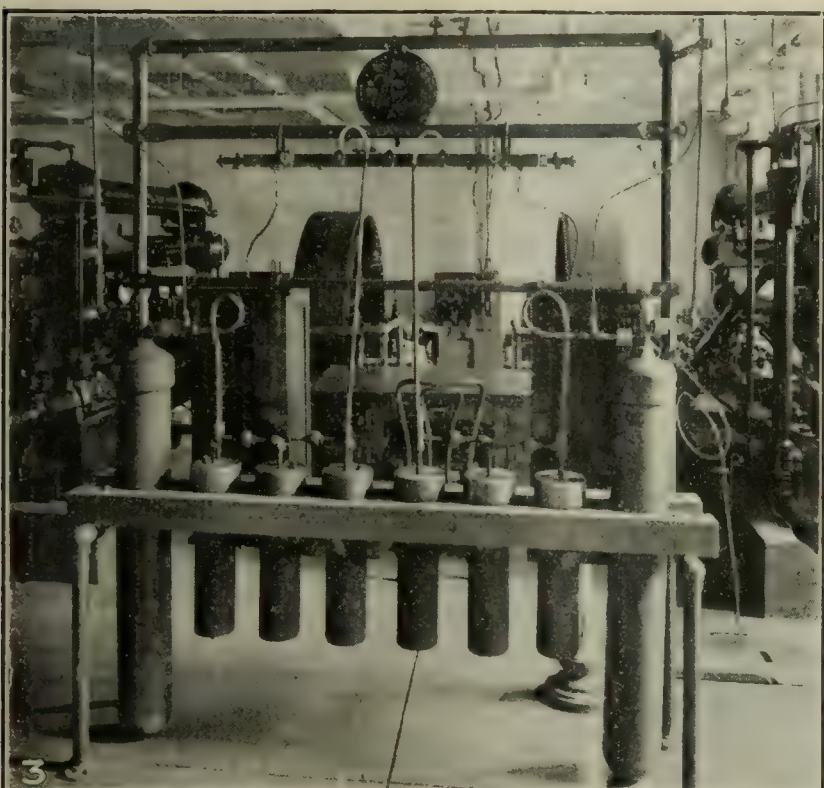
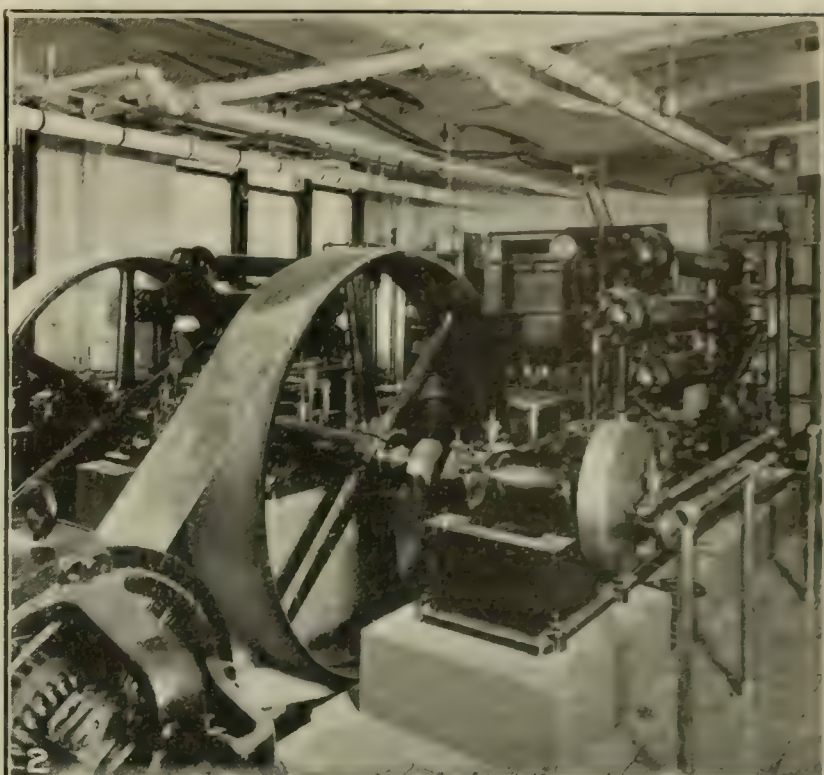
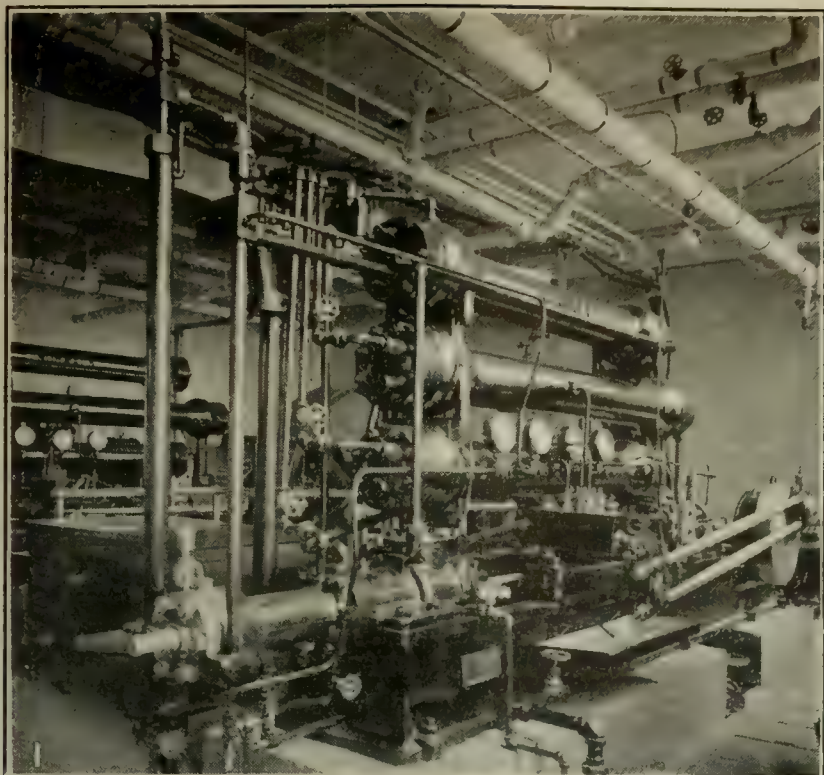
VAPOR PRESSURE STUDIES AND CHARCOAL PURIFIERS

At the present time the work that is being carried on is along two definite lines. First, vapor pressure work in connection with ternary mixtures, and second, in connection with the purification of helium by means of charcoal at low temperatures. It has been found that charcoal at low temperature has a selective action on nitrogen, absorbing this gas, but not absorbing helium, or at least to only a very small extent. This property has been adapted to purifying helium both from nitrogen and from air.

The Army has constructed a repurification outfit on two railroad cars. The first car contains the power plant, and the second car contains the compressors and refrigeration equipment. The Bureau of Mines has been asked to design and install a charcoal repurification unit on this car, and this work is now under way, the equipment being partly constructed in the Cryogenic Laboratory, and the whole will be tested out in this laboratory before installation in the car. If this work is a success it is probable that it will be of sufficient value to install in the production plants also in order to step up the cruder product which is obtained in the plants to 100 per cent helium, which can be obtained by means of the charcoal. The importance of having the higher product is exceedingly great, as a dirigible filled with 100 per cent helium rather than 94 per cent will have a much greater lifting power and also a wider range of operations.

PERSONNEL

This laboratory is under the direct charge of Dr. R. B. Moore, chief chemist of the Bureau of Mines, and the technical personnel consists of J. W. Davis, mechanical engineer, of Cornell University and the University of Illinois; C. W. Seibel, physical chemist, of the University of Kansas; Dr. A. G. Loomis, physical chemist, of the universities of Missouri and California; and Dr. L. Finkelstein, physical chemist, of the Armour Institute of Technology and the University of Chicago.



BUREAU OF MINES CRYOGENIC LABORATORY

Fig. 1. Air compressors.
Fig. 3. High-pressure purifiers.
Fig. 5. Chemical laboratory.

Fig. 2. Air compressors, showing motor drive.
Fig. 4. Compressors for hydrogen and helium cycle.
Fig. 6. Physicochemical laboratory.

Recovery of Volatile Solvents by the Bregeat Process

Descriptive Study of the Application of Phenolic Absorbents — Theoretical Considerations—Equilibrium Curves at 20 Deg. C. Between Cresol and Ether, Ethyl Alcohol, Methyl Alcohol, Acetone and Benzene—Influence of Water Dilution of Absorbent—Operation Data

BY M. ROULLEUX AND ROBERT G. DORT

WHEN a gaseous mixture containing solvent vapor is in contact, for a sufficient length of time, with a certain quantity of an absorbent in a closed vessel, the solvent vapor is partly absorbed from the gaseous mixture into the absorbent. The partial pressure of the solvent vapor in the gaseous mixture decreases, while the vapor pressure from the solvent in the enriched absorbent rises from zero up to the point where the vapor tension of the solvent in the absorbent and the partial pressure of the solvent vapor in the gaseous mixture meet at the same value. There is thus reached a state of equilibrium, which is characterized by two factors: The concentration of the solvent vapor in the gaseous mixture (which is a direct function of the partial pressure of the solvent vapor in the gaseous mixture), and concentration of the solvent in the absorbent.

A good absorbent must show a high ratio between the concentration of the solvent in the liquid phase (i.e., in the absorbent) and the concentration in the gaseous phase when the system is at equilibrium. It is obvious that the higher this ratio the lower the amount of solvent vapor remaining in the gas, other things being equal.

This ratio can be expressed in an experimentally

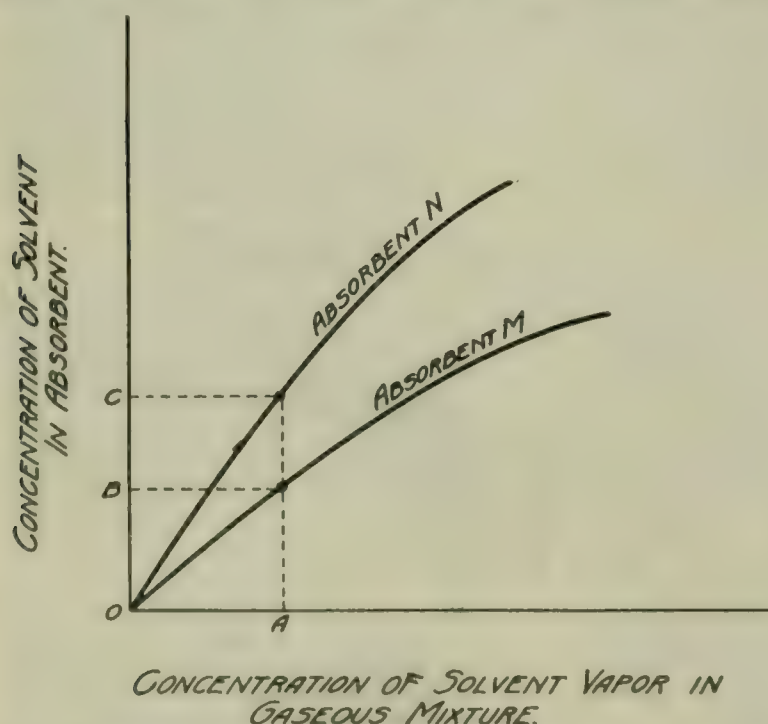


FIG. 1. GENERAL REPRESENTATION OF THE ABSORBING POWERS OF TWO ABSORBENTS

determined curve (see Fig. 1) giving one concentration as a function of the other under equilibrium conditions. For illustration, two arbitrary curves marked "Absorbent M" and "Absorbent N" have been drawn. If OA represents the concentration of solvent vapor in a particular gaseous mixture, then the highest possible concentrations of the solvents in Absorbents M and N are represented respectively by OB and OC. The ratio

OC : OB represents the superiority of Absorbent N over M so far as absorption is concerned.

ABSORPTION BY PHENOLIC ABSORBENTS

The advantage of employing as a liquid absorbent one consisting essentially of phenols was discovered, first appreciated, patented in France, the United States, Germany and elsewhere, and first put into industrial use by J. H. Bregeat.

In the commercial and industrial application of the Bregeat process for solvent recovery, crude cresol is generally used, containing, for example, about 97 per cent phenolic products. Such crude cresol is, in general, a mixture of three isomeric cresols, $C_6H_4CH_3OH$ (ortho, meta, para), obtained from coal distillation.

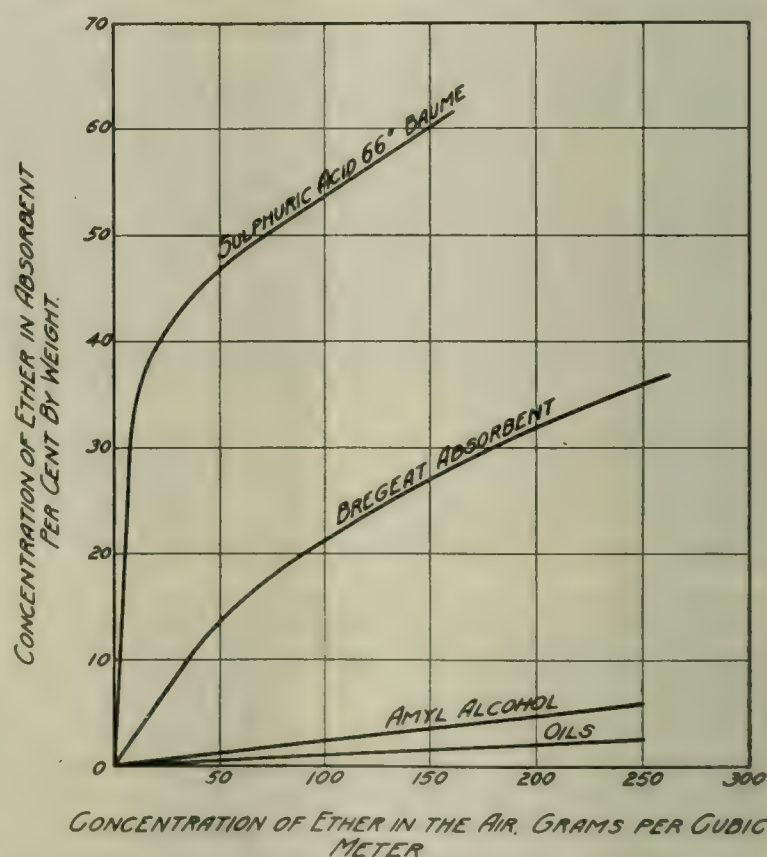


FIG. 2. ABSORBING POWER OF VARIOUS ABSORBENTS FOR ETHER AT 20 DEG. C.

The industrial absorbent employed usually contains about 35 per cent ortho cresol, 40 per cent meta cresol and 25 per cent para cresol, and distills between 190 and 220 deg. C. The specific gravity of this absorbent is about 1.04; the specific heat is about 0.6.

The concentrations which may be reached by the use of the cresols as absorbents for several industrial solvents are illustrated in the figures.

In Fig. 2 curves have been drawn showing the absorbing powers¹ for ether of 66 deg. Bé. sulphuric acid, Bregeat absorbent (cresols), amyl alcohol and petroleum

¹Copied from a report from the French "Ministère de la Guerre, 6e Direction, Poudres" entitled "Etude Théorique sur Différents Procédés de Récupération des Vapeurs Ethero-Alcooliques en Atmosphère Diluée."

oils. (All curves are based on observations at 20 deg. C.) The seeming superiority of concentrated sulphuric acid as an ether absorbent is marked. This superiority is, however, only apparent and is negated by numerous serious objections and industrial inconveniences, as will be briefly explained hereinafter. These curves for ether absorption show clearly the superiority of the cresols over amyl alcohol and oils as absorbing mediums. It might be added that the use of amyl alcohol is ruled out by its extremely toxic effect on the workmen and by its prohibitive price.

Fig. 3 shows the curve indicating the absorbing prop-

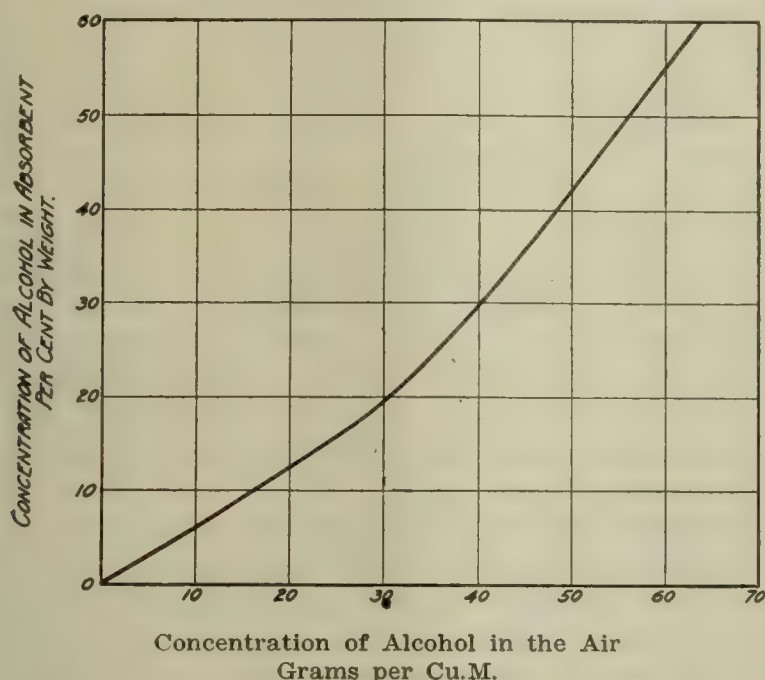


FIG. 3. ABSORBING POWER OF THE CRESOLS FOR ETHYL ALCOHOL

erties¹ of the cresols for ethyl alcohol. It will be noted that as the concentration of alcohol vapor in the gaseous mixture rises, the possible concentration of alcohol in the cresols rises very rapidly. It is proper to conclude that the cresols are very good absorbing media for ethyl alcohol.

Fig. 4 shows the curve for the absorption¹ of benzene by the cresols.

Fig. 5 represents curves showing the concentrations of such pyroligneous solvents as acetone and methyl alcohol in a gaseous mixture, and the possible concentration of these solvents in the cresols. This application will become important in the wood distillation (wood charcoal) industry.

It is of interest to note that the solvents represented in the curves represent a wide range of industry. Ether is used, for instance, in the manufacture of artificial silk and smokeless powder. Ethyl alcohol is used in the manufacture of artificial silk, gas mantles, artificial leather, celluloid, smokeless powder, and is probably lost in considerable amounts from the vats of fermentation plants. Benzene is used particularly in the manufacture of artificial leather and rubber goods; the possibilities of more complete recovery of benzene from coke-oven gas are large. Acetone and methyl alcohol are used, for instance, in the manufacture of films, airplane dopes, explosives and lacquers.

INDUSTRIAL ABSORPTION

In industrial practice the liquid absorbents have the important advantage of allowing the carrying out of the absorption on the countercurrent principle, in which both gaseous mixture and absorbent are made to flow in intimate contact with each other in opposite direc-

tions. By the use of this principle equilibrium between the concentrations of the solvent in the absorbent and in the gaseous mixture is no sooner approached than conditions are mechanically changed in such a way that further absorption is required in order to approach equilibrium again. That is to say, a certain particle of absorbent which has approached equilibrium with the gas surrounding it is being constantly and mechanically moved forward into a new gaseous mixture where the concentration of the solvent vapor therein is higher than in the previous position. As a result of this change the particle of absorbent must pick up more solvent vapor from the gaseous mixture before equilibrium is again approached. When the absorbent leaves the scrubbing apparatus the concentration of the solvent in the absorbent corresponds practically to the maximum obtainable from the gaseous mixture entering the apparatus, provided the scrubbers have been correctly designed. When the gas leaves the scrubbing apparatus it has just been in intimate contact with fresh absorbent, this resulting in the absorption from the gaseous mixture of practically the last traces of solvent vapors, again provided the scrubbing apparatus is correctly designed.

This results in the possibility of obtaining the highest possible concentration of the solvent in the absorbent, together with practically complete absorption. Moreover, this principle allows the reduction of the size of the scrubbing apparatus—i.e., the wetted surface of the scrubbers—to a minimum, other things equal.

Any liquid absorbent theoretically allows obtaining a complete absorption. It is only a question of using a sufficient flow of absorbent in a scrubbing apparatus of sufficient size. But a poor absorbent will lead to the use of a large flow of liquid together with large scrubbers, while a good absorbent allows the reduction of both absorbent flow and apparatus size. From this

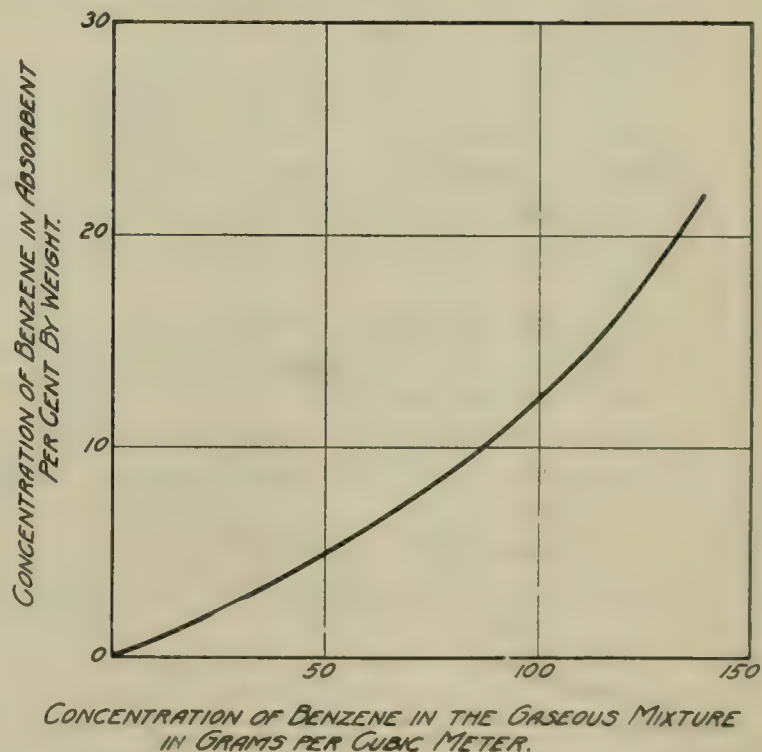


FIG. 4. ABSORBING POWER OF THE CRESOLS FOR BENZENE

point of view the cresol absorption curves (see Figs. 2, 3, 4 and 5) show the advantage of this absorbent, but they do not bring out any of the other advantages of the cresols as absorbents.

The importance of these other advantageous properties is emphasized by the disadvantageous properties of sulphuric acid. The absorbing power of sulphuric acid

for ether and alcohol (as shown in Fig. 2) has attracted many. But up to the present sulphuric acid has failed to prove a commercially good absorbing medium, because its high absorbing power is its only advantageous quality. All its other properties are constant sources of inconvenience. The industrial handling of a large quantity of sulphuric acid requires lead or lava containers, piping, scrubbers, etc. The absorbing power of sulphuric acid is greatly lowered by the presence of water in the air treated. Furthermore, after stripping, the previously diluted sulphuric acid must be reconcentrated, which also prevents the process from being continuous. The sulphuric acid process, moreover, does not always

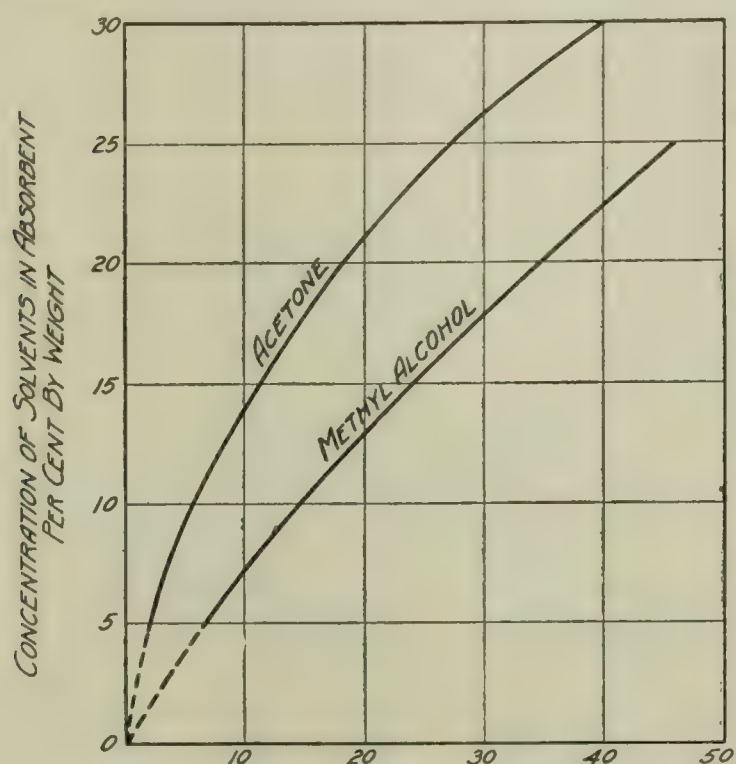


FIG. 5. ABSORBING POWER OF THE CRESOLS FOR ACETONE AND METHYL ALCOHOL

return the absorbed solvent in its original state—ether is partially transformed to alcohol, for example.

All this shows why the Bregeat process has always been able to establish its superiority over the sulphuric acid process whenever there has been a fair competition between them.

Besides its high absorbing power, the Bregeat absorbent has many other advantages, among which the following may be mentioned:

The cresols have no corrosive action whatsoever on the usual apparatus materials, such as steel, copper, brass and concrete.

Large variations in the concentration of the solvent vapors in the gaseous mixtures—a condition generally found in solvent recovery problems—do not affect the efficiency of the Bregeat absorbent; that is to say, there seems to be a distinct hysteresis effect in the evolution of solvent vapors from the cresols at ordinary temperatures and pressures (though this may be the case with other absorbents to a lesser degree). The reduction in the concentration of the solvent vapors in the cresols seems to follow only with a considerable lag the reduction in the concentration of the solvent vapors in the gaseous mixture above it. This means that when the Bregeat absorbent, concentrated to a certain point in solvent, comes into contact (always assuming normal temperature and pressure) with a gaseous mixture much less concentrated in solvent vapor than that which has

previously surrounded it, the cresylic absorbent does not at once attain equilibrium by losing, to a certain extent, its absorbed solvent.

This hysteresis (lag) effect would go some way toward explaining the remarkable success which the use of the Bregeat absorbent has had in treating gaseous mixtures, the concentration of which in solvent vapors varies very suddenly and through wide ranges. For instance, in one of the Bregeat industrial plants the concentration of ether alcohol in the gaseous mixture being scrubbed varied from zero to 50 g. per cubic meter within five-minute intervals, and sometimes more often. Fig. 6, which shows the varying concentration² of ether-alcohol vapor in the gaseous mixtures from presses manufacturing smokeless powder (Poudre "B"), illustrates clearly the type of gaseous mixtures which the Bregeat process handles very successfully.

The observation of this hysteresis effect supports the opinion that the absorption of various solvents by the cresols involves something more than mere solution. Some kind of a molecular association or complex, easily broken down by heat, seems to result. Full and accurate data on this point are still lacking. Certain indications³, however, aside from the hysteresis effect, do seem to tend toward the idea that something more than simple solution takes place.

The cresols also have the important property of not being greatly affected by the absorption of water vapor. Under average plant conditions (humidity) the cresol will not absorb more than 2 per cent of water from the air. The small effect that this amount of water has upon the absorbent effect of cresol for ether, for instance, is shown² in Fig. 7. In fact in industrial practice

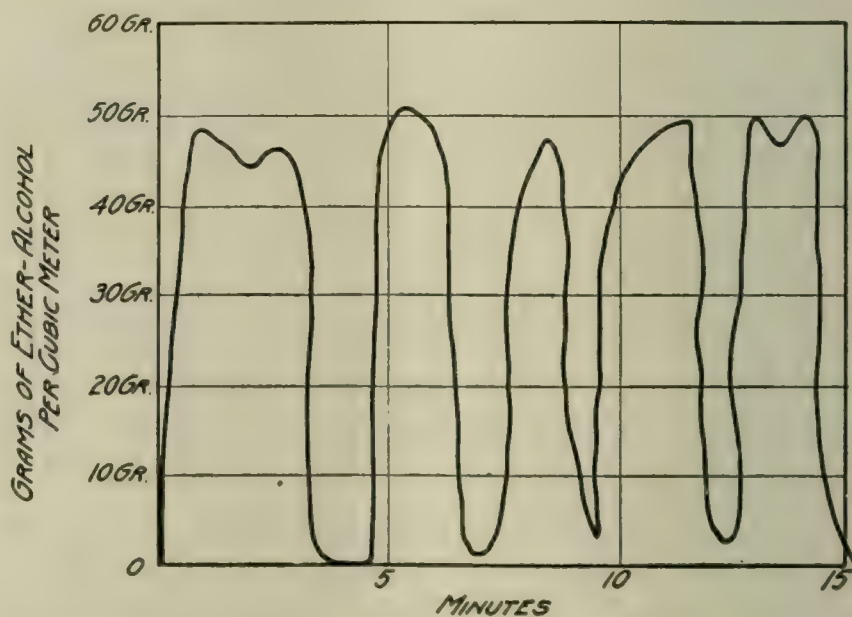


FIG. 6. CONCENTRATION OF ETHER-ALCOHOL IN GASEOUS MIXTURES ESCAPING FROM "B" POWDER PRESSES

small amounts of water are sometimes added to the cresols in order to create a condition which is very favorable for stripping.

The cresols are good absorbents for many different

²Copied from a report from the French "Ministère de la Guerre, 6^e Direction, Poudres" entitled "Etude Théorique sur Différents Procédés de Récupération des Vapeurs Ethero-Alcooliques en Atmosphère Diluée."

³In *J. Am. Chem. Soc.*, vol. 9, pp. 1949-1977 (September, 1917), in a paper by Messrs. Hatcher and Skirrow, dealing primarily with compounds of phenol and cresol with pyridine, it is stated (p. 1953) that when the molecular weight of ortho and para cresol dissolved in benzene is determined by the freezing point method, their molecular weights are found to be smaller than the formulas would indicate. In explanation of this phenomenon the authors state: "Possibly this may be due to combination with the solvent" (benzene). It is also stated in this paper that the same phenomenon has been observed by Amwers, (*Z. physik. Chem.*, vol. 12, p. 689, 1892).

substances used as solvents. This property is of utmost importance in those solvent recovery problems where several kinds of solvents are used simultaneously, successively or in different operations.

The vapor tension of cresol at ordinary temperatures is very low. This means that under average industrial conditions the gas leaving the scrubbers carries only a trace of cresol vapor.

The cresols easily lose their absorbed solvents when heated up to a temperature which never needs to be over 150 deg. C. This temperature is conveniently obtained by the use of steam, at 100-lb. pressure.

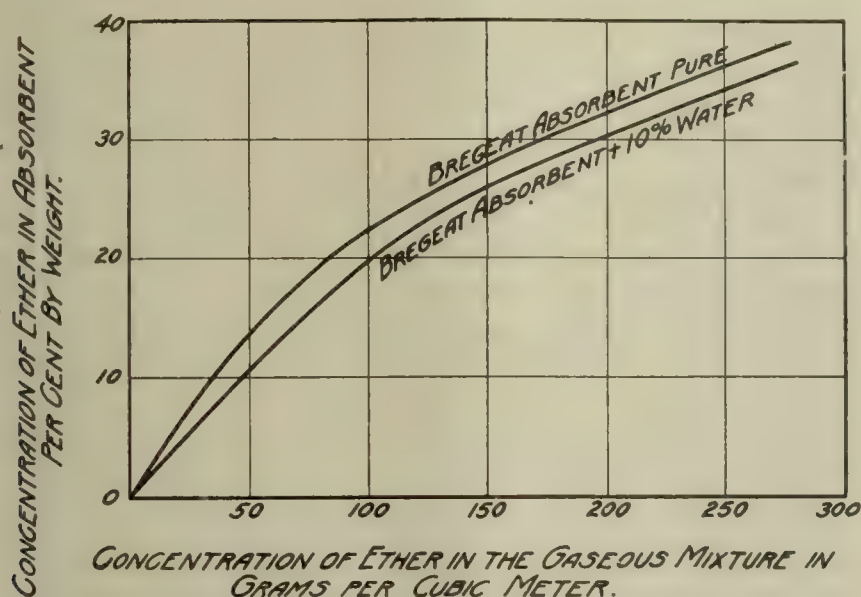


FIG. 7. INFLUENCE OF WATER UPON ABSORPTION

The Bregeat absorbent returns the solvents absorbed therein without alteration and in about the same proportion as that in which they were absorbed.

INDUSTRIAL APPLICATION

Besides the use of a new absorbent the Bregeat process involves the continuous operation of a very efficient apparatus. The Bregeat apparatus is, in many respects, similar to that employed in the debenzolization of coal gas. It (the Bregeat apparatus) has been designed for the employment of cresol to realize the special advantageous properties of this absorbent. In some cases where the solvents have to be separated from one another or from water (if one or more solvents are miscible therewith), the equipment is completed by a continuous rectification apparatus from which these solvents are automatically obtained in the desired state of purity. The types as well as the proportion of the various pieces of apparatus have been carefully studied in view of obtaining the maximum efficiency (percentage recovered) together with the minimum first cost and minimum operation cost.

The general operation of a Bregeat installation is shown schematically in Fig. 8. This diagram is typical of the system, although conditions in each individual installation govern the design of the scrubbing apparatus, and to a greater extent that of the rectification apparatus. In detail, the Bregeat process, as represented in Fig. 8, is as follows:

COURSE OF THE AIR-SOLVENT VAPOR MIXTURE

The course of the air-solvent vapor mixture is indicated on Fig. 8 by arrows with dotted shafts. The air-solvent vapor mixture enters the system at the base of the second scrubber, rises through this scrubber, meeting the descending absorbent. From the top of the second scrubber the air-solvent vapor mixture goes to the bottom of the first scrubber, rises through this, meeting the descending fresh absorbent. From the top of the first scrubber the air, now deprived of all solvent vapors, is discharged into the atmosphere.

COURSE OF THE ABSORBENT IN THE SCRUBBERS

The course of the absorbing liquid is indicated in Fig. 8 by arrows with solid shafts. The absorbent stored in the absorbent storage tank marked "Fresh Absorbing Liquid" is pumped to the top of the first scrubber, where it descends, meeting the rising air-solvent vapor mixture already partly deprived of its solvent vapor by scrubbing in the second scrubber. From the bottom of the first scrubber the absorbent is taken to a pump, whence it is raised to the top of the second scrubber. In this scrubber the gaseous mixture containing the solvent vapors is met by the down-flowing absorbent as in the first scrubber.

COURSE OF THE ABSORBENT IN THE STRIPPING APPARATUS

From the bottom of the second scrubber the absorbent, now containing the solvent, is raised by a pump to the regulating tank. (This regulating tank is connected with a pipe marked "Overflow" through a pipe line leading to the absorbing liquid tank. This is only for use should some stoppage occur in the absorbent line beyond the regulating tank.) From the regulating tank the absorbent goes to the heat exchanger, where it is partly

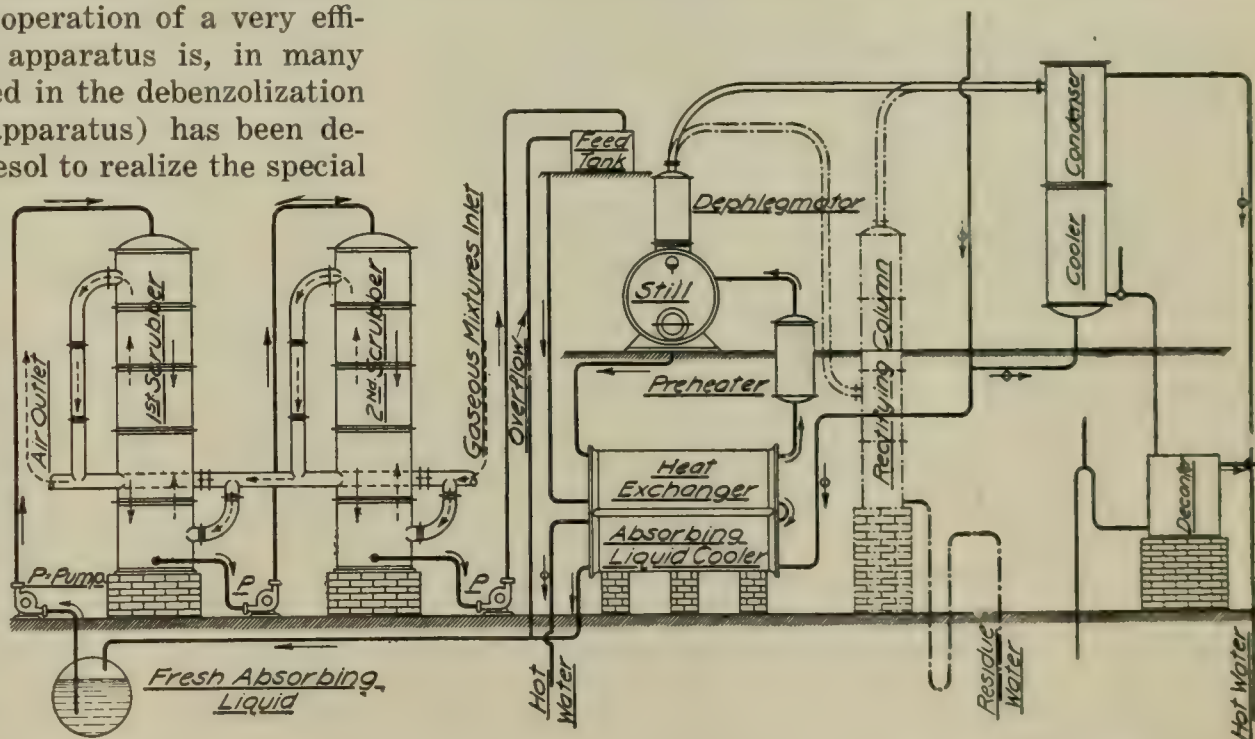


FIG. 8. FLOW SHEET OF THE BREGEAT SOLVENT RECOVERY SYSTEM

heated by hot absorbent coming from the stripping still. From the heat exchanger the absorbent goes to the preheater, where it is heated to about 150 deg. C. by steam coils. From the preheater the absorbent goes to the stripping still (marked "Still" on Fig. 8), where it is heated further. The solvent vapors are driven off from the absorbent here. The absorbent, now freed of solvent vapors, and hot, flows down through the heat exchanger, where it heats the cool, fresh incoming

absorbent. From the heat exchanger the partly cooled absorbent goes to the "Absorbing Liquid Cooler," where it is cooled to about room temperature and thence it flows to the absorbent storage tank.

COURSE OF THE SOLVENT VAPOR STRIPPED FROM THE ABSORBENT

From the stripping still the solvent vapors go to the dephlegmator, where a certain amount of separation and rectification takes place. From the dephlegmator the solvent vapors go either to a continuous rectifying column—if the solvent is miscible with water or if there are several solvents to separate from one another—or to a condenser, then to a cooler, and then to a decanter, if the solvent is not miscible with water. If a rectifying column is used, the vapors from the rectifying column pass into the condenser, whence their course is the same as in the case of the solvents condensed without rectification.

Temperature- and pressure-recording devices, as well as test glasses and test pet cocks, are placed throughout the system.

On Fig. 8 the course of cooling water is indicated throughout by an arrow with an "o" midway up the shaft.

INDUSTRIAL RESULTS OBTAINED BY THE BREGEAT PROCESS

The Bregeat process was discovered and developed industrially in France during the war. At that time the inventor directed all his activity toward the war industries (manufacture of smokeless powder and application of airplane dope), which opened up a very large field for the process. In France alone the consumption of alcohol

for smokeless powder attained a figure of about 20,000 tons per month; the consumption of various solvents for airplane dopes (benzene, ethyl acetate, acetone, methyl alcohol, etc.) attained a figure of 550 tons per month in the middle of 1918.

The first industrial apparatus for the recovery of volatile solvents by means of the Bregeat system was started at the beginning of 1917 at the powder works of Sevran (near Paris). This apparatus, which was built at the expense of the inventor, was furnished only with very lean gaseous mixtures, taken from the atmosphere of the workrooms without any collecting devices whatsoever. In fact the concentration was about 5 g. of ether-alcohol per cubic meter of gaseous mixtures—a very low figure. At the same time at Sevran there was being tried out a process for the recovery of solvent by sulphuric acid (Barbet) and another process by compression-refrigeration (G. Claude).

The Bregeat process proved so successful that the French Government decided to equip all French powder works with it. Table I shows the dates of erection of the various Bregeat plants in France and in England during the war. It will be seen from the dates of putting into operation that little time was lost after the successful Sevran tests that demonstrated the worth of the process. In England sixteen sulphuric acid recovery units were discarded and replaced, or were in the course of being replaced at the time the armistice was signed, by the Bregeat process in various English explosives works.

Since the war contracts have been signed in France, Belgium, England and Germany with film works, coke works, artificial silk works, artificial leather works and explosives works for the recovery of solvents by the

TABLE I. VARIOUS FACTS ABOUT BREGEAT SOLVENT RECOVERY PLANTS IN ENGLAND AND FRANCE DURING THE WAR

Name and Location of Bregeat Plant	Kind of Solvents Recovered	Process From Which Solvents Were Evolved	Conc. (g. per cu.m.) of Solvent Vapor in Mixture	Date of Putting Into Operation	Actual Recovery Over Certain Periods
Sevran (France)—(Test apparatus).....	Ether-alcohol.....	Manufacture "B" Powder.....	5	End of 1916.....	February, 1917—421 kilos
Sevran (France).....	Ether-alcohol.....	Manufacture "B" Powder.....		Oct. 12, 1917.....	Total to Nov. 15, 1918: Ether 303,-901 liters, alcohol 47,280 liters
Ripault Ancienne (France).....	Ether-alcohol.....	Manufacture "B" Powder.....	8 to 10	Dec. 19, 1917.....	Total to Nov. 15, 1918: Ether 963,-750 liters, alcohol 230,034 liters
Ripault Nouvelle (France).....	Ether-alcohol.....	Manufacture "B" Powder.....	8 to 10	Feb. 21, 1918.....	Total to Nov. 15, 1918: Ether 526,-106 liters, alcohol 110,357 liters
Toulouse Braqueville (France).....	Ether-alcohol.....	Manufacture "B" Powder.....	8 to 10	July 6, 1918.....	Total to Nov. 15, 1918: Ether 275,-557 liters, alcohol 58,968 liters
Pont de Buis (France).....	Ether-alcohol.....	Manufacture "B" Powder.....	8 to 10	Aug. 30, 1918.....	Total to Nov. 15, 1918: Ether 160,-012 liters, alcohol 19,754 liters
Toulouse Empalot (France).....	Ether-alcohol.....	Manufacture "B" Powder.....	8 to 10	Oct. 22, 1918.....	Total to Nov. 15, 1918: Ether 39,-052 liters, alcohol 4,527 liters
St. Medard Ancienne (France).....	Ether-alcohol.....	Manufacture "B" Powder.....		Under construction at armistice.....	
St. Medard Nouvelle (France).....	Ether-alcohol.....	Manufacture "B" Powder.....		Under construction at armistice.....	
Bergerac (France).....	Ether-alcohol.....	Manufacture "B" Powder.....		Under construction at armistice.....	
Pyrotechnie Maritime de Toulon (France).....	Acetone, Alcohol.....	Manufacture of Explosives, Lacquering of shells.....			
Voisin-Paris (France)—(Commercial plant).....	Acetone, MeOH Methyl acetate.....	Doping of airplane wings.....	8 5	Completed Nov. 11, 1918	
Gretna (Scotland)—(Government plant).....	Ether-alcohol.....	Manufacture of cordite.....		Dec., 1917	First month 1918: Ether 1,439,375 liters, alcohol 2,158,414 liters
Misk (England)—(Commercial plant).....	Ether-alcohol.....	Manufacture of cordite.....		1918	First month 1918: Ether 1,446,167 liters, alcohol 1,857,942 liters
Ardeer (England)—(Commercial plant).....	Ether-alcohol.....	Manufacture of cordite.....		1918	First month 1918: Ether 1,275,588 liters, alcohol 1,497,201 liters
Pembrey (England)—(Government plant).....	Ether-alcohol.....	Manufacture of cordite.....		1918	First month 1918: Ether 451,559 liters, alcohol 476,946 liters

Bregeat process. Several of these plants are now operating or in the course of being put into operation, among which the following may be mentioned: Pathé Frères, Vincennes (France), (film manufacture); Mines de Carmaux (France), (debenzolization of coke-oven gas); Michaut-Masson, Clichy (France); Jenatzy-Leleux, Brussels (Belgium), (both above manufacturers of coated fabrics); Obourg (Belgium), (manufacturers of artificial silk by the collodion process); Caulille (Belgium), (explosives); Leto-photo, Edgeware, Middlesex (England), (film).

The gaseous mixtures treated in these plants are often very lean—of a concentration of only about 8 to 15 per cent per cubic meter—and in some cases these gaseous mixtures are subject to large fluctuations in concentration of solvent vapor, frequently in very short periods of time.

OPERATION DATA ON THE BREGEAT PROCESS

The accompanying facts and figures (Table II) taken from an official report of the French Government on the operation of the Bregeat process at the explosives works of Ripault (near Tours, France) are given as an illustration of the operation of the Bregeat process in France.

The volume of gaseous mixtures treated was about 12,000 cu.m. per hour at average room temperature. The concentration of ether-alcohol vapors in the air averaged 8 to 10 g. per cubic meter; with regard to this it is to be noted that these gaseous mixtures were taken from the vicinity of the presses and mixing machines, the rich mixtures from the drying ovens being treated by a condensation process already installed. In normal and continuous operation about 90 per cent of the ether-alcohol vapors entering the Bregeat apparatus were re-

TABLE II. CONSUMPTION OF ELECTRICITY, STEAM, WATER AND ABSORBENT PER KILO OF ETHER-ALCOHOL RECOVERED AT RIPAUT (EXPLOSIVES WORKS), TOURS, FRANCE

Items	First Period Consumption	Second Period Consumption	Third Period Consumption	Fourth Period Consumption	Average Consumption
Labor, hr.	0.0116	0.0144	0.012	0.0196	0.144
Electricity, kw.-hr.	0.111	0.13	0.104	0.1694	0.1286
Steam, kilos.	4	7.34	4	4	4.835
Water, cu.m.	0.12	0.2	0.16	0.28	0.19
Absorbent, kilos.	0.085	0.113	0.092	0.149	0.11

covered separately in the liquid form as 65 deg. Bé. ether and 96 deg. Gay-Lussac alcohol, both immediately re-employable in the manufacture.

In Table II the consumption of steam, water, electricity, absorbent and the amount of labor required are set forth.

In 1917, when this Ripault plant was built, the first cost of installation for the recovery of approximately 2,500 kg. of ether-alcohol per twenty-four hours was about 150,000 f. Figuring the interest on this sum at 10 per cent and with an addition of 4 per cent per year for taxes, insurance and maintenance, the resultant average net operating cost per kilo of solvent recovered for Ripault was 0.337 f. per kilo.

The Ripault (Ancienne) apparatus, described above, was one of the earlier and smaller recovery installations. The Bregeat installations in many of the other explosives works in France and in England were much larger. At Gretna there was the largest solvent recovery system in the world, which, although not designed by the

Bregeat engineers, utilized the Bregeat absorbent. And even under the far from favorable conditions obtaining there, the Bregeat system was so satisfactory that the sulphuric acid process was replaced elsewhere in England.

SUMMARY

The history of solvent recovery is one of individual effort, unco-ordinated endeavor, and delusion. Until the Bregeat process had been developed solvent recovery was not an industry by itself. The Bregeat process is responsible for bringing solvent recovery out of the class of an incidental and casual art into that of an independent and well-established business. This is due to the fact that it is the first solvent recovery process to be general in its application.

No longer does the American manufacturer consider the resources of the country inexhaustible. Competition is growing increasingly severe. Conservation of existing materials, recovery or recuperation of materials previously wasted are acquiring rightfully an ever more important place in industry. In the United States, where many manufacturers utilize and to a large extent lose volatile solvents, the opportunity is obviously large for an industrially proved solvent recovery process, one which applies to all cases, such as the Bregeat process.

Pig Iron Production in France

France's production of pig iron before, during and since the end of the war, has been as follows:

	Tons
1913	5,207,197
1916	1,447,000
1917	1,684,000
1918	1,297,000
1920	3,317,371

Of this 3,289,318 tons was made with coke and 28,053 tons in electrical furnaces.

The distribution of this production according to the various types of pig iron before the war and at present is as follows:

	1920 Tons	1913 Tons
Cast iron	797,939	953,683
Refined pig iron	275,153	532,003
Bessemer pig iron	76,289	124,336
Basic pig iron	2,050,129	3,508,837
Special cast iron	117,861	88,328

According to the estimates of industrial engineers, when France has completed the work of reconstruction and is again able to turn to the normal development of her industries, she will be able to produce 11,000,000 tons of pig iron per annum, or 282 kilos per capita, as compared with 132 kilos in 1913.

In 1913 France consumed 5,144,000 tons of pig iron. In 1920 she consumed 2,993,371 tons.

France's exports and imports of pig iron in 1913 and 1920 were as follows:

	1913 Tons	1920 Tons
Exports	148,000	306,000
Imports	70,000	132,000

Alsatian Potash Production During 1920

The total production of Alsatian potash during 1920 reached 1,061,197 tons, according to statistics received from the office of the commercial attaché, Paris. Of this amount 450,000 tons was sold in France, 327,000 tons was exported to the United States, 117,000 tons to Belgium, and 92,000 tons to the United Kingdom.

Ductile Electrolytic Nickel*

An Outline of the Experimental Work on the Electrolytes, Cathodes and Anodes Leading to the Production of Electrolytic Nickel of Greatly Improved Mechanical Properties

By CHARLES P. MADSEN†

THE general failure to produce alloys for electrical heating purposes by metallurgical means which would come outside of the patent situation developed in 1916¹ led to the conception that a better type of resistance alloys and armors for heating units could be made by electrodeposition. It was believed that nickel or cobalt would be the best major ingredient and it was taken for granted that disclosed processes for making heavy deposits of these metals produced the results claimed. A few trials, however, soon showed this belief concerning nickel to be an error. In some cases claimed results of the inventor could not be reproduced, while in others a heavy deposit could be obtained only once in the same electrolyte, and in all cases the metal produced was mechanically very imperfect and became even more brittle after heating.

Attention was then turned to cobalt, and better results were obtained but not perfect enough to warrant the added cost. A more thorough review of the nickel art was then made and research instituted for determining the factors governing the production of heavy and mechanically perfect deposits of nickel.

All known baths were tried and particularly was Dr. O. P. Watts' review² followed carefully. The work has occupied a period of over five years, during which time several thousand deposits of $\frac{1}{2}$ in. (0.8 mm.) thick and over have been made. It has, however, been carried out largely by empirical methods, and sufficient data have not yet been obtained for formulating the physical factors on a scientific basis. However, practical results have been produced, which appear worth while recording at this time.

This paper is therefore intended only as a report of the general work done and how the result was obtained, and it is hoped that the physical data can be standardized at an early date and be made the subject matter of a subsequent paper.

ELECTROLYTES

The early work was concentrated upon the electrolyte, and the results were so erratic and inconstant that the following general conclusions were drawn:

First. The usefulness of any nickel electrolyte can be determined only after its entire metal content has been replaced from the anode.

Second. No conclusion can be drawn from deposits less than 0.01 in. (0.25 mm.) thick.

Third. Reports of results with any electrolyte are of no value, without knowing the exact analysis of the anode used.

It was found that no electrolyte would entirely fulfill the first condition with any type of commercial anode, and the results were therefore variable. The so-called 97-98 per cent cast anodes containing manganese were found to deteriorate the bath most rapidly, while anodes of the same nickel percentage containing tin performed little better and introduced the difficulty of forming metastannic acid under certain conditions. On the other hand, it was found that while the so-called 92-96 per cent cast anodes containing iron maintained the bath nearly constant, although their efficiency was rarely 100 per cent on their nickel content, the large amount of ferric hydrate caused considerable difficulty in making heavy deposits. It was also found that the ratio of the anode to cathode surface was more important than usually supposed and was apparently a function of the anode composition. It was in all cases necessary to have from two to five times greater anode surface than that of cathode, and in some cases from ten to fifteen times.

ANODES

Attention was then turned to the use of relatively pure nickel metal as anodes. Some investigators state that pure nickel is passive, while others claim good results with its use as anodes. Imported pure nickel made by Fleitman³ and Pfanstiehl were tried, also hot-rolled nickel and electrolytic nickel made by the International Nickel Co., as well as domestic so-called cold-rolled malleable nickel. In these cases it was found necessary to have some chloride present, but a limit was found beyond which any further chloride addition did not improve the result in each case. The imported pure nickels performed fairly well for a time, but became passive in a variable and most exasperating manner without apparent cause. The hot-rolled material was always more passive in the same electrolyte than either of the imported pure nickels or any of the cast anodes, and also varied in its performance. Hammond⁴ and Mathers⁵ report the successful use of International electro-nickel as anodes, particularly after annealing, but the annealing methods are not described. It was found that such material unannealed was even more passive than either the imported pure nickel or hot-rolled; annealing always improved their action, but different methods produced different results. Electro-nickel annealed in an atmosphere of CO dissolved with an efficiency of about 95 per cent and did not turn passive as readily as either pure material, but sufficiently so as to cause pitting. Its use for heavy work was, however, furthermore rendered impractical,

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¹Marsh patent, No. 811,859.

²Transactions, Am. Electrochem. Soc. (1913), vol. 23, p. 99.

³Vereinigte Deutsche Nickel Werke. *Chem. News*, 1879, vol. 40, p. 67.

⁴Transactions, Amer. Electrochem. Soc. (1916), vol. 30, p. 103.

⁵Transactions, Amer. Electrochem. Soc. (1916), vol. 29, p. 383.

because of the fact that the anodes dissolved irregularly, producing a sort of lace structure which readily crumbled, causing thereby a loss of from $\frac{1}{4}$ to $\frac{1}{2}$ of the anode and making the cathode deposit very rough unless the anodes were held in bags. The domestic so-called cold-rolled malleable nickel performed the best of any nickel tried, particularly with the proper amount of chloride present in the bath. It dissolved with an efficiency of about 97 per cent when free from passive portions. This type of anode was therefore used exclusively in the subsequent three years of this investigation. The average analysis of this material is as follows:

Ni	95.30
Fe	2.13
Cu	0.25
Mn	0.33
C	0.30
Si	0.23

Dr. Langbein⁶ and others report the use of rolled anodes extensively in Europe, and state that their alkali- and acid-forming characteristic is the reverse of that of cast anodes. It is not clear why this should be so, and the statement has been questioned. It was, however, carefully checked and found to be correct, and furthermore the ratio at which a neutrality balance is maintained was found to be very exact. It was found that when the anode is 1.77 times the area of the cathode, the bath will remain relatively neutral for long periods of time. Any increase of anode surface over this turns the bath acid and any decrease turns it alkaline, provided, however, the anode is free from passive portions. Unfortunately, however, such portions were often present, in which case the bath would always turn acid. Sodium sulphonate alizarin was used as an indicator for this purpose. Using these anodes, the general conclusions on electrolytes were as follows:

ADDITION AGENTS IN THE ELECTROLYTE

Nickel-ammonium sulphate is never an advantage over nickel sulphate as a metal carrier. A little alkali metal salt, however, should be present. The addition of conductive salt, as magnesium sulphate, etc., permits of a higher current rate, but the baths are not stable and reliable. The addition of citrates and other organic compounds diminishes the amount of sludge and favors the production of smooth and bright metal, but such baths are exceedingly unstable and the metal produced is always more brittle and cannot be carried to the same thickness as in the same electrolyte without the addition agent.

It has been reported by others that while a nickel electrolyte should be nearly neutral some free hydrogen ions are necessary. This was found to be correct and that boric acid is the best carrier of such hydrogen ions. It is necessary to have some chloride present, but a bath consisting of nickel chloride only would not produce perfect metal even when containing boric acid. It was found that nickel chloride was best and Dr. Watts' bath was finally adopted as standard for most tests. This bath has, however, recently been modified and addition agents introduced.

Warming the electrolyte is an advantage in all cases, but usually little improvement was obtained above 55 deg. C.

With this modified bath, using the cold-rolled nickel

anodes described, many deposits upward of $\frac{1}{4}$ in. (1.6 mm.) could be made in succession, but they were not fully malleable, nor would they stand heating without becoming more brittle, and they often contained pits and other mechanical imperfections.

ELIMINATION OF BRITTLINESS

Other investigators have shown that the embrittlement of electrolytic nickel and perhaps pits are caused by hydrogen. Various means were tried for eliminating hydrogen. It was found that agitating either mechanically or by air resulted in no benefit, but often instead resulted in a much rougher deposit. Various manipulations of the cathode, as shaking and striking, were tried, but without benefit, and it was observed that the hydrogen bubbles would immediately return after removal. Brushing the cathode mechanically was tried, and it was found that while the deposits thus produced possessed a mirror-like smoothness, they were even harder and more brittle than those produced without brushing.

Since one object of this work was the production of armors for electrical heating units, the deposits were made on objects which were supposed to simulate the character of surface which such a heating unit would possess for coating. These objects were glass tubes about $\frac{3}{8}$ in. (9.5 mm.) in diameter and 3 in. (7.5 cm.) long. They were prepared for deposition by the well-known silver-fire process. Several hundreds of these were made and one reason for adhering to their use was the observation that in addition to determining the limits of the thickness by the deposit bursting open, it would often happen that a deposit would build up thick and develop sufficient strain to crush the glass. In this way data could be obtained on those deposits which did not peel or crack open.

The use of these glass tubes as cathodes, however, led to a discovery in a peculiar way. If the deposit cracked open it would nearly always do so along the bottom, and would often occur a considerable time before being observed. In the anxiety to save time and to detect the crack as soon as formed, the cathodes were often jerked out of the bath quickly in order to inspect the bottom of the tube for cracks and then reimmersed. Since it is taught in the art that interruption of current or removal of the cathode will result in laminated deposits, a careful record of these removals was kept and when a large number of cathodes were studied the surprising fact was disclosed that all those which had been subjected to this removal for observation were both much thicker and much more malleable than others, almost regardless of other conditions. A cathode was then made which was removed and re-inserted quickly every few minutes for twenty-four hours. This was found to be by far the most perfect deposit produced.

TIME FACTORS FOR THE PERIODS OF EXPOSURE AND OF DEPOSITION

The time factors were then determined for both the period of exposure and the period of deposition. It was found that, contrary to former beliefs, the cathode removal, if not over fifteen seconds in duration, produced no laminated deposits, but instead, homogeneous and highly ductile deposits. It was also found that the frequency of removal necessary for producing the best results depended upon the factors of deposition influencing the formation of hydrogen, such as anode efficiency, temperature, acidity and current density.

⁶"Electrodeposition of Metals," 7th Ed., p. 273.

⁷Transactions, Amer. Electrochem. Soc. (1916), vol. 29, p. 395.

With the improved bath mentioned above, operating at 55 deg. C., with a current density of 72 amp. per sq.ft. (8 amp. per sq.dm.), it was found that with 97 per cent commercial cast anodes, this necessary frequency of removal or deposition period was thirty seconds to one minute, while with the cold-rolled anodes it was about one to five minutes. An automatic device was then constructed for carrying out this operation, and all of the sample deposits made at the Bureau of Standards and which were exhibited at our last Atlantic City meeting were made by this means.

PHYSICAL PROPERTIES

A physical study of the metal so produced showed that it possessed a far higher degree of ductility than was expected, even exceeding that of any nickel heretofore produced. It was found to have a slightly lower electrical resistivity but a slightly higher density. It was, furthermore, found that the deposited metal could be heated red-hot either before or after rolling without embrittling it. Wires have been drawn from a bar $\frac{1}{8}$ in. (3 mm.) in diameter down to 0.002 in. (0.05 mm.) without annealing. This new nickel, however, develops considerable hardness and increase in tensile strength upon rolling or drawing. The tensile strength of the deposited metal is about 72,000 lb. per sq.m. (50 kg. per sq.mm.), while the wire mentioned above showed a strength of 250,000 lb. per sq.in. (175 kg. per sq.mm.). The Brinell test of the deposited metal is about 130, while that of metal which has been rolled from a plate $\frac{1}{8}$ in. (3 mm.) thick to $\frac{1}{16}$ in. (0.75 mm.) is about 150 Brinell, and it is still malleable. Tests with the Ericsson machine showed a drawing ability better than that of ordinary hard-rolled brass or copper and about equal to dead soft copper.

The average analysis of this new electrolytic nickel is:

Ni	99.70
Fe	0.01
Cu	nil
C	0.02

CAUSES OF PITS

A contemplation of the general utility of a metal of such remarkable properties in the face of certain war demands caused relegation into the background of the original object of producing electric heating or resistance units, and we concentrated instead upon the development of production of sheet metal and of various intricate forms as dies, molds, etc., for industrial purposes. It was soon found, however, that while the metal produced by the means outlined above was highly ductile, it was not always mechanically perfect. The principal trouble was pits of various types, which would appear and disappear in the most exasperating and unaccountable manner. Much has been written concerning the nature and cause of pits in nickel plating, but without any permanent remedy having been found. The last two years of this work were therefore devoted, more or less, to an investigation into the cause and remedy of pits. Many old means were tried for their elimination but without good results.

It was found that small solid particles would cause imperfections, but that the type of pits most troublesome was not so caused. It was also found that excess of air in the electrolyte, which has been shown to be a cause of producing pits in the electrodeposition of lead¹ was not a primary cause, although its presence might

exaggerate the pits if the primary cause were present. The influence of the exact degree of neutrality with relation to solvent acid hydrogen ions was also studied, and it was found that while more hydrogen was generated and a less malleable metal made in an acid bath, this condition is not the primary cause of pits, but will only exaggerate them, if the primary cause is present. The primary cause of pits was finally traced to inherent characteristics of the anode.

PRODUCTION OF PITLESS METAL

The metallurgy and refining of nickel was then studied and several hundred different kinds of anode castings were made. A new anode composition was finally found which, when used with the hydrogen elimination process, produces pitless metal continuously and without diminishing the metal concentration of the bath. It was furthermore found that for reasons which are not altogether clear this anode causes the generation of so small an amount of hydrogen that the necessary frequency of cathode removal is decreased from every five minutes to every two hours.

Many castings have been made which require a removal only every ten or fifteen minutes and will make pitless metal up to $\frac{1}{2}$ in. (0.75 mm.) thick, while a few casts have been made which require removal only every two hours and pitless cathodes have been made with these up to $\frac{1}{8}$ in. (3 mm.) thick. Indications are that the perfection of these anodes will enable the production of pitless metal of any thickness even without the hydrogen elimination process.

It is thought best to defer the disclosure of this anode until it is fully developed and standardized on a commercial basis.

Killing Molds on Lumber by Steaming*

Molds thrive on the surface of wood when it is moist and warm. In a dry kiln molds often develop on the surface of the lumber to such an extent that they seriously obstruct the circulation of air through the pile. This is such a decided hindrance to successful kiln drying that steps must be taken to prevent the mold growth. Various experiments have been made to find a means of accomplishing this result without injury to the lumber.

The safest method found of stopping the growth of mold on lumber in a kiln is to steam the stock at 170 or 180 deg. for a period not exceeding an hour. This treatment heats the surface of the stock sufficiently to kill the mold, and at the same time the saturated air prevents too rapid surface drying, so that the injurious effects which otherwise would be produced on the wood by such high temperatures are avoided.

Unless it is desired to relieve drying stresses at the same time, the interior of the stock should be heated as little as possible. Therefore, the steam supply should be sufficient to reach the desired temperature in twenty-five or thirty minutes. To accomplish this result, plenty of live steam at a pressure of at least 70 lb. gage must be available. The size of supply line and the number and size of perforations that may be required in the steam jet line will vary with local conditions; it is impossible to make them too large or too numerous, as the quicker the steam is supplied the better the effect.

Care should be taken to see that the stock cools in nearly saturated air. Otherwise the surface will dry too rapidly, and casehardening difficulties will set in.

¹Transactions, Amer. Electrochem. Soc. (1919), vol. 35, p. 279.

*Forest Products Laboratory Technical Notes.

The Control of Chlorine in the Bleaching of Cotton Goods

BY C. M. EDWARD SCHROEDER*

SINCE liquid chlorine became available on the American market in convenient form for handling, the preparation of bleaching liquors of superior quality and uniform composition at once established an improvement which rapidly superseded the more cumbersome and uncertain production of bleach liquors from chloride of lime or bleaching powder. Prior to the introduction of liquid chlorine there had been no material change in the process of cotton bleaching for many years, but the preparation of sodium hypochlorite bleaching liquor, or chemic, with chlorine constituted an improvement of great practical value.

The immediate advantages, aside from cleanliness and ease of handling, derived from using chlorine-soda chemic over the old chloride of lime or bleaching powder solutions are twofold: 1. Chlorine-soda chemic can be made up under constant control of bleaching strength, in clear liquors, ready for immediate use. (Chloride of lime losing strength on exposure and depositing sludge in making up.) 2. There being no lime salts present as in the chloride of lime chemic, goods will not be in danger of tendering or discoloration, and for the same reason goods for dyeing will not show unevenness from lime residues.

During the writer's experience of about ten years past in the handling of liquid chlorine for bleaching purposes, certain improvements and economies have been developed in the matter of control which make this seem a subject worthy of description.

EARLY BATCH MIXING PRACTICE USING CHLORINE

In the earlier experience with preparation of chlorine bleach no attempt was made to control the gas supply by means of special apparatus, but as the gas was obtainable in steel cylinders, holding approximately 100 lb. of chlorine (the filled cylinder weighing about 200 lb.), it was simply necessary to place the cylinder of chlorine on a platform scale and note the amount of gas used up in the preparation of stock chemic.

For further convenience in the daily preparation of large quantities of bleaching liquors, weighing the

chlorine was dispensed with, as it was necessary only to discharge one full cylinder into each tank of soda liquor holding about 800 gal., the cylinders being connected to a $\frac{1}{2}$ -in. lead pipe leading to the bottom of tanks holding the liquor, and the chlorine allowed to enter at full capacity. Of course means had to be employed to overcome reduction of the gas flow due to lowering of temperature caused by such rapid evaporation.

Formerly this was accomplished by placing the cylinders in tubs supplied with warm water, but later the liquid chlorine was allowed to flow from the cylinders placed in a horizontal position, and was conducted through a coiled section of the lead pipe submerged in a tub of warm water, the expanded gas escaping from the end of a lead pipe at bottom of chemic tank. By this means 100-lb. cylinders could be emptied in from one to one and one-half hours.

EXCESS OF ALKALI REQUIRED

It may be observed here that bleach liquors prepared as above described necessarily contain an excess of alkali to insure stability, which in the case of soda ash is not of much consequence excepting as regards cost, but in using an excess of caustic soda there is always danger of deleterious action on the cotton fiber, especially in warm weather, when oxycellulose is likely to form while the material is undergoing the bleaching operation and may cause subsequent tendering and yellowing of the fabrics.

Before the introduction of proper control equipment the procedure was as follows: At first soda ash alone was used to absorb the chlorine, in the proportion of about 3 to 1—that is, taking 300 lb. of soda ash in 800 gal. of water to each 100 lb. of liquid chlorine, yielding a stock chemic with approximately 1.5 per cent available chlorine. This when run in the bleaching machines at 1 to $1\frac{1}{2}$ deg. Tw. furnished a safe and active bleach, although the actual cost of such a bleach was somewhat higher than bleach made of chloride of lime. This cost was later reduced when the chemic tanks were charged with waste caustic soda recovered from mercerizing washings running from 4 to 6 deg. Tw. and enough soda ash added to bring the Twaddell up to about 10 deg.

The excess of soda ash was required to insure stability during the rapid absorption of the gas and while storing the chemic. The bleaching strength was determined on each batch made by titration with N/10 arsenious acid.

PREPARATION OF NEUTRAL CHEMIC

With the installation of Wallace & Tiernan chlorine control equipment the possibility of preparing neutral chemic from caustic soda solutions at once removed the foregoing objections.

There being no need of using an excess of alkali with this method, the cost of soda ash formerly required was entirely eliminated, the waste caustic from mercerizing washings furnishing the necessary supply of alkali. On account of the perfect control of pressure and rate of flow of chlorine, it is possible to utilize caustic liquors of any convenient strength and obtain a sodium hypochlorite of any desired composition and uniformity. That is, by adjusting the chlorine feed valve to supply just enough chlorine to combine with the sodium hydroxide in the caustic liquors, there is

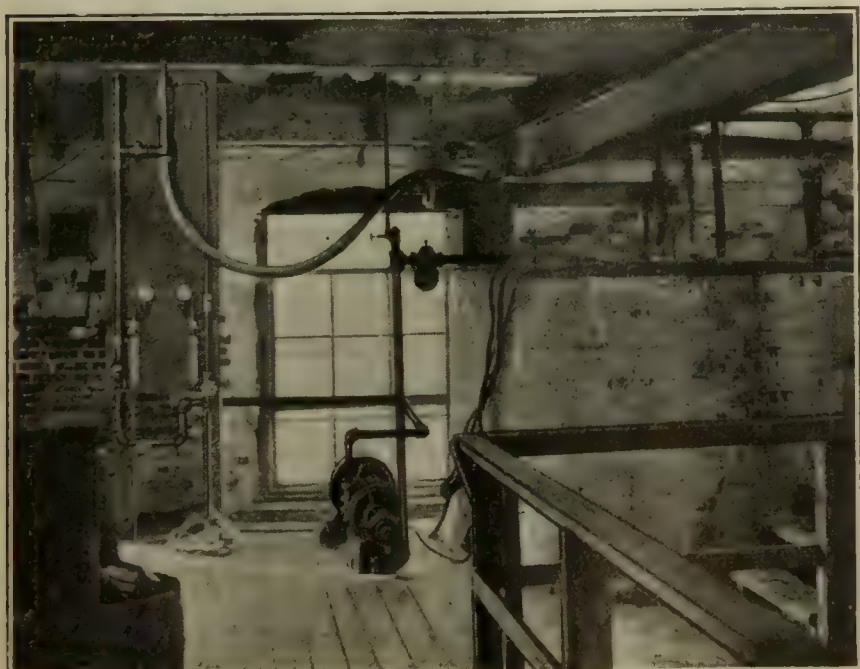
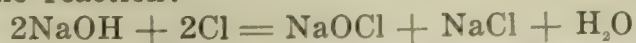


FIG. 1. VIEW OF INSTALLATION

*Consulting Chemical Engineer, Rutherford, N. J.

formed a neutral hypochlorite solution in accordance with the reaction:

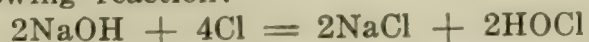


and such a bleach liquor is at once ready for use from the moment of starting and as long as the machine is kept running.

FLEXIBILITY OF OPERATION

A valuable feature of this apparatus is its flexibility in operation. For instance, if a bleach liquor is required for storing any length of time a slightly alkaline liquor can be prepared by simply reducing the proportion of chlorine to the caustic content of the absorbing liquor.

Or, if an acid bleach is required, an excess of chlorine is fed in giving a hypochlorite solution according to the following reaction:



thus furnishing a safe means of producing the more rapid hypochlorous acid bleach without the danger of liberating free chlorine as was apt to occur by the old practice of adding acids to bleaching liquors, with attending deleterious effect on the goods.

DESCRIPTION OF BLEACHERY INSTALLATION

A Wallace & Tiernan control equipment which has been under the writer's observation since August, 1920, at the plant of the Standard Bleachery Co.,

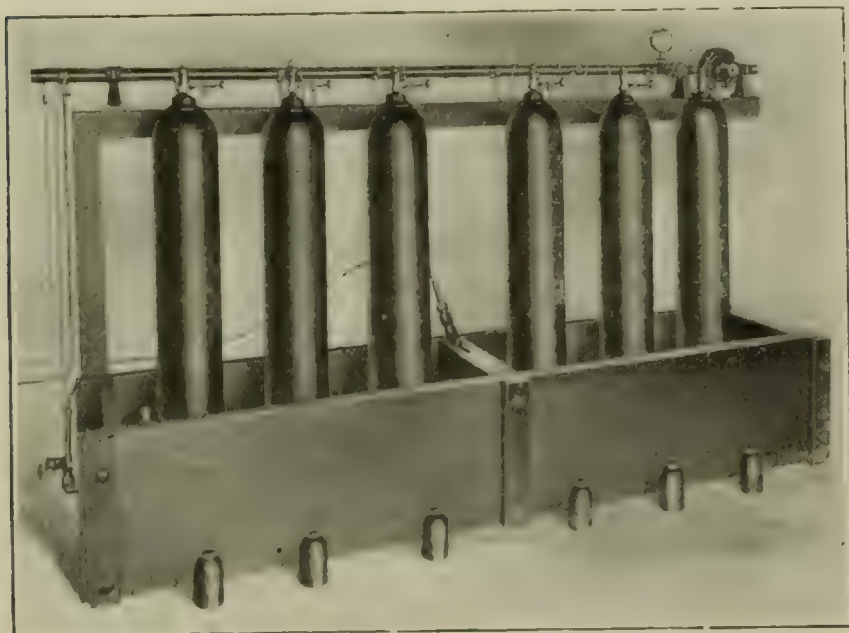


FIG. 2. LIQUID CHLORINE EVAPORATORS

Carlton Hill, N. J., was installed to produce 500 gal. of bleach per hour using only waste caustic liquors of about 4 deg. Tw. for absorbing the chlorine and furnishing a steady supply of chemic with from 1.25 to 1.5 per cent available chlorine.

The apparatus consists of a panel upon which is mounted a specially designed injector which effects the combination of the chlorine with the caustic solution. This combination is practically instantaneous, the chemic of full strength and ready for use passing immediately to the stock tank. Indicating meters of the Venturi type are placed in both the chlorine and caustic lines on the panel. The chlorine gas is supplied at the desired rate and under constant pressure from an evaporator that is essentially a steam-heated water bath equipped with thermostat control and pressure-regulating valve.

The control panel was placed in the same room in which were housed three cylindrical brick tanks of about 800-gal. capacity used for making up and stor-

ing chemic, and without changing the existing layout it was possible with this outfit to furnish a supply of bleach equal to the demand formerly met by the three mixing tanks. The accompanying photograph shows how the apparatus was placed. The brick tank shown to the right is the first of the three chemic tanks above referred to, which was put to use as a reservoir for the waste caustic liquor to be fed to the apparatus by means of the centrifugal pump on the floor.

The bleach liquor is discharged into the large rubber hose falling in a loop from the top of the control panel and conducted to either of the other two tanks, from the bottom of which the chemic is drawn to the bleaching machines. One of these tanks is generally kept partly filled to hold in reserve enough stock chemic to meet any fluctuation in draft.

The evaporator outfit, holding four 100-lb. chlorine cylinders, was placed on the ground level directly below the control apparatus.

The only difference in handling the gas supply by this method as compared with the former in use is that four or more cylinders are connected up at once to a manifold allowing the gas to flow through the meter at a maximum rate of 60 lb. per hour for each 500 gal. of caustic liquor, while by the former method the same number of cylinders are connected up separately for each 800-gal. batch made up. That is, by the old method 300 lb. of chlorine would be consumed in making up three tanks, or 2,400 gal. of chemic in one day, while with the Wallace & Tiernan control equipment 3,000 gal. of chemic can be made up in six hours with a maximum consumption of 360 lb. of chlorine.

SAVINGS BY USE OF THE APPARATUS

The saving in cost of soda ash in one week's run with the control equipment as compared with a week during which the same yardage of goods was run by the older method amounted to \$33.

A comparison of six weeks' steady running of the control equipment with a similar period using part soda ash for chlorine absorption showed a total saving of \$219, or \$36.50 per week.

Production of Camphor in Taiwan

The production of camphor during the year ending March 31, 1921, it is anticipated, will exceed that of the preceding year by 275,000 lb., the amount being placed at 6,000,000 lb. Though exports have stopped for the present, the stock of crude camphor on hand does not exceed 750,000 lb., as it is being turned over to Japanese refiners as soon as it is cleaned and pressed at the plant in Taihoku. The monopoly bureau is gradually increasing its rate of production in anticipation of a revival of the celluloid industry in the late summer or early fall of this year, when present stocks of celluloid will have been depleted, the output having been accelerated from 480,000 lb. during the month of July, 1920, to the present monthly rate of 600,000 lb. It is too early to estimate the total output for the twelve months beginning April 1, 1921, as the survey of the camphor forests has not yet been reported upon. No orders from or allotments to the United States, Great Britain or France for the first quarter of 1921 have been reported. The price of camphor for the second quarter has not been announced, but as prices of commodities in general are declining it is supposed that camphor will also be affected.—*Commerce Reports*.

Molybdenum Steel and Its Application*

Beneficial Effect of a Little Molybdenum on the Physical Properties of Complex Alloys, Especially Allowing Safe Use of High Working Temperatures and a Wide Range of Quenching and Annealing Heats

By M. H. SCHMID

Metallurgical Engineer, United Alloy Steel Corporation

WHILE it is true that molybdenum structural steels were commercially developed during the World War, and through their development great advancement in army and navy equipment and accessories were rendered possible, it is equally true that war conditions merely furnished the impetus for this development. The commercial application of molybdenum steels for industrial purposes was inevitable, the assurance of adequate and accessible domestic supply of this important alloying element allaying all fears as to the ability to meet future commercial demands.

That the earliest experiments in molybdenum steels were confined largely to tool and magnet steels is not surprising in view of the fact that molybdenum was not then known to exist in sufficient quantities to warrant its consideration (other than purely academic interest) for commercial structural requirements. It is surprising, however, to note that in spite of the then limited available supply of this alloying element the earlier experimentation on structural steels was in most cases confined to material of a much higher molybdenum content than is considered advisable at the present time. It is also surprising that practically all study was confined to its direct effect in the ternary steels instead of more research on its indirect effect or additive and intensifying effect on other elements in the quaternary and more complex alloy steels. It is of course quite possible that research along the latter lines was pursued but not published. It is a fact, however, that exhaustive research directed by C. H. Wills established the practicability of the commercial application of molybdenum as an alloying element in the various types of alloy steels.

BENEFICIAL EFFECT OF MOLYBDENUM

A review of the many types of steel on which the addition of molybdenum has a distinctly pronounced beneficial effect enables us to grasp the diversity of the application of molybdenum steels. Its effect is pronounced in straight carbon steels, chromium steels, nickel steels, chromium-nickel steels and vanadium steels. In straight carbon or nickel steels, by uniting with the ferrite additional strength is imparted without corresponding decrease in toughness. In steels containing chromium, probably through the formation of double carbides, additional strength and hardness is imparted together with beneficial effect due to any diffusion in the ferrite. The penetrative effect of heat-treatment, especially in large sections, is decidedly pronounced.

I think most of us can recall the time when the selection of alloy steels for various products was based

almost entirely on the physical characteristics obtainable. There are now a variety of types of alloy steels in which there is very little difference in physical properties, all of which will yield the necessary strength and factors of safety in the finished product. The present consumer of alloy steels, having at his command many types that are satisfactory so far as static and dynamic qualities are concerned, is influenced in his choice of material by the efficiency of the product in proper and economical functioning in the various manufacturing processes. From the manufacturing standpoint he wants a steel which first of all has a tendency toward the minimum of inherent defects; he wants a steel which gives the most efficient response to the various thermal and mechanical manipulations to which it is subjected in the numerous stages of processing from the raw material to the finished product.

REQUIREMENTS OF ALLOY STEEL

Careful consideration of the following requirements should be given by the customer in his selection of an alloy steel:

- (1) It shall meet such specifications as are imposed by the engineering department.
- (2) The elements used in its manufacture shall be readily obtainable with assurance of adequate source of supply for the future.
- (3) It shall not be subject to patent litigation.
- (4) It must be entirely practicable as a commercially manufactured product of uniform quality.
- (5) It must respond satisfactorily to various thermal manipulations with reasonably wide temperature ranges.
- (6) It must respond satisfactorily to various mechanical manipulations.

We will now review these requirements in detail from the standpoint of molybdenum steels.

SPECIFICATIONS

There is little need for a detailed discussion regarding physical characteristics. "Molybdenum Commercial Steels," published by the Climax Molybdenum Co., gives concise information as to just what physical properties may be developed on the various types of molybdenum steel. We know that the chromium-nickel-molybdenum steels used on Liberty motors for aircraft service met the most exacting specifications, and records of tests on physical properties showed results superior to those obtained on any other types of steel used in this class of work. As far as the desired physical properties are concerned, it appears but necessary to select the particular type best suited for the purpose under consideration. For general requirements for automotive or machine construction, the chromium-molybdenum steels are usually recommended. For special requirements it

*Paper presented April 22, 1921, before the Washington Chapter of the American Society for Steel Treating.

becomes necessary to use the more complex types, such as chromium-nickel-molybdenum.

RAW MATERIAL

The supply (present and future) of ferromolybdenum for commercial production has been assured. Sufficient ore deposits adequate for many years' production have been established, with the necessary mining and refining capacity to take care of all future requirements. Four-fifths of the world's known available supply of molybdenum is contained within the borders of the United States. The present supply of chromium, the alloy most commonly used in connection with molybdenum, is practically inexhaustible and is found in most every part of the world.

PATENTS

The recent action whereby any alloy steel manufacturer in the United States may be licensed to produce chromium-molybdenum steels under patents during the life of same on a royalty basis which is so trivial as to have no bearing on the price of the steel should relieve any fear as to litigation.

MANUFACTURE

That the manufacture of molybdenum steels is on a practical commercial basis has been well established. The first heat of electric-furnace steel made by the United Alloy Steel Corporation was tapped Dec. 3, 1917, since which time this company has made in excess of 10,000 tons ingots of various types, comprising carbon-molybdenum, chromium-molybdenum, chromium-nickel-molybdenum, etc. The first open-hearth heat of molybdenum steel was tapped by this company May 24, 1918, and since that time approximately 25,000 tons has been produced.

No serious difficulties are experienced in the various stages of processing from melting and casting on through the rolling and cold-drawing operation. The manufacture of molybdenum steel merely requires the same care as is exercised in the production of any well-made type of alloy steel of similar potential properties—in fact, less care than is necessary on many types.

Molybdenum is available as a furnace addition in two forms, as ferromolybdenum and as calcium molybdate. In the ferro form it is most conveniently obtained and used with a molybdenum content of 50 to 60 per cent, although our company has very successfully used 70 to 80 per cent ferromolybdenum. In the form of calcium molybdate we have a lower percentage of metal, averaging 35 per cent. The ferro-alloy may be added in the open-hearth process as follows:

- (1) All additions in the furnace as the charge is melting down.
- (2) All additions in the furnace just prior to tapping (10 to 15 minutes).
- (3) All additions in ladle.
- (4) Part addition in the furnace and part in the ladle.

In the manufacture of molybdenum steels at our plant we have thoroughly investigated all of the above methods and have adopted the first as standard practice because of the better diffusion and higher degree of uniformity in the finished product, together with higher efficiency or minimized loss of the alloy.

It has been our experience that calcium molybdate is most satisfactorily added in sacks as the scrap charge is melting down, being so placed as to permit the partly molten scrap to cover or envelop the salt.

Greater care is necessary with calcium molybdate than with the alloy in ferro form in order to prevent the draft of the furnace from pulling off part of the powdered molybdate addition and carrying it to the furnace walls, ports and checker chambers. The average loss of metal added in ferro form by the first method outlined above should not exceed 5 to 10 per cent, the loss tending toward the minimum where the same furnace or furnaces are used on successive heats, thereby reducing the purely mechanical loss. Just how this loss may be subdivided is worthy of some discussion. A slight mechanical loss is inevitable and we may assume it as running between 2 and 4 per cent, leaving an additional loss of, say, from 3 to 8 per cent unaccounted for. I am not prepared to state just how this should be distributed. It is probably due to both oxidation and volatilization. Molybdenum additions in the ladle are generally inadvisable and where a high molybdenum content in steel is required should be made only in the molten condition.

Of worthy consideration is the utilization of molybdenum steel scrap, which may be included in the furnace charge with a yield of approximately the same ratio as direct alloying additions.

No special comment is necessary regarding ferromolybdenum and calcium molybdate charges in the electric furnace, where slagging, oxidizing and temperature conditions are under absolute control. Practically 100 per cent alloy efficiency is possible.

The blooming and finish rolling operations on molybdenum steel require no special precautions other than those necessary on corresponding types of other alloy steels, and the practice, measured in per cent of available finished product, is higher than in most types of similar properties. The tendency toward a minimum amount of inherent defects, both surface and subsurface, is very pronounced, especially as compared with nickel and chromium-nickel steels.

While molybdenum evidently has no deoxidizing or scavenging effect, it has at the same time no deleterious effects on the working of the steel, and a chromium-molybdenum steel should process as efficiently as the same type without molybdenum, and a chromium-nickel-molybdenum should process as efficiently as that type without this additional alloy. Molybdenum steels as a class may be considered more free from seams than nickel and chromium-nickel steels of corresponding potential values. It would be absurd, however, to claim that such defects in billets heal up or roll out in the finishing mill.

Wide temperature ranges are available for rolling and forging, and while there is no appreciable difference in the amount of scalage, there is a marked advantage in the texture of the scale over that on nickel steels. The scale is a loose, non-tenacious one, freely flaking from the steel, showing no tendency to roll into the surface and result in pitting.

THERMAL MANIPULATIONS

Molybdenum steels as a class may be subjected to unusually wide temperature ranges for both hot-working and heat-treating. This applies particularly with respect to the more generally used chromium-molybdenum types, which will satisfactorily withstand considerably higher temperatures than the corresponding types of nickel and chromium-nickel steels. Forging companies report that chromium-molybdenum steels flow better in the dies than other types, which advantage is probably

due to a large extent to the use of higher working temperatures. I cannot conscientiously credit molybdenum steels with less scalage loss, but it is certainly true that less difficulty is encountered in forging operations on account of the ease with which scale loosens from the bars in carbon-molybdenum and chromium-molybdenum types. Cleaner forgings are obtained and tumbling and pickling charges are minimized.

The outstanding features relative to the heat-treatment of molybdenum steels are the extremely wide quenching ranges available for practical heat-treatment, the excellent penetrative effect of such treatment on large sizes, and the broad drawing range causing but slight modification in physical properties, this due to the retarded disassociation and reversion to normal state upon heat application after quenching. Data have been published by the Crucible Steel Co., the Carbon Steel Co. and the United Alloy Steel Corporation showing uniformity in static properties through a wide range of quenching temperatures, but without information as to comparisons on dynamic properties.

To show that impact as well as static properties evidence no marked variation with quenching temperatures ranging from 1,500 to 2,000 deg. F. inclusive, I have taken average results from a series of recent experiments in our laboratories on chromium-molybdenum steel analyzing as follows: Carbon 0.27, manganese 0.66, sulphur 0.036, phosphorus 0.018, silicon 0.08, chromium 0.83, molybdenum 0.42. The size treated was $\frac{7}{8}$ in. round and all tests were drawn at 1,050 deg. F., after quenching in water at the temperatures indicated.

Quenching Temperature	Elastic Limit	Tensile Strength	Elongation	Reduction of Area	Brinell	Izod
1500	140,000	163,500	18.5	62.7	319	58
1600	139,500	161,700	17.0	63.1	321	62
1700	138,400	160,400	17.5	61.7	321	60
1800	138,300	158,500	18.0	61.5	319	61
1900	139,600	159,600	16.8	57.9	317	56
2000	140,000	157,000	17.0	59.0	317	55

Striking evidence of the penetrative effect of treating as well as the high drawing temperature available for attainment of high physical properties is manifested in our type "LM," chromium-nickel-molybdenum steel, used for crankshafts and connecting rods in aircraft work. The analysis range of this type is carbon 0.22 to 0.30, manganese 0.50 to 0.70, sulphur 0.035 max., phosphorus 0.030 max., silicon 0.10 to 0.20, chromium 0.70 to 0.90, nickel 2.75 to 3.25, molybdenum 0.30 to 0.50. Heats running 0.25 to 0.30 carbon were selected for crankshafts, and those running 0.22 to 0.25 were used for connecting rods. Physical results taken on a full size prolongation (approximately 4 in. diameter) and averaged from twenty-eight tests taken at random showed: Elastic limit, 130,000 lb. per sq.in.; ultimate strength, 142,000 lb. per sq.in.; elongation in 2 in., 20.5 per cent; reduction of area, 65 per cent; Izod, 67; Brinell, 303.

On a series of tests on 2 in. round, taken from the same type, after quenching in oil at 1,450 deg. F. and drawing as indicated we obtain:

Draw	Elastic	Ultimate	Elongation	Reduction	Brinell	Scleroscope
500	233,000	249,800	14.0	46.8	455	54
900	170,000	189,200	16.0	51.6	363	45
1000	161,000	180,700	18.5	58.3	344	43
1100	149,000	166,800	18.5	60.0	328	41

These results show that there is but slight change in physical characteristics between the 900 and 1,100 draws.

On type "MO.102," an oil-hardened gear steel, we obtain a tensile strength in excess of 200,000 lb. per sq.in. for all drawing temperatures up to 1,000 deg. F. and an elastic limit in excess of 200,000 for all tem-

peratures up to 900. Tests on standard 0.505-in. specimens, quenched in oil at 1,450 and drawn at 400 and 1,000 deg. F. respectively, give:

Draw	Elastic	Tensile	Elongation	Reduction
400	302,000	336,600	10.0	22.4
1000	190,000	202,200	15.5	50.1

MECHANICAL MANIPULATIONS

The most important mechanical operations to which steel is subjected in the manufacture of the finished product are cold-pressing, forming and heading, and machining. Efficient response in the operations involving cold flowing of metal effects savings in fabricating costs resultant from minimization of rejections in semi-finished and finished parts, as well as maintenance costs on dies and tools. The merits of molybdenum steel for this purpose have been established through the results obtained on carbon-molybdenum and chromium-molybdenum types in the cold-forming and pressing operations in the manufacture of automobile frames, steel wheels and rear axle housings; through production of cold-headed parts on the chromium-molybdenum types, and through cold upset balls on the high-carbon, chromium-molybdenum ball and race types.

The molybdenum steels have better machinability than other alloy steels of equal physical properties. This has been established by the production results obtained on several thousand tons processed into rear axle drive shafts and on which no machining difficulties were experienced on shafts heat-treated to conform to a 300 to 340 Brinell specification. On a heat made by the United Alloy Steel Corporation for one of the large automobile companies and put into steering knuckles and front axles, we received a report to the effect that tool-grinding costs were but one-third as high as on $3\frac{1}{2}$ per cent nickel steel of the same hardness and with corresponding shop production. Front axles with Brinells up to 340 maximum machined as well as chromium-nickel steel axles of 302 Brinell.

The scope of application of molybdenum steels appears wider than that of any of the other types of alloy steels. While the greater portion of the molybdenum steel manufactured to date has been used in automotive forgings and pressed metal parts, its excellent properties have likewise warranted its use in a variety of other parts, embracing railroad forgings and track bolts, armor plate, air flasks, agricultural implements, shovels, machinery forgings and piston rods, various edge tools, etc.

The general utility of molybdenum steels promises an increased demand in a well-diversified field.

Explosives in 1920

The total production (excluding exports) of explosives in the United States during the year 1920, according to reports that the U. S. Bureau of Mines has received from manufacturers, was 537,954,750 lb., an increase of 120,320,280 lb., or 29 per cent over the total output in 1919.

The production for 1920 is segregated as follows: Black blasting powder, 254,879,825 lb.; "high" explosives other than permissible explosives, 229,112,084 lb.; and permissible explosives, 53,962,841 lb. As compared with 1919, these figures represent an increase of 41 per cent for black powder, 15 per cent for high explosives and 39 per cent for permissible explosives.

The reports show that all classes of consumers used larger quantities of explosives in 1920 than in 1919, the principal increase being in coal mining.

Legal Notes

BY WELLINGTON GUSTIN

Principles of Shipping and Delivery of Goods Enunciated by Court Decision

The misdelivery of goods by the seller to a carrier other than the one named by the buyer completely exonerates the buyer from liability for loss of the goods, holds the Supreme Judicial Court of Massachusetts in a recent decision in an action brought by St. John Bros. Co. against Falkson, 130 N. E., 51. The decision involves some simple but important principles of shipping and delivery of goods.

The suit was one on contract to recover the price of a shipment alleged to have been sold and delivered by the company to defendant. It appears that the company received an order for the products at a stated price, "terms net ten days, to be shipped by freight via Metropolitan Line," that it be properly packed, addressed and made shipment to the buyer by the New England Steamship Co., but that delivery of same was never made to the buyer.

The company argued that on all the evidence it should have had a verdict, although the shipment was not made by the carrier designated by the defendant and although the goods were lost in transit. The defense was on the ground of the misdelivery to a carrier other than the one named by the buyer. The court said if there was nothing more the buyer would not be liable. And the company contended that the buyer had waived the right to stand on its defense of misdelivery.

The facts for this contention were that after the shipment of the products considerable correspondence passed between the parties; that in none of the letters written by the buyer did he make complaint or even refer to the fact that delivery had been made to the wrong carrier; that the buyer had received the bill of lading without protest as to the carrier named therein; that said buyer had made claim and brought action at law against the New York, New Haven & Hartford R.R., on two counts, one in contract for failure to deliver the goods, and the other for negligence in transportation, in each count the buyer herein describing himself as the consignee of the goods delivered to the carrier by the company, and which action is still pending. These facts were said to show a waiver as matter of law, but the court said that when more than one rational inference can be drawn from the evidence, a question of fact is presented, and the result is not a pure question of law.

WAIVER DEFINED

The court says: "Waiver is the voluntary relinquishment of a known right. It may be established either by words or conduct or both. It may be found to flow from all the circumstances as well as by express revelation of purpose." Whether there has been a waiver is usually a question of fact. Omission in his letters to the shipper to refer to the shipment by another carrier than the one named by him is not decisive. He was persistent throughout the correspondence in his denial of liability and in his refusal to pay.

Delivery of a non-negotiable bill of lading to the buyer of goods by the seller thereof, who shipped by an

unsanctioned carrier, and its retention by the buyer are not conclusive on the issue of waiver of his rights arising from the misdelivery, says the court. Possession of such bill of lading is of little significance as to title, for the carrier rightly could deliver to the consignee and discharge its liability without surrender of such a bill.

Further, the naming of the buyer of goods as consignee in a bill of lading, taken by the seller from a carrier not designated by the buyer, was some evidence that he was owner, but was not absolute proof; and an action at law, never brought to trial by the buyer, was not an unequivocal assertion of waiver of his right to rely on the seller's failure to perform its contract with him as to the selection by the carrier. This action may have been regarded as an attempt of the buyer to help the seller in tracing the goods or as founded on some other ambiguous design.

The effect of all these circumstances, the court rules, was not decisive to the effect that there was a waiver by the buyer of his right to defend on the ground of misdelivery. Whether there was a waiver was for the jury to decide.

Judgment for the buyer was upheld.

What Constitutes a Contract by Letters and Telegrams

A large volume of business is done by means of letters and telegrams, there being nothing else to express the contract between the parties. What is an offer and such acceptance to make a contract by means of such correspondence is not always clearly understood. In all cases there must be a complete meeting of the minds of the parties thereto on the subject matter of the negotiations, which means there must be an offer on the one side and a complete acceptance of that offer, without change or modification, to constitute a binding contract. To accept conditionally is not an acceptance, but a counterproposal or offer to the original offerer, which he in turn may accept or reject.

A recent decision of the Supreme Court of Arkansas relates to a contract for the sale of cottonseed oil in which letters and telegrams were used to confirm oral negotiations. The oil company sued to recover damages for defendants' refusal to deliver to it 100 tons of cotton seed which it had purchased from him. The agent of oil company claimed he had a conversation with the defendant and had purchased the cotton seed at \$37 per ton. Defendant claimed he should be allowed to draw draft for the full amount, but the agent said no, the balance would be paid when cars came with full weight. The agent then asked the defendant to confirm the sale by a telegram, which was sent as follows:

"I confirm sale of 100 tons cotton seed immediate shipment at 37 f.o.b. Conway."

The oil company replied by telegram stating it was mailing written instructions. The letter was confirmatory of the telegrams and the instructions authorized the seller "to draw for 90 per cent of the value of each car, with bill of lading and invoice attached to your drafts with the understanding you will guarantee shipping weight."

The defendant immediately wrote that he could not sign the confirmation of purchase sent him, for the reason that it contained a contract essentially different from the one he had offered to enter into. He stated that the contract agreed upon was that he should draw on the purchaser with bill of lading attached for the

full amount of the invoices, and that he should only guarantee the weights to be within one-half of one per cent of the weights shown by the invoices.

AGREEMENT MUST BE MUTUAL IN EVERY ESSENTIAL

Passing on the case, the Supreme Court said that a binding contract of sale may be entered into by letters and telegrams, and that an acceptance by letter or telegram of an unconditional offer, made in the same manner, will constitute an obligatory contract. It is equally well settled that before the contract is consummated each party must agree to the same proposition, and the agreement must be mutual to every essential term of the contract.

The oil company in its telegram of acceptance of the sale referred to its letter and the shipping instructions as a part of its acceptance of the offer made by the seller in his telegram. Hence they constituted a part of the negotiations, and it cannot be said that the two telegrams alone constituted a binding contract between the parties, said the court.

The limitation of the right of the seller to draw for only 90 per cent of the invoice price of the cotton seed and requiring him to guarantee the weights and quality at destination were different from those contained in the seller's telegram. The new terms as indicated in the letters prevented the telegram of the oil company from being an unconditional acceptance of the offer. The seller rejected the proposal contained in these letters as soon as he received them. Hence there was no meeting of the minds of the parties on the same terms.

Metal Protective Paints*

BY HENRY A. GARDNER†

THE causes underlying the corrosion of steel and the principles to be adopted in designing protective paints are well understood as the result of comparatively recent work.¹ In fact, the manufacture of the majority of high-grade paints now produced is based upon these principles. Briefly stated, they are as follows:

1. Basic substances in sufficient concentration inhibit the corrosion of iron. Basic pigments that are effective for this purpose are litharge, red lead, blue lead (basic lead sulphate), white lead, zinc oxide.

2. Chromic compounds (soluble bichromates), even in great dilution, prevent the corrosion of iron. Chromate pigments that are similarly effective when used in sufficient amounts are as follows: Basic lead chromate, normal lead chromate, zinc chromate.

3. Neutral substances that do not ionize to acid reaction are considered inert. So-called neutral or inert pigments, such as iron oxide, which do not excite corrosion, produce with linseed oil very durable films. Such pigments include black, brown and red oxides of iron, china clay, silica, talc, and barium sulphate.

4. Substances that form a galvanic couple with steel in the presence of moisture cause rapid corrosion. Pigments which act in this fashion (graphite, carbon black, lampblack) are used only as constituents of the finishing coats on steel surfaces, when first insulated from

the metal by a coat of basic or chromate pigment paint. These carbon pigments with linseed oil form very durable and water-resisting coatings.

PRIMER PAINTS

From the above data it is apparent that paints for priming steel should preferably be made of a substantial amount of one or more basic or chromate pigments, and that these paints should be covered with water-resisting finishing coats of carbon or iron oxide paints. For instance, steel that has been primed with high-grade red-lead paint and finished with two coats of a carbon paint will be protected from corrosion under most conditions for a long period of time.

In many instances, high-grade proprietary primer paints contain a mixture of red lead, chromate pigments, iron oxide and zinc oxide.

FINISHING PAINTS

The finishing coats of such paints contain carbon black or lampblack, generally with 5 per cent of litharge, and often certain amounts of iron oxide and silica. The liquid for such paints is raw or boiled linseed oil with a total of about 15 per cent of liquid drier, turpentine or mineral spirits. Where high gloss is desired, the addition of spar varnish is indicated.

In many places the use of black or other dark colored finishing paints may be objectionable from an æsthetic standpoint or because of their gloomy appearance. Light-gray paint made of white lead and zinc oxide, or of zinc oxide and barium sulphate (navy practice), tinted with lampblack, have been used as finishing coats on steel bridges, government structures and vessels. While possibly not as durable as red or black paints, they give much higher light-reflecting values and are of more pleasing appearance. For use around acid and chlorine factories, black bituminous coatings have usually been adopted. Of recent years, however, there has come a demand for white and light-colored paints. The only white opaque pigment for such paints that is insoluble in most acid gases is titanium oxide. This pigment, which is now produced by an electrochemical process and contains 25 per cent of titanium oxide precipitated on 75 per cent of barium sulphate, possesses tremendous hiding power. It is usually applied with up to 40 per cent of zinc oxide to give it sufficient hardness. In white or tints, such mixtures are very durable.

Various metal powders are now being applied to some extent as constituents of metal protective paints. When applied direct to steel surfaces, zinc powder and aluminum powder have much greater rust-preventing properties than the powders of other metals, on account of the high electro-positive nature of zinc and aluminum. Because of the great light-reflecting properties of aluminum powder, its use is indicated for special purposes on exterior work. Probably the most satisfactory liquid for suspending this powder is a high-grade exterior spar varnish. When used with linseed oil, a rather slow drying paint results.

CONCLUSION

Standard painting practice for iron and steel calls for the application of a primer containing basic or chromate pigments. Finishing coats generally contain red oxide or black carbon pigments. A wider use of white and light-tinted paints of high light-reflecting power is indicated for many purposes as finishing coats.

*Paper presented at the meeting of the American Electrochemical Society, Atlantic City, N. J., April 23, 1921.

†H. A. Gardner Laboratory, Washington, D. C.

¹Corrosion and Preservation of Iron and Steel—Cushman and Gardner; Paint Researches—Gardner; Papers on Paint and Varnish—Gardner.

The Nature of Zinc Dust*

Complete Chemical Analysis of Zinc Dust From Retorts and Electric Furnaces—Five Hexagonal Crystals of Zinc Oxide Found—Briquetting Tests—Good Recovery of Metallic Zinc by Melting Under Salt Mixtures Containing Zinc Chloride

BY OYSTEIN RAVNER

AN additional study on the operation of electric distilling furnaces, supplementary to those on the Condensation of Zinc Vapor, appearing in *CHEMICAL & METALLURGICAL ENGINEERING*, Vol. 24, p. 885, May 18, 1921, some zinc dust from a smelter using electrothermic processes was secured, both from the ore furnaces and refining or redistillation furnaces. Analyses were as shown in Table I.

TABLE I. ANALYSES OF ZINC DUST

	From Spelter Furnaces, Per Cent	From Zinc Redistilla- tion, Per Cent	Methods of Analyses
Zn.....	40.10	76.61	Total Zn was determined by precipitation as ZnS, which was dissolved and electrolyzed (Treadwell).
ZnO....	48.48	20.10	By determining the reducing action of the dust on a standardized potassium bichromate solution (Frankel). See Nissenson "Die Untersuchungs metodes Zinks."
Pb.....	6.15	0.17	Electrolytically as PbO.
Fe.....	0.58	0.05	After precipitation with NH ₃ the precipitate was dissolved and titrated with N/20 KMnO ₄ sol.
Cd.....	0.09	0.07	Determined as sulphate according to H. Nissenson, <i>Chem. Zeit.</i> 1906, p. 16.
As.....	0.05	0.01	The dust was dissolved in HCl, KClO ₃ added to avoid AsH ₃ and As determined by means of KBrO ₃ sol., according to A. Ledebur, "Leitfaden für Eisenhütten Laboratorien."
S.....	0.94	0.00	Determined as BaSO ₄ after fusion with soda and saltpeter.
Sb.....	traces	traces	
Insoluble and C..	3.28	2.32	Spelter dust contained 0.10 per cent C and the zinc dust 0.22 per cent C. Determined as CO ₂ by wet combustion with CrO ₃ (Treadwell).
Nitride..	0.34	0.33	
Water...	0.37	0.24	
Total..	100.38	99.90	

As a comparison, typical analyses from the smelter are given below:

	From Spelter Furnaces			From Zinc Redistillation		
Zn, per cent	39.30	35.05	36.38	71.25	75.39	81.20
ZnO, per cent	48.50	55.30	48.30	25.09	20.09	12.86
Pb, per cent	9.45	7.60	6.50	0.12	0.15	0.09

When these results are compared with analyses of zinc dust from retort furnaces, a great difference will be found.

The following analyses in Table II are taken from R. G. Max Liebig's "Zink und Cadmium" and from W. R. Ingalls' "The Metallurgy of Zinc and Cadmium."

OXIDE AND SULPHUR IN ELECTRIC FURNACE DUST

The great amount of sulphur and oxide in spelter dust from electric furnaces is remarkable. The sulphur was present principally as sulphide. However, there were traces of SO₂ radicle.

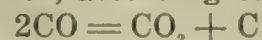
These facts may be explained as follows: The process

at the electrothermic smelters is continuous, while at the old smelters, using externally heated retorts, the process is intermittent. Moreover, the electric furnaces have a much greater capacity than the others. They require therefore much larger condensers, and the time

TABLE II.

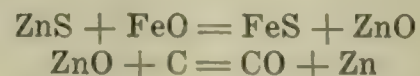
	Typical Analyses of Zinc Dust From Retort Furnaces			Zinc Dust of Commerce	
Zn, per cent.....	84.46	86.95	87.75	86.95	87.75
ZnO, per cent.....	4.88	10.15	9.85	10.15	9.85
Pb, per cent.....	4.27	2.05	1.95	2.05	1.95
Cu, per cent.....	.....	.....	.....	0.02	0.01
Cd, per cent.....	2.65	0.15	0.11	0.15	0.09
As, per cent.....	.....	.....	.....	0.27	0.17
Sb, per cent.....	.....	0.42	0.28	0.15	0.11
Fe, per cent.....	.....	0.01	traces	0.01	traces
S, per cent.....	.....	.....	.....	traces	traces
Fe ₂ O ₃ , per cent.....	0.90	.....	.....	.....	.....
Lime, per cent.....	2.46	.....	.....	.....	.....
Magnesia, per cent.....	0.23	.....	.....	.....	.....
Ins. + C, per cent.....	0.12	.....	.....	.....	.....
SiO ₂ , per cent.....	.....	0.22	0.06	0.22	0.06

between distillation and deposition will consequently be much longer. The longer this time is the more carbon dioxide will be formed, according to the reaction:



and the carbon dioxide will form oxide with the zinc vapor. Cooling of the vapor should therefore proceed as quickly as possible.

The great amount of sulphur in the dust is due to the fact that the electric furnaces do not always use ore as low in sulphur as the old processes do. The following reactions take place at distillation temperatures.



At the high temperature employed, however, a little zinc sulphide may volatilize.

PHYSICAL PROPERTIES OF ZINC DUST

Dust from spelter furnaces was a powder of light gray color. Examination under a binocular microscope showed it to consist principally of a gray, homogeneous powder, among which small metal globules could be seen.

Dust from the redistillation furnace was a black powder with large and small globules of a metallic luster. By examination under the binocular microscope it was seen to consist chiefly of metallic globules of various sizes, together with a black powder, probably carbon from the electrodes. Some of the metallic globules were covered with a gray powder; others had a violet color.

Samples weighing 100 g. were taken and screen sized. As the grains in the powder were spherical, the diameter is given as representing the grain size, in Table III.

Particularly parts having a grain size between 0.6 and 0.13 mm. contained clear white crystals, which were picked out and examined. In one sample twelve

*Translated from *Tidsskrift for Bergvaesen*, 1919, No. 11, p. 138. Portions of a dissertation prepared at the Institute of Inorganic and Physical Chemistry, Dr. P. Forup, director, Technical High School of Norway.

TABLE III. SIZING TEST OF ELECTRIC FURNACE DUST

Grain Size	Spelter Dust, per Cent	Zinc Furnace Dust, per Cent
1—Grains over 1 mm.	40.0	26.4
2—+1-0.6 mm.	9.2	12.3
3—+0.6-0.3 mm.	5.7	10.8
4—+0.3-0.13 mm.	13.3	19.7
5—+0.13-0.09 mm.	6.2	7.7
6—less than 0.09 mm.	25.4	23.0
Loss	0.2	0.1
Total	100.0	100.0

particles were found. They were boiled for some time in concentrated hydrochloric acid, when four of the grains disappeared, while the remainder did not seem to be affected. The acid then showed the presence of zinc only. The insoluble residue from the hydrochloric acid solution was fused with soda, and tested qualitatively; SiO_2 , Al and Zn were found to be present.

In order to determine the composition quantitatively, as many crystals as possible were picked out, boiled in concentrated hydrochloric acid, washed and dried. Analysis then gave the following result: SiO_2 , 61.75 per cent; Al_2O_3 , 11.52 per cent; ZnO , 27.42 per cent.

Some of the grains were entirely transparent, others were not. Whether only one kind of crystals were present, or if there was a mixture of, for instance, zinc spinel, ZnAl_2O_4 , and quartz, could not be determined, as the crystals were small and incomplete and, moreover, occurred in such small quantities.

It seems peculiar that these crystals were found principally in the spelter dust and that they occurred only in sizes under 0.6 mm. This may be explained on the assumption that these particles were pulled from the charge during distillation. A much more violent generation of gas occurs in the spelter furnace, where ore and coke are charged, than in the refining furnace, where only zinc is distilled. It would therefore seem but natural that these crystals have their origin in the furnace lining, especially since they are found in small quantities in the dust from the redistillation furnaces.

In order to examine the crystals which were insoluble in hydrochloric acid more closely, some crystals from the lining of a zinc furnace were obtained. Some of these were found to be completely insoluble in concentrated hydrochloric acid, and the analyses proved them to consist of pure zinc oxide. According to determinations by Prof. J. Vogt, the crystals were hexagonal. ZnO occurring in nature has the same crystalline form.

SPECIFIC GRAVITY

In order to determine the specific gravity, the same apparatus as employed for determining the specific gravity of cement was used. The liquid used was turpentine and the increase in volume corresponding to a weighed amount of dust was read on a graduated neck. Dust from the spelter furnace weighed 5.81 g. per c.c., while dust from refined zinc weighed 6.10 g. per c.c.

BRIQUETTING EXPERIMENTS

An apparatus was used for these tests on which the corresponding volume was read directly for every pressure applied. The zinc dust was introduced into a hollow cylinder 8.8 cm. high of the best grade of axle steel, with a tight fitting piston of the best grade of tool steel. As the cross-section remains the same, the volume will be proportional to the height of the cylinder of zinc dust. Fig. 1 shows the compressibility graphically.

It was very difficult to get the briquets out of the

cylinder, as they adhered very strongly to it. The maximum pressure used was 1,500 kg. per sq.cm. This pressure compressed the dust from the redistillation furnace to 54.55 per cent of the original volume. When the pressure was released, the briquet expanded 0.2 mm., so that the final volume became 54.77 per cent of the original volume. The briquet had but little strength, and fell to pieces when taken out.

The maximum pressure of 1,500 kg. per sq.cm. corresponded to a volume of 51.14 per cent of the original volume of the dust from the spelter furnace. When the

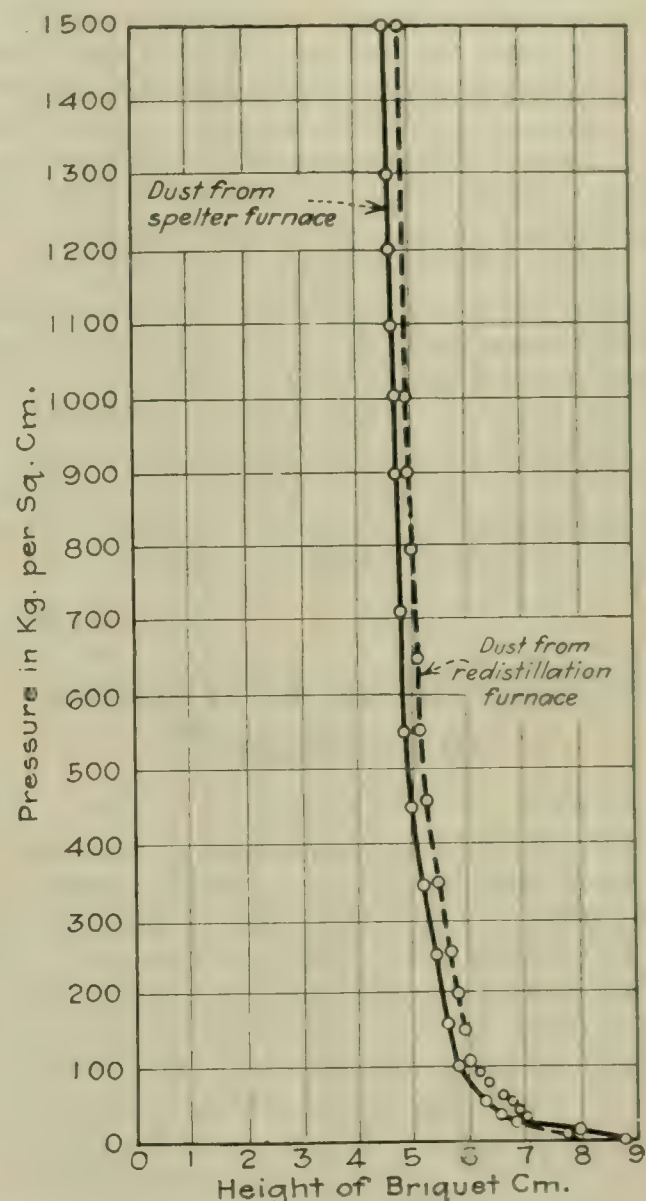


FIG. 1. VOLUME OF ZINC DUST BRIQUETS AFTER VARIOUS PRESSURES

pressure ceased, this briquet also expanded 0.2 mm., so that the final volume became 51.36 per cent of the original volume.

This briquet had more strength than the briquet of refined zinc dust. It weighed 4.35 g. per c.c.

As the specific gravity of the dust was 5.81 g. per c.c., the empty space per c.c. is:

$$p = 1 - \frac{4.35}{5.81} = 0.25$$

or a porosity of the briquet is still 25 per cent. It can probably be compressed considerably more by means of a sufficiently high pressure.

The dust was treated with oil before briquetting, but the strength was not improved thereby. However, briquets which contained a little tar or bituminous matter were considerably stronger.

CHEMICAL PROPERTIES

On account of its finely divided form, zinc dust is a powerful reagent. The use of zinc dust to effect reduc-

ing actions in organic chemistry is well known. Other less known reactions follow.

A mixture of one part zinc dust and two parts sulphur flowers burned like gunpowder when ignited. White fumes of zinc sulphide were given off, which compound was volatile at the temperature of this reaction.

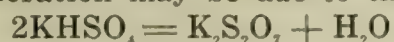
A mixture of dry zinc dust and iodine reacted violently when moistened with a drop of water.

Zinc dust has also pyrophoric properties. If it is heated in the air, it will ignite, and burns to oxide before it melts.

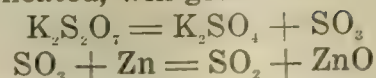
In order to melt together the metallic grains, the dust from the refining furnace which contained 76.61 per cent metallic zinc was heated in various molten salts or salt mixtures to exclude the air, in an attempt to cause the zinc to run together in the bottom, so that when this process was practiced on a large scale it would be possible to tap out the molten metal.

Forty grams KHSO_4 was melted and 20 g. dust added to the fused mass and stirred in to make it sink. A perceptible generation of SO_2 took place while the heating was continued, and after 10 minutes the melt was poured into an iron button mold. The zinc dust had collected at the bottom, but the zinc had not run together.

The SO_2 generation may be due to the reactions:



and this, when heated, will give:



The zinc will therefore be gradually oxidized.

An attempt was then made to melt the zinc by keeping the dust in a molten mixture of NaCl and Na_2CO_3 , but the dust remained as such in the bottom. A mixture of NaCl and CaCl_2 gave the same result.

A melt, however, of 50 g. ZnCl_2 + 50 g. NaCl , to which 50 g. zinc dust was added, gave a zinc button which after having been washed in hot water and dried weighed 31.2 g. As the zinc dust holds 76.61 per cent metallic zinc, the recovery was 81.44 per cent. To the melt from the preceding test, 5 g. zinc dust was again added, and 33.5 g. zinc was obtained, giving a recovery of 87.71 per cent.

A melt of 50 g. CaCl_2 and 50 g. ZnCl_2 with 50 g. zinc dust added gave a zinc button which weighed 35.1 g., or a recovery of 91.62 per cent.

According to these tests, it seems that ZnCl_2 should be present in order to melt the zinc. This may be explained by saying that ZnCl_2 dissolves zinc oxide, thus freeing the metallic zinc and enabling it to coalesce. Further confirmation of this idea may be found in the fact that the recovery, when treating dust from the spelter furnace which contained more oxide, was not even approximately as high if the amount of zinc chloride in the melt was not increased proportionately.

Organization of Workers in Germany*

IN GERMANY, as in all countries affected by the war, the power of labor and especially of organized labor has increased considerably. In order to secure an uninterrupted supply of war materials concessions without end had to be made to the working classes. The greatly augmented power of the working classes which was acquired during the war underwent an even more extraordinary increase during two years following the armistice. The most distinguished feature of this vastly increased power of labor is to be found in the development of the trade unions, particularly of the so-called "free" trade unions.

The most important groups of the German trade unions are the "Free," the Christian, the Hirsch-Ducker, the Syndicalist and Communist, and the so-called "Yellow Unions." The development of the German trade union movement has repeatedly been discussed in publications of the Bureau of Labor Statistics. For this reason and owing to lack of space only a very sketchy description of the development of the individual trade union groups is given below.

THE "FREE" TRADE UNIONS

The "free" or Social Democratic trade unions (*Freie Gewerkschaften*) embrace the great majority of the organized workers in Germany, and constitute the most highly organized labor organization in the world. At present the number of members is over 7,000,000. The movement was started in the '60s of the last century, mainly by members of the Social Democratic Party. By 1874 the early unions, which were viewed with dis-

favor by the government, had died out. Attempts were made to revive them, but the anti-socialist law of 1879 destroyed not only socialist bodies but also practically all trade union organizations. Between 1878 and 1888, 108 trade unions were dissolved by the authorities; but in spite of that, many unions contrived to keep alive under the form of mutual benefit societies, so that, when the anti-socialist law lapsed (it was never repealed), a large number of unions were in existence in a more independent form than before, though the members were still pledged to work for the Social Democratic Party.¹

In 1890 it was decided to link up the unions in a central organization, and at a conference in Berlin the General Commission of German Trade Unions was founded. This conference also decided on the form that trade union organization should take, that the real power should be left with the national federations, which still remain the strongest and most characteristic element in German trade union organization. Until the tenth congress in July, 1919, the central co-ordinating agency was the General Commission, with its headquarters in Berlin. It consisted of a committee of thirteen members, elected by delegates of the trade federations, meeting every three years at a trade union congress. Its functions were to carry on general trade union propaganda and publish trade union statistics. It also issued the *Korrespondenzblatt*, the weekly organ of the Social Democratic unions.

In 1913 there were 2,548,763 members of the "free" trade unions in forty-seven organizations. Each of the unions had its own journal. The local branches and district organizations are very closely supervised by the national executives of the unions. The local branches of the unions are federated in "cartels" (*kartelle*) which correspond more to the British trade councils and the

*From *Monthly Labor Review*, vol. 12, No. 3, March, 1921, p. 131.

See "Organization of Employers in Germany," *CHEM. & MET. ENG.*, vol. 24, No. 20, p. 889.

¹*Labor Overseas*, vol. 1, No. 1, p. 116; London, 1920.

American central labor unions than to the French bourses du travail or the Italian chambers of labor. They do, however, manage strikes in their own districts. The secretary of the cartel is very often in charge also of the local labor secretariat (*Arbeitersekretariat*).

At the tenth trade union congress at Nuremberg in July, 1919, a complete reorganization took place. The General Commission was abolished, and the General Federation of German Trade Unions (*Allgemeiner Deutscher Gewerkschaftsbund*) was constituted. Its aim is to "form a permanent means of co-operation between the affiliated unions in representing the common interests of all workers organized in trade unions." The federation has an executive committee consisting of fifteen members elected by, and responsible to, the congress. The former council is replaced by the federation committee which consists of one member of the executive committee of each of the central unions (generally the president). The cartels are now known as local committees.

ACTIVITIES OF THE FREE TRADE UNIONS

When the war broke out the unions made a truce (*Burgfriede*) with the employers, and their services were entirely at the disposal of the government. They co-operated with the employers in joint councils (*Arbeitsgemeinschaften*) and greatly extended the system of collective agreements. At the revolution they took no part in political action. Friction soon developed between them and the workers' councils (*Arbeiterräte*) owing to attempts to exclude the unions from influence in the councils.

The split in the Social Democratic party naturally brought about a division in the unions. The trade union congress in July, 1919, declared its political neutrality owing to this division. At this congress the "patriotic" attitude of the General Commission was sharply criticized, but a vote of confidence was ultimately passed. There is a strong revolutionary minority in the federation which has captured the powerful Metal Workers' Union and the Berlin Trade Union Commission. This minority is opposed to all negotiation with employers, and the joint council in the metal trades has been dissolved. The majority is in favor of a wide extension of joint councils in preparation for "the social state." The majority leaders maintain that works councils, if they are to be successful, must not be more than the organs of the unions within the various establishments, while the minority hold that they must be revolutionary agencies.

The most interesting event in recent trade union history was their entrance into the political field at the time of the Kapp coup in March, 1920. The unions organized a general strike against the usurping junker government, with the co-operation of both the majority and the independent socialists and with the approval of the public; their action was the chief cause of Dr. Kapp's failure. The federation declared that the struggle would be continued until the government granted a list of demands which included trade union "influence" over the reorganization of the government, social and economic legislation and the resignation of Herr Noske, Minister of Defense. Although the concessions made by the government were not wholly satisfactory to the unions, it is significant that such demands were made. Before the war, the unions, while closely connected with the Social Democratic party and believing in the class war, had held that all such questions should be left to

the political party, and that the immediate business of the unions was to work for improvement in the position of the workers, mainly by means of better wages and working conditions. They were active in encouraging international co-operation, and in pre-war times the great majority of the international trade union federations had their headquarters in Germany.

THE CHRISTIAN UNIONS

The religious trade union movement was first co-ordinated about 1890 in opposition to the socialism and militant methods of the "free" unions. There are three branches, the Christian, the Catholic and the Evangelical. They are strongest in the industrial and mining districts of Rhenish Westphalia, where the Catholic Church is very influential, and in Bavaria. In 1899 a Federation of Christian Trade Unions of Germany was formed to admit members of any Christian denomination. Its aims were stated to be to promote the common interests of employers and workers and to increase production. Its methods were to be conciliatory, the strike to be admitted only as a last resource. Occasionally they have co-operated with the "free" unions for common, strictly economic ends.

In 1919 a federation was formed called the German Trade Union Federation composed of the "Christian" unions, the Trade Union of Non-Manual Workers and the Union of German Officials. The membership was stated to be 1,700,000 at the end of 1919. The unions forming the new body were stated to be inspired by the conviction that not class warfare and internationalism but national consciousness and the fostering of the ideals of the German people were the right path for the future.

HIRSCH-DUNCKER UNIONS

The Hirsch-Duncker unions date from about 1868 and were due mainly to the efforts of Dr. Marx Hirsch, who drew his inspiration from the English trade unions of that period. They were meant partly to counteract the influence of the Social Democratic unions which were then springing up. They were originally political and economic associations of workingmen more or less in sympathy with the radicalism of their founder. At their congress in 1906 they declared themselves to be "neutral organizations for economic ends." They believe that the interests of employers and workers are fundamentally the same and that concessions must be obtained by agreement and not by aggressive methods, and without political action. At their congress in 1908 their aims were defined as the repudiation of class warfare and community of property, support of arbitration and conciliation in preference to strikes, and the establishment of collective agreements. At the end of 1919 they had only 188,831 members and, though this number has probably grown with the general spread of trade unionism, they have no great significance in the German labor movement.

SYNDICALIST AND COMMUNIST UNIONS

Syndicalism in Germany is organized in the associations centralized in the Free Workers' Union of Germany. They are described in the journal of the Metal Workers' Union (itself extreme), as "extremist organizations whose principles are those of class war." They are strongly opposed to social democracy. Before the war they were known first as the Federation of Syndicalists and later as the Free Association of German

Trade Unions. Since then the name has been changed several times, the name Free Workers' Union of Germany (*Freie Arbeiter-Union Deutschlands*) being adopted at the congress in December, 1919, as many workers in Germany are shy of the name of syndicalism. In some districts they are known as "localists." The writer in the *Metal Workers' Journal* states that numerically they are not strong; they had 15,000 members before the war and 110,000 at the end of 1919. A delegate at the 1919 congress said that progress had been rapid in the Ruhr district, where 90 per cent of the miners were organized in syndicalist organizations.

As the contributions exacted by the union are very low, it is unable to finance strikes successfully and prefers to adopt "ca'canny" methods and passive resistance, in order to reduce output to such an extent that the employer may be compelled to shut down his factory. The state, it is believed, would then have to hand over the establishment to the workers.

The General Workers' Union (*Allgemeine Arbeiter-Union*) is a communist organization and is the outcome of the dissatisfaction felt by the workers with the "reactionary and bourgeois" tendencies shown by some trade union leaders. Opposition to trade unions was strengthened by rumors that the Russian Communists were unfriendly to the unions and that there was no room for the latter in a soviet republic. It was asserted that there should be only one proletarian organization, whose aim should be the conquest of political power.

The Communist party refused to support these ideas, but, when the Communist Labor party was formed at Berlin in April, 1920, it refused to recognize the trade unions, because they were willing to co-operate and make compromises with capitalism.

AIMS OF SYNDICALIST AND COMMUNIST UNIONS

The most prominent feature of the bylaws of the General Workers' Union is the antipathy shown toward the Social Democratic trade unions. The union is organized on the basis of works organizations. Workers in one establishment form a "union" under the leadership of the works council. This union works in close co-operation with the Communist Labor party. Its aims are (1) to destroy the trade unions, and (2) to prepare for the communist system.

Thus the syndicalist free union and the communist general union differ widely, the former aiming primarily at industrial conquest and the latter at political supremacy. They are at one, however, in attacking official trade unionism as bureaucratic. In their opinion leaders are unnecessary, and their own spokesmen have no position of authority and no responsibility. The free union attacks all forms of centralization, and accuses even the general union of a tendency toward centralization through its co-operation with the Communist Labor party.

"YELLOW" UNIONS

The so-called "yellow" workers' movement in Germany was promoted before the war by large firms, such as Krupp's and Siemens'. The total membership before the war was 280,000. During the war their membership decreased and in a national agreement between the largest employers' organizations and all of the large workers' central organizations, concluded on Nov. 15, 1918, it was expressly stipulated that employers must sever all connection with the movement. In an article in *Freiheit* (Berlin, July 2, 1920), Herr Aufhäuser,

president of the Federation of Social Democratic Unions of Technical and Office Employees and a member of the National Economic Council, states that the "yellow" movement is being revived. The new organizations are the National Federation of German Trade Unions (*Nationalverband Deutscher Gewerkschaften*) and the National Federation of Technical Employees (*Nationaler Bund Technischer Angestellten*). They are stated to be subject to the influence of Herr Karl Friedrich von Siemens (president of the Siemens Co. and one of the leaders of the Democratic party). The actual leader of the movement is Herr Geisler, a Reichstag Deputy of the People's party. The above unions are organized in industrial groups with the avowed object (as stated in Herr Geisler's journal the *Deutsche Arbeitgeberzeitung*) of "obtaining the strongest possible representation in the works councils and of making the latter organs of increased production instead of organs of the bolshevization of the German life."

Gasoline Engine Shovel

Announcement of considerable interest to contractors and chemical engineers as well as the clay products industry comes in the nature of a new gasoline engine shovel, manufactured by the Austin Machinery Corporation of Chicago. This shovel, as shown in the



NEW GASOLINE ENGINE SHOVEL

accompanying illustration, is not a makeshift adaptation, but an entirely new design built for gasoline operation. Air-controlled clutches enable the operator to manipulate with ease, and the cushion drive clutches of the swinging and crowding devices insure the necessary overlapping of operations. All movements may be quickly reversed at any time. The swinging machinery and hoisting drums are locked by means of automatic brakes when the power is shut off. Other features of the machine include a three-lever digging control, a "slam the dipper" door, insuring a clean dipper; a power boom hoist, quick replacement of clutch bands, and interchangeability of clutch parts.

Determination of Spelter by Measuring the Hydrogen Evolved

The Kauffman-Lattimer Co., manufacturer of scientific apparatus at Columbus, Ohio, has just put on the market the Cushman Coating Tester which has recently been designed by Dr. A. S. Cushman.

The determination of the weight and spelter coating by this method is based upon the action of hydrochloric acid upon the galvanized coating, collecting and meas-

uring the hydrogen gas evolved. The weight of coating may be determined upon flat sheets, corrugated sheets and formed culverts, by the use of differently shaped rings provided with the apparatus. The coating upon wire can be determined by placing a definite length of wire under the flat ring on a glass plate.

The metallic rings used are made of nickel, tinned iron or other acid-resisting metal and are fitted with No. 12 three-hole rubber stoppers. A measuring burette and leveling bottle are provided for collecting and measuring the hydrogen evolved.

The number of cubic centimeters of hydrogen measured at 20 deg. C. (68 deg. F.) multiplied by the factor provided with each ring will give the ounces of spelter coating per square foot of actual surface on one side of the culvert. By doubling this figure the coating in ounces per square foot of sheet surface can be obtained.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Extraction of Hydrocarbons.—A mixture of sulphur dioxide and a ketone, such as acetone, is used for the extraction at ordinary temperatures of hydrocarbons from coal and for the separation of unsaturated from saturated hydrocarbons. Other ketones which may be employed are methyl ethyl ketone, diethyl ketone, methyl propyl ketone, and ethyl propyl ketone. The extraction may take place under pressure. According to examples: (1) Acetone is saturated with sulphur dioxide and allowed to remain at atmospheric temperature and pressure in contact with pieces of hard coal; by steam distillation of the reddish liquid produced a yellow oily hydrocarbon is obtained. Increasing the pressure gives a larger yield of the product; an apparatus is described in this connection. (2) The extraction of lignite or bituminous brown coal with the acetone-sulphur dioxide mixture yields a resinous wax-like substance, which apparently results from the action of the sulphur dioxide on the lignite and the solution in the acetone of the product. The lignite may previously be treated under pressure with alcoholic or aqueous caustic alkali and the residue after evaporation used for the acetone-sulphur dioxide treatment. (3) Crude naphtha, when extracted with the acetone-sulphur dioxide mixture, separates into two layers, the clearer of which, after evaporation of the acetone and sulphur dioxide, yields unsaturated hydrocarbons; the paraffine hydrocarbons remain in the other layer, being undissolved by the acetone-sulphur dioxide mixture. (4) The acetone-sulphur dioxide mixture is used for absorbing diolefines, and thereby separating them from other hydrocarbons employed or produced in their manufacture; an addition product of the diolefine and sulphur dioxide is apparently formed at ordinary temperatures, and this splits up on heating. (Br. Pat. 156,123; not yet accepted; H. PLAUSON, Hamburg, and J. A. VIELLE, Westminster. March 2, 1921.)

Chlorinated Hydrocarbons.—Chlorinated hydrocarbons of low boiling point are obtained by cracking oils of comparatively high boiling point in the presence of chlorine or hydrochloric acid. Steam may be introduced into the reaction; a contact material, such as quartz, porcelain, platinum and like metals, or metallic chlorides, may be present; and the reaction may take place under increased pressure. Specified starting materials are petroleum, mineral oils, solar oil, mazut, tar oils, resin oils, paraffine oil, and Galician or Roumanian gas oils. By elimination of chlorine from the products, diolefine hydrocarbons can be obtained. According to examples: (1) Equal parts of petro-

leum vapor, hydrochloric acid gas and steam are passed through a tube heated in a furnace. After condensation of the product and neutralization with lime, a mixture of hydrocarbons and chlorinated hydrocarbons is obtained, which can be separated by distillation. (2) Tar oil and hydrochloric acid or chlorine gas are passed over a white hot platinum spiral in an apparatus resembling an isoprene lamp. The high boiling fraction of the product is again passed through the apparatus, and the low boiling fraction of chlorinated hydrocarbons allowed to accumulate. (3) A mixture of an atomized gas oil and hydrochloric acid is forced into a heated retort. (4) A mineral oil is heated under pressure with concentrated hydrochloric acid solution in an autoclave, and after some hours the product permitted to distill over into a vessel containing lime. The chlorinated hydrocarbons deposited are then purified by fractional distillation. The reaction is facilitated by the presence of small quantities of chlorides, such as calcium, zinc, magnesium, aluminum, manganese or tin chloride. (Br. Pat. 156,139; not yet accepted; H. PLAUSON, Hamburg, and J. A. VIELLE, Westminster. March 2, 1921.)

Edible Yeast Preparations.—To improve the taste of yeast and to render it more digestible it is treated with hydrogen under heat and pressure. It may first be treated with a solution containing ammonium or sodium carbonate or borax and washed to remove the bitter flavor, and disintegrated in any known way. It is then treated with hydrogen at a pressure of 100 to 200 atmospheres and a temperature of 100 to 130 deg. C. The liquid thus obtained may be used directly, mixed with fats or oils to form an artificial milk, or dialyzed by electro-osmosis or otherwise to remove salts. The action is facilitated by the presence of small quantities of sodium chloride, or organic acids such as formic, acetic, tartaric or citric acid. The yeast may also be first reduced to a dry power and treated with hydrogen in this state. Catalysts such as nickel or palladium may be employed in masses, but not as powder. Higher temperatures and lower pressures may be employed, in which case the yeast must be washed after treatment. (Br. Pat. 156,153; not yet accepted; H. PLAUSON, Hamburg, and J. A. VIELLE, Westminster. March 9, 1921.)

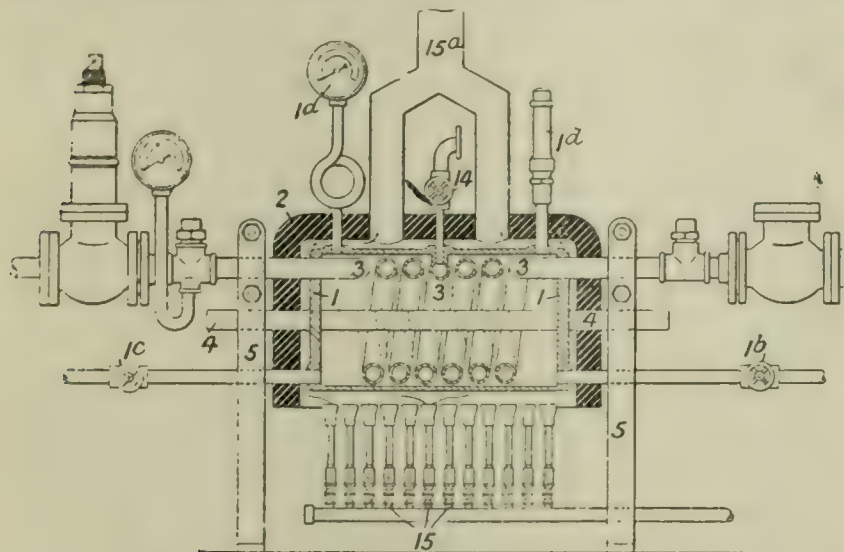
Anthraquinone.—Anthraquinone is prepared by oxidizing anthracene, preferably dissolved or suspended in a liquid medium, by means of oxygen or an oxygen-containing gas in the presence of an oxygen carrier. Thus, oxygen is passed under pressure into a hot mixture of anthracene and acetic acid containing a little fuming sulphuric acid, or oxygen containing a small percentage of nitrous gases is introduced into a hot mixture of anthracene and acetic acid containing cobalt nitrate. Similarly, anthracene sulphonic acids can be oxidized to the corresponding quinone compounds. (Br. Pat. 156,215; not yet accepted; CHEMISCHE FABRIKEN WORMS AKT. GES., Frankfurt-on-Main, March 9, 1921. See also Pats. 156,538 and 156,540.)

Tanning.—A tanning process consists in the use of mixtures of heavy metal salts of lignin-sulphonic acids from waste sulphite liquors, with salts of other organic or inorganic acids such as sulphuric, formic, lactic acid, etc., and with or without addition of other tanning or non-tanning agents. The mixed salts precipitate glue and are stated not to flocculate in dilute aqueous solutions. The following examples are given: (1) Tanning is effected with a liquor containing about 2 to 3 per cent of tanstuff prepared by decomposing an aqueous solution of 100 kg. of sodium lignin-sulphonates with 100 kg. of crystallized aluminum sulphate. The solution may be used directly or evaporated to dryness. The leather obtained is then stuffed and dried. (2) Tanning is effected as in example 1 with a tanstuff prepared by decomposing 100 kg. of calcium lignin-sulphonates with 170 kg. of crystallized ferric sulphate, the calcium sulphate being filtered off. (Br. Pat. 156,186; not yet accepted; CHEMISCHE FABRIKEN WORMS AKT. GES., Frankfurt-on-Main. March 9, 1921.)

Catalytic Oxidation of Hydrocarbons.—Hydrocarbons are oxidized to aldehyde, ketonic or carboxylic compounds by passing a mixture of their vapor with oxygen over a catalyst of a non-basic character maintained at a temperature below red heat. Suitable catalysts are vanadic acid,

molybdic acid, and salts of uranic or chromic acid, distributed over a support, such as pumice. In this way anthracene is converted into anthraquinone; aromatic hydrocarbons with side-chains give a mixture of aldehyde and acid—e.g., toluene yields benzaldehyde and benzoic acid; and unsaturated hydrocarbons of high molecular weight are converted into acids. (Br. Pat. 156,244; not yet accepted; A. WOHL, Dantzig. See also Pat. 155,245. March 9, 1921.)

Acetaldehyde; Acetic Acid.—Acetaldehyde is produced by hydrating acetylene with steam under pressure and at a fairly high temperature. The reaction is facilitated by the presence of small quantities of acids, such as acetic acid, sulphuric acid, nitric acid, phosphoric acid and organic sulphonic acids, acid anhydrides or sulphur acids. Inert gases or vapors may be employed as diluents. The apparatus comprises a pressure chamber 1, surrounded by an insulating



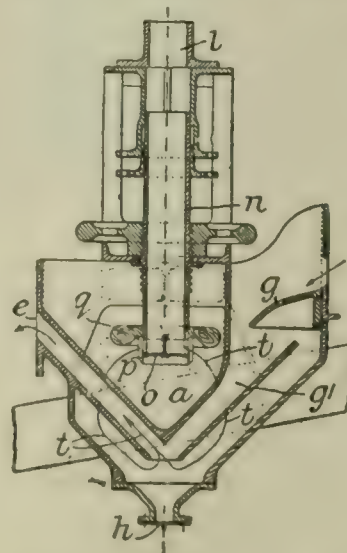
jacket 2 and supported on legs 5 above a battery of gas burners 15, the hot gases from which pass between the chamber and the jacket to the flue 15^a. The chamber 1 contains the reaction spiral 3, a pyrometer tube 4, and is fitted with steam inlet and outlet pipes 1^b, 1^c, a manometer 1^a and a safety valve 1^d. The reaction tube 3 is made of steel, iron, nickel steel, aluminum steel, nickel copper, ferrosilicon, nickel covered with gold or of steel or other metals covered with platinum, iridium, osmium, gold, etc., or with an acid-resistant enamel. The mixture of acetylene and steam in equal volumes is forced through the reaction tube, heated to 250-300 deg. C. at a pressure of 5-10 atmospheres. The product is condensed, and the unchanged acetylene again circulated through the apparatus. The catalytic acid may be mixed with the reacting gases before passing into the apparatus. Acetic acid is obtained by introducing sufficient oxygen or air through the pipe 14 into the middle of the reaction tube 3. (Br. Pat. 156,152; not yet accepted; H. PLAUSON, Hamburg, and J. A. VIELLE, Westminster. March 9, 1921.)

Acetaldehyde; Acetic Acid.—Acetaldehyde or acetic acid is prepared by forcing acetylene through a conductive porous anode, the pores of which are filled with an insoluble mercury compound. The electrolytic bath being acidic, the mercury compound is continuously regenerated by anodic oxidation. The bath is maintained at such a temperature that the product is continuously distilled off, and the pressure may be reduced to facilitate the distillation. If the potential difference between the electrodes be maintained below the decomposition potential of water simple hydration of the acetylene to acetaldehyde takes place; whereas with a potential difference above the decomposition potential of water the acetaldehyde produced is immediately oxidized to acetic acid. A suitable electrolyte is phosphoric acid, and the anode may be formed of wire netting, or perforated or corrugated sheets made of iron, steel, nickel, nickel steel, ferrosilicon, iron-nickel or iron-aluminum alloys, or copper coated with platinum or gold. The mercury compound—e.g., mercurous oxide or mercury phosphate—may be employed as such, or mixed with oxides, peroxides or porous fibrous substances such as asbestos, paper, thread, wool or cellulose ester powder, with or without binding agents. An apparatus is described. (Br. Pat. 156,147; not yet accepted; H. PLAUSON, Hamburg, and J. A. VIELLE, Westminster. March 2, 1921.)

Preparation of Cellulose.—In the preparation of cellulose from ligneous plants and plant fibers, such as jute, hemp, manila, "cotton," reeds, bamboo, esparto and the like, the materials are digested with weakly alkaline or neutral lye containing one part of an alkali acetate and two parts of an alkali sulphite under pressure. Other inert salts may be present. The waste liquor may be acidified with sulphuric acid or sodium bisulphate, and a mixture of sulphurous acid and acetic acid boiled off, the residual liquor being evaporated to dryness and incinerated to produce a raw soda lye which may be converted for re-use by adding the mixture of sulphurous and acetic acids boiled off. The waste liquor may be treated with caustic lime and then with sodium sulphate, a solution of sodium acetate being obtained and calcium monosulphite and sulphate precipitated. Sulphurous and acetic acids may be obtained from the monosulphite and acetate and used for the preparation of fresh lye. (Br. Pat. 156,512; not yet accepted; M. MULLER, Finkenwalde, Germany, and O. HEIGIS, Pilsen, Bohemia, March 9, 1921.)

Removing Carbon From Iron and Other Metals or Alloys.—In a process for removing carbon from iron and other metals or alloys by means of oxygen, the admission of oxygen is regulated in such a manner that only so much metal oxide is formed as can again be reduced by the active carbon present so that oxidation and reduction take place at practically the same rate and at the same time. The bath in which the operation takes place is externally heated and maintained at a temperature not exceeding the melting point of the metal or alloy under treatment. The oxygen is admitted by means of inclined nozzles of small cross-section so that the bath is given a circulating movement by the action of the impinging gases which may also heat the bath. The oxygen may be used in the pure state or as air with or without admixture with oxygen or other gases. Thus the carbon is removed without any appreciable loss of substances such as manganese, chromium, silicon, etc. (Br. Pat. 156,548; not yet accepted; H. SCHUTZ, Düsseldorf. March 9, 1921.)

Upward Current Ore Classifiers.—The upward current is obtained by means of a head of water in the apparatus kept constant by a float and also independently adjustable.



Water is fed to the main chamber *a* through a pipe *l* formed in two relatively adjustable sections. The outlet of the lower section *n* is provided with a cover plate *o* spaced from its end, and is surrounded by a float *q* which carries a sleeve *p* controlling the area of the outlet from the pipe *n*. The water passes as shown by the arrows *t* to an outlet *e*. The material to be classified is fed with water to a chute *g* and passes down a passage *g'*. The heavy constituents fall to an outlet *h*, while the light constituents pass up with the water to the outlet *e*. (Br. Pat. 156,226; not yet

accepted; E. P. F. JALABERT, Constantine, Algeria. March 9, 1921.)

Nitric Acid.—In the preparation of concentrated nitric acid by the absorption of nitrous gases in strong sulphuric acid, the nitro-sulphonic acid thereby produced is decomposed by means of vapors of watery nitric acid. The latter, together with a gas, preferably containing oxygen—for instance, air—are passed into the bottom of a tower packed with acid-resisting material, down which the nitro-sulphonic acid is allowed to flow. Nitrous gases and vapors of nitric acid are evolved. The latter, on condensation, form red fuming nitric acid, while the former are condensed in water and used for decomposing further quantities of nitro-sulphonic acid. The nitrogen oxides obtained by passing air through the fuming nitric acid to decolorize it are similarly employed. The concentration of the denitrated sulphuric acid is 80 per cent. Br. Pat. 156,800; not yet accepted; NORSK HYDRO-ELEKTRISK KVAELSTOFAKTIESELSKAB, Christiania, March 16, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Program of the Detroit Meeting of the A.I.C.E.

The thirteenth semi-annual meeting of the American Institute of Chemical Engineers will be held at Detroit, Mich., June 20 to 25 inclusive. A party of members from the East will leave New York for Albany on the Hudson Night Line at 6 p.m., Saturday, June 18, and take the Sunday night Detroit and Chicago boat sailing at 6 p.m. from Buffalo to Detroit, arriving there Monday at 8:30 a.m.

MONDAY, JUNE 20

Meeting at Hotel Statler

9 a.m. Business sessions, reports of council, officers and committees.

"Possible Developments of the Chemical Engineering Catalog," Dr. William M. Grosvenor.

10 a.m. Reading of papers.

Address of welcome by the Hon. James Couzens, Mayor.

"The Chemical Engineer and the Auto Industry," C. F. Kettering, chief of research, General Motors Corporation.

"The Manufacture and Application of Automobile Finishes" (illustrated), Dr. C. D. Holly.

"Monel Metal," W. M. Corse, general manager, Monel Metal Products Corporation.

"Manufacture of Pyroxylin Artificial Leather," G. C. Given.

12:30 p.m. Luncheon, Hotel Statler, \$1.25.

2 p.m. Excursion. Inspection of plant of the Cadillac Motor Co., Michigan Ave. special car.

5:30 p.m. Leave Hotel Statler for Boat Club, D. U. R. and Boat Club ferry.

6:30 p.m. Dinner dance at Detroit Boat Club. Informal, complimentary.

TUESDAY, JUNE 21

8 a.m. Leave by special interurban cars for Ann Arbor, Mich.

10 a.m. Inspection of laboratories and campus, University of Michigan.

12:30 p.m. Luncheon at Michigan Union, complimentary. Address by President M. L. Burton.

1:30 p.m. Reading of papers.

Address of President Wesson.

"The German and American Haber Synthetic Ammonia Plants" (illustrated), R. S. Tour, chief engineer, Nitrate Division, Ordnance Department, Washington, D. C.

"The Motor Fuel Situation," E. H. Leslie, associate professor chemical engineering, University of Michigan.

"The Relation of the Chemical Engineer to Highway Engineering" (illustrated), A. H. Blanchard, professor highway engineering and highway transport, University of Michigan.

"Evaporator Design," W. L. Badger, professor chemical engineering, University of Michigan.

"Control of Ferrous Materials in the Auto Industry," A. E. White, director department of engineering research, University of Michigan.

"Some Problems in Non-Ferrous Metallurgy," Dr. J. H. Ransom, chief of research, Michigan Smelting & Refining Co.

6 p.m. Dinner at Michigan Union, \$1.50.

8 p.m. Return by special interurban cars to Detroit. Those who wish to return to Detroit earlier may take the cars at 5 p.m.

WEDNESDAY, JUNE 22

9 a.m. Excursion. Leave by special cars for Ford River Rouge plant, D. U. R.

12 noon. Return to Detroit by special cars.

1 p.m. Luncheon at Board of Commerce, \$1.25.

3 p.m. Cars to ferry and Belle Isle Ferry to Walkerville. Inspection of plant of Hiram Walker & Sons, Ltd., Walkerville, Ont.

6 p.m. Barbecue on shores of Lake St. Clair, complimentary.

9 p.m. Return to Detroit.

THURSDAY, JUNE 23

8 a.m. Half-day boat trip, steamer Britannia.

12 noon. Return to Detroit.

2 p.m. Meeting at Hotel Statler. Reading of papers.

"Heat Treatment of Steel," W. A. Gatward, engineer, Hoskins Manufacturing Co.

"The Future of Aeronautics," W. B. Stout, chief engineer, Stout Engineering Laboratories.

"More Miles Per Gallon," O. C. Berry, chief engineer, Wheeler-Schebler Carburetor Co.

"The Determining Factors for the Life of a Pneumatic Tire," William G. Nelson, chemist, Morgan & Wright.

"A New Spray Nozzle for Acid Work," James R. Withrow.

"Evolution of the Glue Industry and Grease Extraction," Ludwig A. Thiele.

7 p.m. Subscription Dinner, Hotel Statler (informal), \$5.

FRIDAY, JUNE 24, AND SATURDAY, JUNE 25

Optional visits to manufacturing plants:

1. Diamond Crystal Salt Co., St. Clair. Trip will be made on Friday, June 24, boat leaving at 8 a.m. and returning in the evening. The plant of this company is the most modern and up-to-date of its kind in the world.

2. Parke, Davis & Co. Large plant.

3. Michigan Smelting & Refining Co.

4. Hoskins Manufacturing Co.

5. Acme White Lead & Color.

6. Detroit Edison Co., Conners Creek plant.

7. Morgan & Wright Co.

8. Detroit City Gas Co.

9. Dodge Bros. Motor Car Co. Fine plant.

10. Berry Bros. Paint and Varnish Manufacturing Co.

11. Schmidt Tanning Co.

12. Trus-Con Laboratories.

13. Detroit Sulphite & Paper Co.

14. Ford Motor Co.

15. Inland Delray Salt Co.

16. Pennsylvania Salt Co.

17. Michigan Stamping Co.

18. Burroughs Adding Machine Co.

19. Parker Rust Proof Co. of America.

Corrosion of Duralumin Sheet

An inspection has been made of corroded duralumin in the form of thin sheets used in the construction of all metal airplanes. The material became brittle in service owing to the development of intercrystalline "cracks" evidently as a result of corrosion. The attempt was made to produce the brittle condition in portions of the sheet which apparently were still ductile. By corrosion alone, as well as by the simultaneous action of corrosion and stress, it was possible to develop intercrystalline brittleness in the specimens. Annealing of the material, annealing followed by slight cold-rolling and severe cold-rolling of the commercial stock did not appear to affect materially the corrosion. In this case it appears certain that the deterioration was the result of the corrosion of the sheet. Brittleness developed because of corrosion from both acid and neutral solutions, but an alkaline attack did not appear to cause the development of brittleness.

Sodium Compounds in 1920

The production, imports and exports of sodium compounds all increased in the United States in 1920 over 1919, according to figures compiled by R. C. Wells, of the United States Geological Survey, Department of the Interior.

The sales of all sodium compounds and of metallic sodium amounted to 9,886,020 tons, valued at \$139,336,338, an increase of about 8 per cent in quantity and 17 per cent in value. The accompanying table shows the sales of the individual compounds.

SODIUM COMPOUNDS SOLD IN THE UNITED STATES
IN 1919 AND 1920

Product	1919		1920	
	Quantity (Short Tons)	Value	Quantity (Short Tons)	Value
Sodium acetate.....	778	\$116,667	1,020	\$143,887
Sodium benzoate.....	126	230,224	201	365,841
Sodium bicarbonate.....	134,962	3,486,635	188,906	4,256,715
Sodium bichromate.....	26,526	6,233,566	25,973	5,531,954
Sodium bisulphite.....	11,819	687,750	22,059	1,028,373
Sodium bromide.....	499	493,319	543	523,724
Sodium carbonate:				
Soda ash.....	981,054	29,895,343	1,242,490	39,083,726
Monohydrate.....	30,796	710,748	2,267	115,256
Trona.....			10,609	343,911
Sal soda.....	80,090	2,229,994	62,857	2,128,937
Sodium chloride (common salt)				
Salt in brine.....	2,850,639	1,423,424	2,819,881	1,834,362
Rock salt.....	1,642,057	6,240,450	1,683,020	7,338,079
Evaporated salt.....	2,390,206	19,410,820	2,444,002	21,334,840
Sodium citrate, tartrate, and bi-tartrate.....	33	58,128	45	67,115
Sodium ferrocyanide.....	3,437	1,346,285	2,930	1,318,049
Sodium fluoride and acid fluoride.....	(a)	(a)	934	210,782
Sodium fluosilicate.....	(a)	(a)	719	143,800
Sodium hydroxide.....	311,388	20,091,978	382,680	25,894,641
Sodium iodide.....	12	86,985	10	29,905
Sodium nitrite.....	676	151,621	140	56,184
Sodium phosphate.....	14,760	1,733,996	30,515	3,233,896
Sodium silicate.....	300,138	5,879,628	304,503	5,751,088
Sodium cyanide, peroxide and nitrate (refined)....	17,188	5,331,123	8,633	3,415,085
Sodium sulphate:				
Salt cake.....	134,685	2,035,543	184,946	2,076,350
Glauber's salt.....	42,087	860,977	44,479	963,293
Niter cake.....	83,402	271,424	308,638	788,544
Sodium sulphide.....	45,448	2,645,181	42,952	2,962,033
Sodium sulphite.....	()	()	3,778	197,782
Sodium tetraborate.....	28,518	4,351,891	35,281	5,674,012
Sodium thiosulphate.....	32,212	1,709,223	24,868	1,283,697
Other sodium compounds	2,190	1,144,883	6,141	1,240,477
	9,165,726	\$118,857,806	9,886,020	\$139,336,338

(a) Included in other sodium compounds.

(b) Included in sodium bisulphite.

Sodium bichromate, ferrocyanide, nitrite, thiosulphate (hyposulphite) and sal soda were the only compounds that showed considerable decreases in 1920. Several of the compounds made good advances over 1919, and sodium bicarbonate, bisulphite, phosphate and borax made new records.

NATURAL SALTS

The sales of sodium compounds derived directly from natural sources in 1920, exclusive of common salt, also probably made a new record. They amounted to 41,683 tons, valued at \$1,513,179, as compared with 29,120 tons, valued at \$874,083, in 1919. The salts included under this head are sodium carbonate, sulphate, trona and borax.

The following list gives the imports of certain salts in 1920 and the changes from 1919. Compounds in which there were no significant changes in imports over 1919 are not included:

Product	Quantity		Increase	
	(Short Tons)	Value	(Short Tons)	Value
Sodium carbonate.....	761	\$37,844	323	
Sodium chlorate.....	281	50,266	262	
Sodium chloride.....	137,654	686,499	78,140	
Sodium cyanide.....	3,795	1,091,443	1,208	
Sodium ferrocyanide.....	1,101	400,873	452	
Sodium nitrate.....	1,480,519	63,121,035	1,024,053	
Sodium nitrite.....	5,845	1,378,992	4,570	
Sodium silicate.....	330	15,162	131*	
Sodium sulphide.....	519	47,064	315*	
All other sodium salts	260	36,777	146	
	1,631,065	\$66,865,955	1,108,708	

* Decrease

The only compounds whose imports exceed the domestic production are sodium nitrate and nitrite. Moreover, the imports of sodium nitrate vastly exceed those of any other compound.

The following table gives the exports of domestic sodium compounds for 1919 and 1920. The table does not include foreign salts re-exported, chiefly sodium nitrate and common salt. It will be seen that good increases were made

in 1920. The total is believed to be a record. Japan, Canada and Mexico were the leading consumers of our exports.

DOMESTIC SODIUM SALTS EXPORTED FROM THE UNITED STATES IN 1919 AND 1920, BY CLASSES

Product	1919		1920	
	Quantity (Short Tons)	Value	Quantity (Short Tons)	Value
Sodium bicarbonate.....			10,321	\$616,261
Sodium carbonate:				
Soda ash.....	50,481	\$2,656,608	8,338	4,689,591
Sal soda.....	5,563	178,285	6,015	220,487
Sodium chloride (common salt).....	119,416	1,396,625	139,278	1,901,593
Sodium hydroxide (caustic soda).....	82,118	6,748,762	112,069	10,944,007
Sodium silicate.....	12,150	338,818	17,048	450,770
Sodium tetraborate (borax).....			7,163	1,206,936
All other sodium salts....		7,226,322		7,161,784
		\$18,545,420		\$27,191,429

PRICES

The prices obtained for sodium compounds in 1920 were generally better than those in 1919, although toward the end of the year the prices of most of the salts fell to about the levels they reached at the beginning of the year. Jobbers' prices appeared to be an accurate index of the consumers' demands. Sodium sulphate was in especial demand in 1920 on account of foreign bids, and it closed the year at a slightly higher price than in the previous year. The price of sodium bichromate was at one time higher than it was during the war, but fell abruptly later in the year.

In view of the differences that still exist in the costs of the various items that make up the costs of manufacture existing prices of sodium compounds now appear to be practically down to pre-war levels.

Circuit Court Reverses Federal Trade Commission on Gasoline Container Ruling

The United States Court of Appeals for the Second District has handed down a decision reversing the ruling of the Federal Trade Commission of April 27, 1920, which ordered the Standard Oil Co. of New York and the Texas Co. to cease furnishing gasoline containers to retail dealers at a nominal rental.

The ruling was made by the Federal Trade Commission, after taking a great deal of testimony, to the effect that both companies were engaged in the practice of supplying tanks, pumps and other devices to retail dealers for the supplying of gasoline to automobiles, for which only a nominal rental was charged. The commission found that neither company was engaged in the manufacture of such equipment, and held that such practice tended to create a monopoly, inasmuch as the retail dealer would furnish only gasoline made by the company which supplied the equipment.

The petitions of the companies for a reversal of the order were submitted to the court without argument.

The opinion of the court, which was written by Judge Hough, states that the court was unable to find there was any contract between the companies and the retailers by which the latter were restricted to the use of a certain container or from selling any brand of oil. The court held, however, that it would be unfair and dishonest for a retailer to sell the product of one company from the container supplied by another and that all that secured trade for the wholesaler was the amount of business which the retailer could secure in his community through obviously fair and honest practices.

It was possible, the court held, that where any system of distribution of an article of prime necessity and enormous consumption is well established, temptation may arise through competitive distribution to enter into treaties for regulation of price, classification of customers and division of the areas supplied, thus creating a sphere of influence—one for each of the distributing parties.

However, the court held that such a condition did not exist under the facts submitted, and from the testimony adduced at the hearing, held that the system was extremely advantageous to the company, economical and not unfair in law. The leases as made, the court held, did not constitute a violation of section 3 of the Clayton act and the ruling of the commission was ordered reversed.

Conferees Agree on Emergency Tariff Bill

With the exception of a reduction from six to three months in the time during which the War Trade Board may continue to exercise its authority over dye imports, the dye-stuffs title of the emergency tariff bill was unchanged by the conferees. The conferees agreed upon various compromises at a late hour on May 18, after a series of very acrimonious sessions. The principal differences between the conferees, however, had to do with the administrative features of the bill.

Merchants' Association of New York Urges Increase of Patent Office Salaries

In accordance with action taken by the board of directors of the Merchants' Association of New York appeal has been made to Congress to increase the personnel and compensation of the employees in the Patent Office. This appeal took the form of a letter addressed by S. C. Mead, secretary, to the members of the Committee on Patents of the House of Representatives as follows:

The Merchants' Association of New York desires to be recorded with you, as chairman of the House Committee on Patents, as in favor of the enactment of H.R. 210, a bill to increase the force and salaries in the Patent Office. As we understand it, this bill is identical with H.R. 11984 in the former Congress, which finally failed of passage.

Our committee which has jurisdiction over these matters is of the unanimous opinion that an increase in the personnel and morale of the employees in the Patent Office is necessary in order to clean up the large amount of applications awaiting the attention of the Patent Office.

In this connection we desire to be on record as in favor of the bill as it now stands and to record our opposition to the amendment which was attached to H.R. 11984 while in the Senate, this amendment providing for placing in the hands of the Federal Trade Commission jurisdiction over certain patent procedure. It is the belief of the Merchants' Association of New York that the enactment of H.R. 210 in its present form and without any such amendment as was added to the former bill is desirable.

Superpower Survey Meeting

Prior to completing its final report on June 30, the Superpower Survey held a meeting in New York on May 13 at which members of its advisory board and several guests were invited to discuss the physical, legal and financial phases of the problems under consideration. Prof. L. P. Breckenridge, chairman of the advisory board, presided. W. S. Murray, chairman of the Superpower Survey, discussed the physical features, E. G. Buckland, vice-president, New York, New Haven & Hartford Railroad, the legal aspects and W. S. Barstow, president, W. S. Barstow & Co., the financial phases. In addition to those just mentioned, the following were present: Dr. George Otis Smith, director of the United States Geological Survey, which is conducting the superpower survey; General Guy E. Tripp, chairman of the board, Westinghouse Electric & Manufacturing Co.; Thomas E. Murray, president of Thomas E. Murray, Inc., consulting engineer; H. I. Harriman, president, New England Power Co.; A. J. Sheldon, Lee Higginson & Co.; M. W. Alexander, chairman National Industrial Conference Board; C. L. Edgar, president of the Edison Electric Illuminating Co. of Boston; George Gibbs of Gibbs & Hill, consulting engineers; Colonel Charles Keller, Board of Engineers for Rivers and Harbors; Arthur D. Little, of Arthur D. Little, Inc., chemist; James H. McGraw, president McGraw-Hill Co., Inc.; J. H. Pardee, president J. G. White Management Corporation; Walter Thayer, Pennsylvania R.R.; Henry Flood, Jr., engineer-secretary Superpower Survey.

PHYSICAL ASPECTS

W. S. Murray in his summary of the physical aspects of the survey pointed out that had the facilities which he is advocating for the superpower zone been in existence during 1919 the coal savings would have amounted to 4,300,000 tons for the utilities, 9,566,000 tons for the railroads and 11,000,000 tons for the industries, or a grand total of 24,866,000 tons. If the generation of power continues unco-

ordinated, he contended, the annual coal waste will be 50,000,000 tons by 1930, which at \$5.35 a ton would represent a monetary loss of \$266,500,000. Mr. Murray estimated that the project would require \$100,000,000 each year for the next ten years.

DISCUSSION

In answer to E. G. Buckland, who asked how much less than \$100,000,000 per year would be required by the separate utilities to take care of increasing business without the superpower company, W. S. Murray said that more money would be required for construction by individual companies than would be necessary for the superpower system.

Mr. Edgar agreed with Mr. Murray that there was nothing in the superpower proposition that has not already been done. What has already been done over 600 miles will be applied to over 30,000 miles. The educational value of Mr. Murray's report should be great, he said.

The legal and financial phases were also discussed at length. Several important legal difficulties which would have to be overcome were cited by H. I. Harriman in the development of his argument that the superpower company should be organized under a federal charter rather than under a charter granted by any state. He indicated several obstacles to interstate business embodied in laws of several of the New England States. These obstacles he thought could be overcome more readily under a federal charter. On the other hand, Dr. George Otis Smith said that the project should not be owned or operated by the Government and called attention to the conservation by the project of financial as well as physical resources.

Regarding the educational value of the project James H. McGraw said that the superpower plan should appeal to the "man in the street" because the results can be demonstrated. Prof. Breckenridge pointed out that the wage earner in this country uses two and a half to three and a half times as much power as the wage earner in Europe—another strong appeal to "the man in the street."

To Urge Continuance of Muscle Shoals Dam

An investigation of the whole Muscle Shoals proposition has been made by a committee of the Farm Bureau Federation. This is the principal organization of farmers represented in Washington. The committee is now preparing its report and declines to comment on it in advance of its completion, but it is understood that it will urge strongly the resumption of work on the Wilson dam at Muscle Shoals at the earliest practicable moment.

Representative Graham, who as the head of the committee which investigated war expenditures evinced particular enmity to the Muscle Shoals project, has introduced a bill authorizing the Secretary of War to lease the dam and Nitrate Plant No. 2. The Farm Bureau committee is said to be opposed to any such plan because of the difficulty likely to arise in arranging for the manufacture of cyanamide by other than the Government. Other objections are that Congress would demand such safeguards in connection with a lease as to make it impracticable from the commercial standpoint. The Graham bill provides that the Secretary of War may lease Plant No. 2 for a period not to exceed twenty years to any co-operative agricultural association or corporation. The lease is to include the steam power plant and may be extended so as to empower the lessee to complete the dam. The bill provides that the lessee must provide a bond to guarantee the maintenance of the plant in good condition. It is to be surrendered to the United States at any time on the demand of the President when it may be required for military purposes. The bill further specifies that the plant must be maintained as an air nitrate operation.

Chemical Warfare Service Appropriation

The appropriation for the Chemical Warfare Service for the next fiscal year is \$1,350,000 in the Army bill as passed by the House. An effort will be made to increase the amount in the Senate. This is one-sixth of the amount originally requested by General Fries and less than one-third of the amount declared by the Secretary of War to be necessary to the proper conduct of that service.

Physical Methods for the Chemist

Optical methods as servants of the chemist were discussed in a symposium at the Chemical Society of Washington on May 12. At this time five speakers developed various phases of optical measurement or investigation which afford large promise in both the routine and the research branches of pure and applied chemistry.

QUANTITATIVE SPECTRUM ANALYSIS

"Quantitative Spectrum Analysis" was the title of the first paper, which was by W. F. Meggers, of the Bureau of Standards. This speaker pointed out that following the elementary use of the platinum wire and bunsen burner for identification of materials by the color of the flame most chemists fail to utilize spectrum analysis further in their scientific work. It has quantitative as well as qualitative possibilities in chemical as well as in stellar analysis, and with the proper recognition of modern methods is applicable to a number of particularly difficult analytical problems.

SPECTRO-PHOTOMETRIC METHODS

W. E. Mathewson, of the Bureau of Chemistry, discussed the application of spectro-photometric methods to the estimation of colorless substances. Using a suitable spectro-photometer the accuracy depends upon the matching of the brightness of two fields. With ordinary light this matching cannot be accurately done because the percentage change in transmission of white light is not of sufficient magnitude in most cases. However, using monochromatic light or observing the transmission of certain parts of the spectrum a much greater percentage variation of the transmission can be noted with a given change in concentration. Dr. Mathewson applies this method to solutions of colorless materials after treatment of the material to be identified so that it is converted into a colored substance or dyestuff.

DIRECT-READING SPECTRO-PHOTOMETER

I. G. Priest described the form of direct-reading spectro-photometer for measuring the transmissivity of liquids which he has developed at the Bureau of Standards. A beam of monochromatic light is divided into two parts, one of which passes directly to the observing telescope through a sector disk of variable transmission. It is compared by photometric methods with the second part of the beam which passes through the solution to be tested. The distance between the inlet and outlet prisms which conduct the light into and out of the solution may be varied. An equal brightness of the two beams can be established either by adjusting the opening in the sector disk or by varying the distance between the prisms—that is, varying the distance within the solution through which observation is being made. The instrument reads directly in terms of the extinction coefficient or the percentage transmission, as well as in terms of depth of liquid and percentage transmission of the disk.

The apparatus is applicable to colorimetric investigation of vegetable oils, dyestuffs, sugar solutions and other colored liquids. Moreover, the results give a scientific definition of color independent of the characteristics of the illumination or the personal defects of vision of the observer.

POLARIMETRY

F. J. Bates, chief of the sugar laboratories of the Bureau of Standards, discussed the possibilities and applications of polariscopic methods in chemical investigations. He pointed out that for many years an error in the standards of about one-tenth per cent was the cause of many unexplained discrepancies in this work. However, this cause of difficulty has now been eliminated and it is possible to do polariscopic work with apparatus good to one one-thousandth circular degree and with apparatus of variable sensitivity suitable for a wide variety of materials.

Tool's application of the Brace half-shade principle permits further work on double refraction of materials under strain and measurement of different phenomena. This combined with determinations of magnetic rotation affords possibilities for the identification of oils. For example, a

single observation is often sufficient to show whether a fuel oil or gas oil is a straight-run product or has been partly cracked. Obviously the straight-run oil is vastly more satisfactory for gas making or gasoline manufacture than an oil which has already been partly cracked. Therefore this difference is of very great importance. Similar applications in other fields are expected by Dr. Bates.

CRYSTAL OPTICS

F. E. Wright, of the Geophysical Laboratory, discussed the application of crystal optics in chemistry. He pointed out that the methods used in this field are of much greater complexity from a practical standpoint than in the other fields discussed. Long and continued experience in the use of these methods is of greater importance than in the other cases, and it is obvious, therefore, that the chemist cannot expect to get as much in this province of optics as in the others.

University of Chicago Reports Favorably on Plan for Scientific Research

Wallace Heckman, counsel and business manager of the University of Chicago, in his annual report favors the plan for promotion of scientific research as outlined by William Hoskins and Russell Wiles in *CHEMICAL & METALLURGICAL ENGINEERING*, issue of April 20, 1921, page 689. The text of his announcement is as follows:

"Men engaged in research in our scientific laboratories frequently obtain results of importance which, if accomplished in commercial laboratories, would be gratifyingly valuable in financial returns.

"It is well known that the reports, addresses and talks of advanced scientific men are closely attended to by those who are acquainted with the value of what is being done and discovered, and these discoveries are actually patented and realized upon by those having no relation to the work and not entitled to those returns.

"This laboratory work is conducted upon high ethical principles, and the individuals conducting these researches disdain to derive the personal benefits from them which the law would justify. If, to the results of this work educationally and scientifically, its financial value can, without injury to these other values, be conserved, it would place the institution in possession of additional and legitimate resources.

"The advantage of such a course to these laboratories would seem to be obvious. These legitimate returns might reasonably be expected ultimately to provide the amplest equipment and provisions for these departments."

It is interesting to note that the text of the article mentioned above was submitted by Mr. Hoskins to the university many months ago and the official notice of the favorable action of the university was not made public until May 9, 1921.

Weights and Measures Conference

The fourteenth annual conference on weights and measures is in session (May 23-26) at the Bureau of Standards in Washington. Pending legislation looking to the adoption of the metric system of weights and measures is to be one of the subjects discussed at this conference. Other matters which will be taken up include: The slack-filled package bill; proper sealing of commercial weighing and measuring apparatus; the weight problem in interstate commerce; enforcement of bread weight legislation; testing of liquid-measuring devices; standardization of containers for food; net weight-marking on packages of commodities other than foods.

Chemical Exhibition at Wilmington

During the week of May 10 the National Research Council, Washington, D.C., held an interesting and instructive chemical exhibit in the lobby of the Hotel du Pont, Wilmington, Del., under the direction of Major H. S. Kimberly. The exhibition covered the work of the Chemical Warfare Service, and was brought to the city through the efforts of the local Chamber of Commerce. A complete model of an American dye manufacturing plant was also shown.

Supreme Court Ruling on Mixed Acid

The Supreme Court of the United States in an opinion May 16 in the case of the United States vs. the Aetna Explosives Co. ruled that "The applicable tariff act granted free entry to both nitric and sulphuric acids and viewed practically the commodity in question was nothing more than nitric acid rendered non-injurious to steel tanks by adding sulphuric acid of small value. The two acids do not interact and the result was a mere mechanical mixture not intended or adapted as such for commercial use and not a chemical mixture," within the true intent of the statute. The case arose from the importation of nitric acid by the Aetna Explosives Co. from Canada during the war. The acid, intended for use in the manufacture of explosives for the Navy, was mixed with sulphuric acid in order that it might be shipped in compliance with the law. Customs officials ruled that this mixture formed a new compound which was dutiable.

Improved Conditions in Leather Industry

Recovery from the abnormal conditions which existed in the leather industry during 1920 is indicated in the following statement by Vice-President Julius Hollander, of the Amalgamated Leather Co.:

"The leather business looks very promising. It is bound to increase as the season progresses and I sincerely believe that we are going into quite an active season. Stocks of raw skins in this country are very small. The situation is righting itself very materially. In our business we are getting hurry calls right along for kid. Buyers are purchasing today from necessity because of depleted stocks. This makes for a fundamentally sound condition. In 1919 if a man needed only 1,000 dozen skins he would buy perhaps 2,000 dozen. Today the situation is reversed. There is no disposition to load up."

Electric Heating Exhibit

During the week of June 6 practically all of the electrical appliances for industrial and domestic heating that have been perfected within the past five or ten years will be exhibited at the showrooms of the New York Edison Co., Irving Pl. and 15th St., New York. Forty-one manufacturers will be represented and at least one hundred different applications of electric heat will be shown. These include self-contained units for localized heating capable of producing very high temperatures, tubular heaters for oil, paraffine and other flammable liquids where an exposed flame is dangerous and a wide range of industrial heating equipment.

No admission fee will be charged and the show will be open every day from 9 a.m. to 6 p.m.

Many New Chemical Companies Formed

During the first four months of the present year new chemical companies with an aggregate capital of \$49,900,000 were organized and incorporated in the United States, as compared with a total capitalization of \$64,863,000 for similar industries in the same period of 1920. In March thirty-two companies with individual capitalization of \$50,000 and over were formed, with an aggregate capital of \$11,765,000. In April twenty-eight such companies were organized, with a total aggregate capitalization of \$9,390,000. In April, 1920, the companies in this line which were formed had a total capital of \$4,675,000.

Reprint of Nitrogen Report Asked

A resolution has been introduced in the Senate asking that a reprint be made of the report of the Secretary of Agriculture concerning ammonia, nitrogen and nitrogenous materials manufactured, imported and used in the United States. The report was sent to the Senate April 8, 1918.

No Chance for National Daylight Saving

It has been decided definitely by the committees of Congress having jurisdiction over daylight saving bills that the subject is not to be given consideration. This puts an end to the hope that daylight saving might again be made national during the coming summer.

Chemical Exhibit Draws Crowd

When the National Research Council obtained permission to display its chemical exhibit in the caucus room of the House Office Building a precedent was established in that this is the first time that an exhibit of this character has been staged in the halls of Congress on Capitol Hill. The exhibit was on display throughout the week beginning May 16. Since Capitol Hill is the mecca of every tourist and most business visitors to Washington, an opportunity was given to enlighten a large number of persons as to the relationship between the chemical industry and the national defense.

The exhibit was made realistic and attractive by models showing how the crude materials were carried through their various processes. Special effort was made to emphasize the fact that the primary processes are the same whether the products are to be those of peace or those of war.

An interesting part of the exhibit was the display of American-made dyes, flavoring extracts, coloring extracts, perfumes and coal-tar products. There were cleverly executed charts bringing out some of the salient facts concerning the relationship of chemistry and the national defense. The Chemical Warfare Service also displayed one of its exhibits. Judging from the expressions of visitors it was clear that the exhibit was successful in that it demonstrated that the wizardry of the chemist is essential for industry as well as for war.

Personal

T. E. BARKER, for fourteen years production manager of the Miehle Printing Press Co., Chicago, has resigned to accept a post with the Denver Rock Drill & Manufacturing Co. Mr. Barker has been prominently identified with the early development of the American Society for Steel Treating, serving as first chairman of the Chicago Section of the Steel Treating Research Society, two years as national president of the American Steel Treating Society, and is now acting as first vice-president of the American Society for Steel Treating.

W. F. CARMAN of the China Chemical Co., New York, has returned from a business trip to Europe.

CHESTER M. CLARK, formerly head of the corporation department of Stone & Webster and secretary of the underlying corporation of Hog Island, has become treasurer of Arthur D. Little, Inc., in the place of W. W. Caswell.

SIDNEY COHN, president of the Pacific Chemical Co., New York, sailed on the Mauretania, May 12, for a four months' business trip in England, France and Germany.

BENJAMIN S. DOWELL of the du Pont Chemical Co., Elkins, W. Va., has been appointed secretary of the local Chamber of Commerce.

J. A. GERBER has resigned as manager of the chemical department of the Caravel Co., New York, to organize the Federal Chemical Co., Nitro, W. Va., of which he will act as head.

ANDREW H. GREEN, JR., formerly manager of the Detroit plant and also vice-president in charge of the Detroit works of the Solvay Process Co., was recently placed in complete charge of all technical and operating departments of the company, with headquarters at Syracuse, N. Y.

DONALD M. NELSON, who has worked up through the chemical organization of Sears, Roebuck & Co., has recently been made manager of the clothing department for this concern. Mr. Nelson is looked upon by the chemical profession of Chicago as being one of the best informed men in the textile industry.

T. A. PATTERSON has resigned his position as assistant superintendent of the Niagara Alkali Co., Niagara Falls, N. Y., to accept a position as superintendent of the Belle Alkali Co., Belle, W. Va.

Dr. FREDERICK BELDING POWER, in charge of the phytochemical laboratory of the U. S. Department of Agriculture,

has been presented a gold medal by Henry S. Wellcome, of London, in recognition and appreciation of distinguished services to science as director of the Wellcome Chemical Research Laboratories. Dr. Power has been with the federal government at Washington for several years, but was in London for more than eighteen years engaged in the work for which he has been thus honored.

HUGO SCHLATTER of Wilmington, Del., who for several years has been manager of the Chemical Products Division of the Hercules Powder Co., has resigned his position and is planning a trip to Europe in June. While abroad Mr. Schlatter will visit a number of manufacturing plants and will make special investigations and reports for firms in the United States which have taken advantage of the opportunity to have him execute technical commissions for them.

MARTIN R. SUMNER, formerly chief engineer for New England for Fred T. Ley & Co., and of the staff of the Fuller Development Co., has joined the staff of Arthur D. Little, Inc., as chief engineer.

Obituary

GEORGE J. FORAN, engineer, art collector and member of the committees on condensing apparatus of the U. S. Shipping Board and the War Industries Board during the war, died recently at his home in New York City, after an illness of several weeks. Mr. Foran was manager of the condenser department of the Worthington Pump & Machinery Corporation and the associated companies of the International Steam Pump Co. from 1901 until his death. He was born in Boston, Mass., Jan. 22, 1862.

FRANKLIN KNIGHT LANE, Secretary of the Interior in President Wilson's Cabinet, died at Rochester, Minn., May 18. Mr. Lane was born near Charlottetown, Prince Edward Island, on July 15, 1864. In his childhood the family removed to California and he was educated at the University of California, class of 1886. He then engaged in newspaper work, came to New York for a time as the correspondent of various Western papers and later became editor and part owner of the Tacoma (Wash.) *Daily News*. Having been admitted to the California bar in 1889, he engaged in legal practice and began to give some attention to politics. His first public office was that of corporation counsel of San Francisco, which he filled from 1897 to 1902. In 1905 President Roosevelt appointed him a member of the Interstate Commerce Commission, in which place he remained for eight years. He won the reputation of being a constructive statesman of broad principles and progressive ideas and attracted the favorable attention of men of all parties throughout the nation. Indeed, his repute became international, for in 1910 he was elected a member of the permanent International Railway Commission which was organized at the International Railway Conference at Berne, Switzerland. Mr. Lane was made Secretary of the Interior in the first Cabinet of President Wilson in 1913. During America's participation in the World War, Secretary Lane was a member of the Council of National Defense and was active in Red Cross affairs and was chairman of the National Industrial Conference which was convened because of conditions created by the war. As chairman of the Railroad Wage Commission in 1918 he was chiefly to be credited with averting a number of strikes and settling numerous disputes. At the end of the war he was energetic and farseeing in plans for the restoration of normal conditions. He devised methods for the profitable employment of the returning troops, advocating legislation which would settle upon agricultural lands all soldiers who wished them, and urged Congressional legislation for the complete naturalization of all foreign-born soldiers. On Feb. 7, 1920, he sent to the President his resignation, to take effect on March 1 following. The reason which he gave for this action was the necessity that he should "think of other duties." Mr. Lane received the honorary degree of LL.D. from New

York University, the University of California and Brown University. He was married on April 11, 1893, to Miss Anne Wintermute, of Tacoma, Wash., who survives him with their two children—Mrs. Nancy Lane Kauffman, of Washington, and Lieutenant Franklin K. Lane, U. S. A., of Los Angeles, Cal.

JOHN MCQUADE, president of John McQuade & Co., Brooklyn, N. Y., manufacturer of paint, died recently at his home in that city.

CHARLES HOSMER MORSE, founder and chairman of the board of directors of Fairbanks, Morse & Co., died May 5 at his home in Winter Park, Fla., after an illness of several weeks' duration. Mr. Morse was a pioneer in the field of oil engine development, having worked with the inventor of the gasoline engine, James A. Charter, in the early '90s and subsequently developed considerable apparatus in the electrical and railway appliance fields. He is survived by his wife, Helen H. Morse, and two sons, Charles Hosmer and Robert Hosmer, both of whom have been associated with him in business for many years.

Dr. EDWARD BENNETT ROSA, chief physicist of the Bureau of Standards, died suddenly at his desk on May 17. Dr. Rosa was born in Rogersville, N. Y., in 1861 and was graduated from Wesleyan University, Middletown, Conn., in 1886. Five years later he received his doctor's degree from Johns Hopkins University. He returned to Wesleyan as a professor of physics, where he invented a number of measuring instruments, besides conducting important investigations in dielectric measurements, alternating-current wave forms, electromagnetic units, etc. In 1901 he joined the Bureau of Standards as a physicist. Much of the work which was done under his direction at the bureau is of fundamental importance to electrochemical as well as electrophysical investigations. These researches include studies of dry cells and storage batteries, the basic work on the mercury ohms, standard cell investigations of international significance, and the finest work on the silver volt-ammeter which has ever been done. Dr. Rosa had an exceptional appreciation of the value of chemistry and the chemist in physical research, and was most successful in combining physics and chemistry for fundamental work that neither science alone could accomplish. He was a fellow of the American Institute of Electrical Engineers, a former director of the Illuminating Engineering Society and was one of the most active members of the American Engineering Standards Committee. Dr. Rosa had been a member of the International Electrical Commission, was honorary secretary of the International Electrical Congress held in San Francisco in 1914, and in 1913 was elected to the council of the French Physical Society.

ADOLPH SORGE, JR., well known in engineering circles in Chicago, died May 5. Mr. Sorge was a graduate of the Stevens Institute of Technology of the class of 1875. After leaving school he went with the E. W. Bliss Co., Brooklyn, N. Y., and in 1893 he became general manager of the Wood-Mosaic Co. of Rochester, N. Y. While in Rochester he acted as adviser to Selden in framing the claims of the famous automobile patent subsequently issued to the latter. In 1895 he became general Western representative of the Harrison Safety Boiler Works of Philadelphia, subsequently incorporated as the H. S. B. W.-Cochrane Corporation. He was the first to see the advantages of heat in the chemical treatment of water for the removal of hardness, and the present Sorge-Cochrane hot process water softener is a further development of ideas originally patented by him. He was often consulted on steam plant problems and his skill in rectifying defective steam plant piping was widely known throughout the West. He was one of the originators and founders of the Technical Club of Chicago and was also a member of the Engineers clubs of Chicago and New York, as well as of the American Society of Mechanical Engineers. His command of concise, perspicuous English was exceptional and he also spoke French and German fluently, enjoying an extensive acquaintanceship among European engineers. His home was in St. Joseph, Mich., where he gratified his love for country life and things agricultural. His wife survives him.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, May 23, 1921.

The general condition of the chemical market during the past week has been somewhat similar to that noted recently. There is a marked gradual increase in confidence all around and outside developments seem to be working favorably toward establishing the market on a stable basis. Although buyers have not come into the market to any appreciable extent, the influx of miscellaneous inquiries is growing larger and there is no doubt that consumers are taking a greater interest in market developments than for some time past. There have been several large inquiries on the market from Japan, and while these have not resulted in the actual consummation of important business it is very significant that conditions are improving in the East. It looks as if the Orient will be a large buyer before the year is over. The passage of the emergency tariff bill by the Congress will regulate the prices at which foreign sellers can compete with domestic commodities. *Nitrite of soda* responded immediately to the prospects of the tariff law becoming effective in the very near future.

READJUSTMENT OF FREIGHT RATES NEEDED

One of the most unfavorable features confronting the chemical producers at the present time is the railroad freight situation with its abnormally high rates. A reduction in rates would no doubt have a stimulating influence on many branches of industry throughout the country. With a prompt reduction in freight rates a readjustment of prices will likely take place on the more important basic chemicals. The signing of the reparations agreement with the German Government is an important factor toward speeding up reconstruction work, which is practically depending on the industrial world. A general reduction in labor costs is spreading in various parts of the country without any noticeable disarrangement. In summarizing, it is apparent that freights are going to be lowered. Costs are being regulated more closely and the foreign situation has shown signs of a gradual improvement. It seems almost certain that a credit system will be established with Europe to permit the purchase of raw materials. All these features show that the intense problems facing business are being slowly solved and the drift of events is decidedly encouraging to the restoration of better times.

CITRIC AND TARTARIC ACID PRICES DECLINE

Among some of the price changes during the week was a decline in *citric acid* prices on spot and a similar decline in imported *tartaric acid* quotations. The absence of any demand has brought on a keener state of competition among holders and price shading was inaugurated with the idea of increasing business. Makers of *acetone* reduced prices more in line with the cost of production. *Yellow prussiate of soda* held its recent advance well, under small lot trading. *Nitrite of soda* was one of the strongest items on the list and the position of the market appears much stronger through prospective tariff legislation. Solid *caustic soda* and light *soda ash* have remained very steady with producers placing fair sales for domestic use in soap, textile and glass industries.

CHEMICALS

Strength in the spot market on *bichromate of soda* was a feature and a good call was reported for small lots from the consuming trade. Resale offerings are relatively small and sellers are asking 8@8½c. per lb. for standard brands with sales reported at the inside figure. Some resale domestic *caustic potash*, 88-92 per cent, was offered at 5½c. per lb. on spot. There are sellers of the imported at 6c. and upward depending upon quantity. Producers'

views are unchanged on this grade and 12c. per lb. was being quoted f.o.b. works. Manufacturers report sales of *chlorate of soda* at 7½c. per lb. works for prompt shipment. A moderate inquiry is reported for domestic consumption. Sales of *nitrite of soda* were made during the week as high as 7¾c. per lb., with some sellers asking all the way up to 8½c. Some holders have withdrawn their offerings from the market, as they are firm in the belief that higher prices will soon be recorded. Buyers are showing considerably more interest in the situation and there is a very confident feeling in trade circles. Dealers in foreign *prussiate of soda* report a firm spot market and state that business is going through in small lots at 12½@12¾c. per lb. Offerings are not heavy and there seems to be a disposition to tighten up in some quarters. Resale offerings of light *soda ash* are gradually decreasing and the spot market shows an extremely firm tendency. Most dealers are not willing to shade \$2.10 per 100 lb. on single bags and some are asking above this figure. The best price heard on ash in barrels was 2¾c. per lb., while 2½c. was asked in several directions for limited quantities. Dealers in *bleaching powder* report additional sales on a basis of 2¼c. per lb. f.o.b. works in large drums. Spot material is held at 2¼c. and upward according to quantity. Resale lots of *sulphide of soda*, 60-62 per cent, fused, were offered at 5½c. per lb. spot N. Y. There is a pronounced scarcity of resale offerings of ground sulphide and the market is quoted firm. *Yellow prussiate of potash* continues in relatively limited supply and the market is quoted steady at prices ranging from 26@28c. per lb. Demand has not been markedly active for this chemical, but buyers have found a stiff proposition when they attempted to operate. Trading in *formaldehyde* is reported at 14½c. per lb. on spot in barrels. The price range extends upward to 15c. depending upon quantity and seller. Small lots continue to merit the most attention, but there seems to be an absence of round lot transactions.

COAL-TAR PRODUCTS

A gradual improvement in the various industries which directly affect the coal-tar products market is commencing to be reflected in different quarters of the trade by inquiries and orders for items that have long been dormant. Silk piece goods business is picking up and the woolen market is rapidly gaining strength. Along the line of colors and dyestuffs, the reports of manufacturers find the demand spreading. A good call from foreign sources has started and an immediate improvement in this field is expected to continue along steady lines. With the emergency tariff bill and protection against dumping practically assured, the general tone of the market is far more optimistic than at any previous time this year.

The intermediate market is decidedly firmer and calls have been received recently for some inactive items. Factors in home quarters report a regular supply of *alpha naphthylamine*. The volume of inquiries is light and very little business is said to be passing. Prices have shown very little change from the former level and range from 35@40c. per lb. The market for *anthracene* is of a routine nature, with a limited supply moving into consuming channels. There has been no change in the market price, which ranges from 85c.@\$1 per lb. for the 80 per cent grade. The consuming demand for *phthalic anhydride* continues along routine lines and the same may be said of the crude. Supplies are easy with quotations ranging from 50@60c. per lb. Business in most quarters on *alpha naphthol* is reported as dull. Producers have made no recent change in prices, which are quoted on a basis of \$1.10@\$1.15 per lb. for the crude and \$1.25@\$1.30 for the refined material. Trading in the market for *dinitrotoluene* is limited to small lots. Supplies are of a fair volume and range in price from 25@27c. per lb. The market on *ortho-nitro-phenol* reflects a firm tone and a steady demand for supplies is heard in some directions. Available supplies are rather light and quotations range from 80@85c. per lb. Some factors report the consuming demand for *para-toluidine* of small volume. Prices are quotably unchanged at \$1.25@\$1.40 per lb. Consumers seem to be fairly well supplied with *aniline oil* for the time being and only small lots are in request at irregular intervals. Supplies are easy and while some holders

are steady in their views at 20@26c. per lb. shading is possible on a firm order.

VEGETABLE OILS

Offerings of spot *chinawood oil* were scanty and holders in some directions were asking up to 14c. per lb. on small lots. May-June-July shipments from the East were offered on the basis of 10½c. per lb. c.i.f. N. Y. No sales of round lots of *coconut oil* were reported. The Coast market for *Manila oil* closed at 8c. per lb. bid and 8½c. asked. sellers' tanks May-June shipment. For June-July contracts it was reported that 8c. could have been done on a firm bid. *Ceylon grade oil* on the spot was firm at 10½c. per lb. asked. It has just come to light that a prominent soapmaker has purchased 1,000 tons of *palm oil* for shipment from either Liverpool or Africa at purchaser's option. It was intimated that the market was shaded considerably for this deal. Several crushers of *linseed oil* moved the prices up to 73c. per gal., carlot basis. Shrewd buyers, however, could have still purchased May-June shipment at 70c. per gal. Foreign cables on linseed oil were higher, with the Dutch product advanced to 68c. per gal. c.i.f. N. Y., duty paid, May-June shipment from Rotterdam. English oil was offered at £39 per ton, prompt shipment, cooperage included.

WAXES

The market on *beeswax* was fairly steady, demand being rather quiet. African crude was generally held at 16@17c. per lb., but an occasional odd lot appeared on the market at a concession. Brazilian crude was held at 24@26c. per lb. Pure white, refined, was quoted at 40@45c. per lb. according to brand and quantity. Importations of *carnauba wax* during the past week amounted to several hundred bags. The market was irregular, offerings of spot goods having increased of late. Most of the business noted was among dealers. The No. 2 North Country was quoted on a basis of 28@30c. per lb. No. 3 North Country was held at 16@17c. per lb. Offerings of *Japan wax* for spot delivery were noted at 18@18½c. per lb. This really is the normal quotation. On forward shipments 15c. per lb. was quoted with the market barely steady. Competition in *paraffine wax* for the business pending, which was not of any large volume, resulted in further unsettlement in prices. Scale wax, 122-124 deg. melting point, was offered at 2½c. per lb., carlot basis, with the 124-126 material available at 2¾c. Match wax could have been bought at 3¼c. per lb. Refined wax of 120-122 deg. melting point was offered as low as 3½c. per lb., with the 135-137 deg. melting point held at 5½c. per lb.

The Chicago Market

CHICAGO, May 20, 1921.

Nothing of importance developed in the industrial chemical markets during the past two weeks. So far as the consuming trade was concerned purchasing, as for some time past, was confined to small quantities for early consumption and there were no important transactions reported among dealers. With supplies of many products liberal competition among sellers is keen; however, there were few changes reported in prices.

GENERAL CHEMICALS

The *caustic soda* situation lacked new features, the market being steady, with the inquiry limited to small quantities. The ground 76 per cent continued to be quoted at \$4.75@\$4.95 per 100 lb. and the solid at \$4.10 in 1-ton lots. *Soda ash* is firm and is moving in a fair way at 2¾c. per lb. *Sal soda* is also moving in a small way at 2¼c. per lb. There is a somewhat better inquiry for *aluminum sulphate*, iron free, and the price is steady at 3c. per lb. *Ammonium chloride*, white gran., is lower, single casks being offered at 8½c. There is little or no demand for *ammonium carbonate* and ample supplies are available at 11c. per lb. *Ammonium sulphate* is quiet and steady at 3½c. per lb. for ton lots. The inquiry for *formaldehyde* has dropped off somewhat and the principal dealers have reduced their prices to 15c. per lb. for barrels. *Caustic potash* is in an unsteady position and it is possible to obtain prices of a wide variation. The

88-92 per cent material is offered freely at 7½c. per lb. and it is quite possible that a lower figure could be obtained with firm business. *Potassium bichromate* is very quiet, with supplies available at 14¾@15¼c. per lb. *Sodium bichromate* is in the same position and small quantities are offered at 8¾c. per lb. Offers of *sodium nitrite* were heard as low as 7½c. for spot goods, but few sales were reported. There is a fair movement of *sodium bicarbonate* and dealers are maintaining their prices at 2½@2¾c. per lb. *Glycerine*, c.p., is in poor demand at 16¾c. per lb. and no large sales were noted. The present low price on this material should prove attractive, as it is hardly possible for it to go much lower.

The list of acids is unchanged as to prices and a better inquiry is reported from some quarters. Lower prices are predicted by some factors on *acetic acid*, 28 per cent. This article is now quoted at 2¾@3c. per lb. in barrels and the inquiry from the photographic trade is reported to be good. There is a better demand for *citric acid*, but no sales of consequence were noted and the price is unchanged at 47@48c. per lb. Requests for *sulphuric acid* were more numerous and manufacturers continue to quote \$19@\$20 per ton in tank cars f.o.b. works.

NAVAL STORES

The naval stores market has fluctuated considerably during the past two weeks and as yet shows no signs of steadiness. *Turpentine* is quoted today at 67½c. per gal. in drums and is said to be moving in a very fair way. Prices on *rosins* are very unsettled and some factors are asking as high as \$9.60 per 280 lb. for the WG grade.

COAL-TAR PRODUCTS

There is little or nothing doing in the coal-tar products branch of the trade and prices are unchanged. *Benzene* is quoted at 31c. per gal., ex-warehouse, for the 100 per cent and *toluene* is offered at the same rate. A few sales of *naphthalene flakes* were noted and the price is steady at 8½c. per lb.

The Iron and Steel Market

PITTSBURGH, May 20, 1921.

The steel trade now feels convinced that there will be no material improvement in the market in the near future, which means that there is no prospect of improvement before August, since July could not be expected to develop favorable conditions.

If demand does not improve, production of steel instead of remaining stationary will decrease, as bookings in the past week or two have not been equal to shipments. The rate of steel production in the past week has been barely 30 per cent of capacity, against an average of about 31 per cent in April, and a 25 per cent rate is not unlikely to be seen before increases begin.

On account of having a regular clientele with a large tonnage of unfilled contracts the United States Steel Corporation continues able to operate at a better rate than the independents, its percentage rate of operating, relative to capacity, being nearly double that of the independents. This is a partial offset to the lower prices the Steel Corporation accepted in 1920 as compared with the independents.

Buyers are making commitments for only very small lots, whether their commitments are in specifications against contracts, as is the case with most of the Steel Corporation business, or is in new orders, as is the case with the bulk of the current bookings of independents. Carload business is practically the rule, while orders for more than 100 tons are exceptional. Immediate shipment is usually required, which makes it that speed in delivery frequently determines where an order will go.

PRICES MAINTAINED

There are only very occasional reports of price concessions being made in finished steel products, showing that market prices are really very well maintained. In an active market concessions are not unknown, in the case of particularly desirable orders, and pass unnoticed, while in a dull market any concession is widely discussed. The

market exhibits no great degree of strength in adhering to regular prices, since incentive for cutting prices is very largely lacking, individual orders being too small to make price cutting worth while.

Of all the finished steel products, tin plate attracts the most attention on account of presenting a dull market, because tin plate has been in fairly good demand every year, not feeling industrial depressions like steel products that figure largely in construction work. Until 1919 the production of tin plate never fell in any year more than 16 per cent below the previous high record, but 1921 is now certain to show a spectacular decline. At this time in the year demand for the shipment of tin plate has always been very active, but now the tin mills are not operating at more than about 30 per cent of capacity and there are large stocks at mills, not moving to any extent. Some of the stock is tin plate made up against orders of consumers, the consumers not being willing to accept delivery as yet. For production tin plate the regular price of \$6.25 is maintained, but odd lots out of stock can be had at \$6 or less.

The pipe mills present the appearance of being decidedly busier than other departments of the finished steel trade, the average of operations being above 50 per cent, but the condition is largely explained in the fact that pipe-making capacity has increased less in the past few years than steel capacity in general.

READJUSTMENT PROCEEDING

For some time past the steel trade has been convinced that the chief deterrent to business activity has been the labor situation, both the failure of wages in many lines of activity to decline to a safe level and the unwillingness of workmen in the building trades to give a fair day's service. Building activity is regarded as impossible in the circumstances. Accordingly the steel trade has been particularly pleased by the announcement of the Railroad Labor Board this week that a reduction in wages of railroad labor is justified by conditions. The steel trade had felt that a reduction in railroad wages would be helpful in three respects: It would eventually give the railroads some spare money out of their receipts, it would improve railroad credit and it would have a favorable sentimental influence upon workmen in other lines whose wages should be reduced to put industry on a safe basis.

PIG IRON AND COKE

The pig iron market continues dull and listless. The local market remains at \$24 for bessemer, \$22 for basic and \$23.50 for foundry f.o.b. valley furnaces, with \$1.96 freight to Pittsburgh.

As nearly all the merchant furnaces are out of blast, the pig iron now being offered in the market is chiefly iron from producers' stocks, and prices are far below the actual production cost of such iron. The coke market has declined and while 1921 season prices for ore have not been developed it is established that there will be a heavy reduction from the 1920 schedule. Wages at blast furnaces have been reduced. Counting instead of the actual cost of the pig iron now offered its replacement cost, it is a question whether the iron is offered below cost. The actual experience of a valley furnace interest shows that in 1913 the total freight cost of assembling the raw materials necessary to make a ton of pig iron was \$5.33, while the cost after the rate advance of Aug. 26, 1920, was \$9.82. This is actual furnace experience, and there was a reduction in the quantity of coke consumed, so that if the 1920 quantity of coke were taken for 1913 the assembling cost would have been 25c. less. Thus the increase caused by freight rate advances on the cost of producing a ton of pig iron is \$4.74. This does not take account of the charge now imposed for slag wasting, necessary for most furnaces, so that the total increase may be set conservatively at \$5 for a valley furnace. For several years before the war the lowest market price of basic pig iron at valley furnaces was \$12.25. To get an equally low price under present conditions \$5 should be added for freights and allowances made for higher wage rates in coke making, limestone quarrying, ore mining and furnace operation. Connellsville coke is now \$3.25.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

Acetic anhydride	100 lb.	\$1.12	\$1.21	\$1.42	\$1.49
Acetone	100 lb.	2.50	2.75	3.25	3.25
Acid, acetic, 28 per cent.	100 lb.	4.00	4.25	4.50	5.30
Acetic, 56 per cent.	100 lb.				
Acetic, glacial, 99 1/2 per cent, carboys,	100 lb.	9.75	10.00	10.25	10.25
Boric, crystals	lb.	13	14	14 1/2	15
Boric, powder	lb.	15	15 1/2	16	16
Citric	lb.			4 1/2	4 1/2
Hydrochloric	100 lb.	1.50	1.65	1.75	2.00
Hydrofluoric, 52 per cent.	lb.	13	13	14	14
Lactic, 44 per cent tech.	lb.	10	11	11	11
Lactic, 22 per cent tech.	lb.	04 1/2	05 1/2	6	7
Molybdic, C. P.	lb.	4.00	4.50	4.50	5.00
Muriatic, 20 deg. (see hydrochloric)	lb.				
Nitric, 40 deg.	lb.	06 1/2	06 1/2	7	7
Nitric, 42 deg.	lb.	07 1/2	07 1/2	7 1/2	8 1/2
Oxalic, crystals	lb.	17	18	18	20
Phosphoric, Ortho, 50 per cent solution	lb.	17	17 1/2	18	19
Picric	lb.	20	25	27	35
Pyrogallol, resublimed	lb.			9 1/2	2 1/2
Sulphuric, 60 deg., tank cars	ton			11	12 1/2
Sulphuric, 60 deg., drums	ton			13 1/2	15 1/2
Sulphuric, 66 deg., tank cars	ton	18.00	20.00		
Sulphuric, 66 deg., drums	ton	22.00	22.50	23.00	23.50
Sulphuric, 66 deg., carboys	ton				
Sulphuric, fuming, 20 per cent oleum	ton	23.00	24.00		
Sulphuric, fuming, 20 per cent (oleum)	ton				
Sulphuric, fuming, 20 per cent (oleum)	ton	25.00	26.00	26.50	27.00
Sulphuric, fuming, 20 per cent (oleum)	ton				
Sulphuric, fuming, 20 per cent (oleum)	ton	32.00	35.00	40.00	
Tannic, U. S. P.	lb.			90	1 1/2
Tannic (tech.)	lb.	50	52	54	57
Tartaric, crystals	lb.			31	35
Tungstic, per lb. of WO	lb.			1.30	1.40
Alcohol, Ethyl	gal.			4.65	4.90
Alcohol, Methyl (see methanol)	gal.				
Alcohol, denatured, 188 proof	gal.			32	38
Alcohol, denatured, 190 proof	gal.			40	45
Alum, ammonia lump	lb.	74	04 1/2	04 1/2	04 1/2
Alum, potash lump	lb.	04	04 1/2	04 1/2	05
Alum, chrome lump	lb.	13	13 1/2	14	15
Aluminum sulphate, commercial	lb.	01 1/2	02	02	02 1/2
Aluminum sulphate, iron free	lb.	03	03 1/2	03 1/2	04
Aqua ammonia, 26 deg., drums (750 lb.)	lb.	07 1/2	07 1/2	08	08 1/2
Ammonia, anhydrous, cyl. (100-150 lb.)	lb.	30	32	33	35
Ammonium carbonate, powder	lb.	08	08 1/2	09	10
Ammonium chloride, granular (white)	lb.	06 1/2	07	07 1/2	07
Ammonium chloride, granular (gray)	lb.	08	08 1/2	08 1/2	09
Ammonium nitrate	lb.	08	08 1/2	09	10
Ammonium sulphate	100 lb.	2.50	2.75	2.80	2.90
Anilacetate	gal.			4.00	4.25
Anilacetate tech.	gal.			2.50	3.00
Arsenic oxide, (white arsenic) powdered	lb.	7 1/2	08	08 1/2	08 1/2
Arsenic, sulphide, powdered (red arsenic)	lb.	12	12 1/2	13	14
Barium chloride	ton	58.00	59.00	60.00	65.00
Barium dioxide (peroxide)	lb.	19	20	21	22
Barium nitrate	lb.	10	10 1/2	10 1/2	11
Barium sulphate (precip.) (blanc fixe)	lb.	04 1/2	05	05 1/2	06
Bleaching powder (see calc. hypochlorite)	lb.				
Blue vitriol (see copper sulphate)	lb.				
Borax (see sodium borate)	lb.				
Brimstone (see sulphur, roll)	lb.				
Bromine	lb.	40	41	42	45
Calcium acetate	100 lb.	2.00	2.05		
Calcium carbide	lb.	05 1/2	05 1/2	05	05 1/2
Calcium chloride, fused lump	ton	27.00	29.00	30.00	32.00
Calcium chloride, granulated	lb.	01	01 1/2	02	02 1/2
Calcium hypochlorite (bleach'g powder)	100 lb.	2.25	2.40	2.50	2.75
Calcium peroxide	lb.			1.25	1.50
Calcium phosphate, tribasic	lb.			15	16
Camphor	lb.			63	65
Carbon bisulphide	lb.	07	07 1/2	07 1/2	08
Carbon tetrachloride, drums	lb.	10	10	11	12
Carbonyl chloride (phosgene)	lb.			75	1.00
Caustic potash (see potassium hydroxide)	lb.				
Caustic soda (see sodium hydroxide)	lb.				
Chlorine, gas, liquid-cylinders (100 lb.)	lb.	08	09	09 1/2	10
Chloroform	lb.			38	40
Cobalt oxide	lb.			3.00	3.10
Copperas (see iron sulphate)	lb.				
Copper carbonate, green precipitate	lb.	20	21	22	23
Copper cyanide	lb.			50	62
Copper sulphate, crystals	lb.	05 1/2	05 1/2	05 1/2	06
Cream of tartar (see potassium bitartrate)	lb.				
Epsom salt (see magnesium sulphate)	lb.				
Ethyl Acetate Com. 85%	gal.			90	1.00
Ethyl Acetate pure (acetic ether 98% to 100%)	gal.				
Formaldehyde, 40 per cent	lb.	14 1/2	14 1/2	15	15 1/2
Fusel oil, ref.	gal.			3.00	3.25
Fusel oil, crude	gal.			1.75	2.00
Glauber's salt (see sodium sulphate)	lb.			17	17 1/2
Glycerine, C. P. drums extra	lb.			3.75	3.85
Iodine, resublimed	lb.			10	20
Iron oxide, red	lb.			1.50	1.75
Iron sulphate (copperas)	100 lb.	1.00	1.25	1.50	1.75
Lead acetate	lb.			11 1/2	13
Lead arsenate, paste	lb.	09	09 1/2	10	11
Lead nitrate	lb.			15	20
Litharge	lb.	08 1/2	09	09 1/2	10
Lithium carbonate	lb.			1.25	
Magnesium carbonate, technical	lb.	09	09 1/2	10	11
Magnesium sulphate, U. S. P.	100 lb.	2.75	3.00		
Magnesium sulphate, technical	100 lb.			1.10	2.25
Methanol, 95%	gal.			75	77
Methanol, 97%	gal.			78	82
Nickel salt, double	lb.			14	14 1/2
Nickel salt, single	lb.			15	15 1/2
Phosgene (see carbonyl chloride)	lb.				
Phosphorus, red	lb.	45	46	47	50
Phosphorus, yellow	lb.			35	37
Potassium bichromate	lb.	11 1/2	11 1/2	12	12 1/2

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$.31 — .32	\$0.31 — \$0.32
Potassium bromide, granular..... lb.	16 — 25	16 — 25
Potassium carbonate, U. S. P..... lb.	35 — 40	45 — 50
Potassium carbonate, 80-85%..... lb.	.06 — .06	.06 — .07
Potassium chlorate, crystals..... lb.	.08 — .10	.10 — .14
Potassium cyanide..... lb.	10 — 32	30 — 32
Potassium hydroxide (caustic potash)..... lb.	.06 — .06	.06 — .08
Potassium muriate..... ton	50 00 — 53.00	2.75 — 3.00
Potassium iodide..... lb.	09 — 09	10 — 12
Potassium nitrate..... lb.	35 — 36	37 — 38
Potassium permanganate..... lb.	35 — 37	38 — 40
Potassium prussiate, red..... lb.	26 — 26	27 — 28
Potassium prussiate, yellow..... lb.		1.75 — 1.80
Potassium sulphate (powdered)..... per uri		
Rochelle salts (see sodium potas tartrate).....		
Sal ammoniac (see ammonium chloride).....		
Salt soda (see sodium carbonate)..... ton		32.00 — 33.00
Salt cake..... oz.		1.30 — 1.35
Silver cyanide..... oz.		.41 — .42
Silver nitrate..... lb.	2 10 — 2 15	2.25 — 2.50
Soda ash, light..... 100 lb.	2 20 — 2 30	2.40 — 2.75
Soda ash, dense..... 100 lb.	04 — 04	.05 — .05
Sodium acetate..... lb.	2.25 — 2.40	2.50 — 2.75
Sodium bicarbonate..... 100 lb.	.08 — .08	.08 — .09
Sodium bichromate..... lb.	5 00 — 5 25	5.50 — 6.50
Sodium bisulphate (nitre cake)..... ton	.05 — .05	.05 — .06
Sodium bisulphite powdered, U.S.P..... lb.	.06 — .06	.07 — .07
Sodium borate (borax)..... lb.	2 00 — 2 10	2.15 — 2.50
Sodium carbonate (sal soda)..... 100 lb.	.07 — .07	.08 — .08
Sodium chlorate..... lb.	.22 — .24	.25 — .30
Sodium cyanide..... lb.	12 — 12	13 — 14
Sodium fluoride..... lb.	3 60 — 3 75	3.80 — 4.00
Sodium hydroxide (caustic soda)..... 100 lb.		.03 — .04
Sodium hyposulphite..... lb.	2 90 —	3.00 —
Sodium nitrate..... 100 lb.	.07 — .08	.08 — .10
Sodium nitrite..... lb.	.25 — .26	.27 — .30
Sodium peroxide, powdered..... lb.	.04 — .04	.05 — .05
Sodium phosphate, dibasic..... lb.		.27 — .28
Sodium potassium tartrate (Rochelle salts)..... lb.	.12 — .12	.13 — .14
Sodium prussiate, yellow..... lb.	1 25 — 1 35	1.40 — 1.50
Sodium silicate, solution (40 deg.)..... lb.	.02 — .03	.03 — .03
Sodium silicate, solution (60 deg.)..... lb.	1 50 — 1 75	2.00 — 2.25
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	.05 — .05	.06 — .06
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.03 — .04	.04 — .04
Sodium sulphite, crystals..... lb.	15 — 15	16 — 17
Strontium nitrate, powdered..... lb.	.07 — .07	.07 — .08
Sulphur chl ride, red..... lb.	20 00 — 22 00	
Sulphur, crude..... ton	.08 — .08	.09 — .10
Sulphur dioxide, liquid, cylinders extra..... lb.		2.25 — 3.10
Sulphur (sublimed), flour..... 100 lb.		2.00 — 2.75
Sulphur, roll (brimstone)..... 100 lb.	18 — 19	
Tin bichloride, 50 per cent..... lb.		40 — 42
Tin oxide..... lb.	16 — 18	19 — 20
Zinc carbonate, precipitate..... lb.	11 — 11	11 — 12
Zinc chloride, gran..... lb.	45 — 49	50 — 60
Zinc cyanide..... lb.	12 — 13	13 — 14
Zinc dust..... lb.	.08 — .09	.09 — .10
Zinc oxide, XX..... lb.	.03 — .03	.04 — .05
Zinc sulphate..... lb.		

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1 10 — \$1 15
Alpha-naphthol, refined..... lb.	1 25 — 1 30
Alpha-naphthylamine..... lb.	35 — 40
Aniline oil, drums extra..... lb.	20 — 25
Aniline salts..... lb.	26 — 29
Anthracene, 80% in drums (100 lb.)..... lb.	85 — 1.00
Benzaldehyde U. S. P..... lb.	1.00 — 1.50
Benzidine, base..... lb.	85 — 90
Benzidine sulphate..... lb.	75 — 80
Benzoic acid, U.S.P..... lb.	65 — 70
Benzoate of soda, U.S.P..... lb.	65 — 70
Benzene, pure, water-white, in drums (100 gal.) gal.	27 — 32
Benzene, 90%, in drums (100 gal.)..... gal.	25 — 28
Benzyl chloride, 95-97%, refined..... lb.	28 — 30
Benzyl chloride, tech..... lb.	20 — 25
Beta-naphthol benzoate..... lb.	3.50 — 4.00
Beta-naphthol, sublimed..... lb.	.70 — .75
Beta-naphthol, tech..... lb.	.33 — .45
Beta-naphthylamine, sublimed..... lb.	2.00 — 2.25
Cresol, U. S. P., in drums (100 lb.)..... lb.	16 — 18
Ortho-cresol, in drums (100 lb.)..... lb.	25 — 27
Cresylic acid, 97-99%, straw color, in drums..... gal.	70 — 80
Cresylic acid, 75-97%, dark, in drums..... gal.	65 — 70
Cresylic acid, 50%, first quality, drums..... gal.	45 — 50
Dichlorobenzene..... lb.	.06 — .09
Diethylaniline..... lb.	1.20 — 1.25
Diamethylaniline..... lb.	.42 — .55
Dinitrobenzene..... lb.	.32 — .35
Dinitrochlorobenzene..... lb.	.20 — .30
Dinitronaphthalene..... lb.	.30 — .40
1-nitrophenol..... lb.	.35 — .40
1-nitrotoluene..... lb.	.27 — .30
Dip oil, 25%, tar acids, car lots, in drums..... gal.	40 — 45
Diphenylamine..... lb.	.60 — .65
H acid..... lb.	1.30 — 1.50
Meta-phenylenediamine..... lb.	1.15 — 1.20
Monochlorobenzene..... lb.	.12 — .14
Monomethylaniline..... lb.	1.75 — 1.85
Naphthalene crushed, in bbls (250 lb.)..... lb.	.07 — .08
Naphthalene, flake..... lb.	.07 — .08
Naphthalene, balls..... lb.	.08 — .09
Naphthionic acid, crude..... lb.	.70 — .75
Nitrobenzene..... lb.	.12 — .15
Nitronaphthalene..... lb.	.30 — .35
Nitro-toluene..... lb.	.16 — .18
Ortho-amidophenol..... lb.	3.15 — 3.40
Ortho-dichlorobenzene..... lb.	.15 — .20
Ortho-nitro-phenol..... lb.	.80 — .85
Ortho-nitro-toluene..... lb.	.15 — .20
Ortho-toluidine..... lb.	.20 — .25
Para-amidophenol, base..... lb.	1.50 — 1.60
Para-amidophenol, HCl..... lb.	1.75 — 1.80

Para-dichlorobenzene..... lb.	.15 — .20
Paranitroaniline..... lb.	.90 — 1.00
Para-nitrotoluene..... lb.	.90 — 1.00
Para-phenylenediamine..... lb.	1.95 — 2.00
Para-toluidine..... lb.	1.25 — 1.40
Phthalic anhydride..... lb.	.50 — .60
Phenol, U. S. P., drums (dest.), (240 lb.)..... lb.	.12 — .14
Pyridine..... gal.	2.00 — 3.50
Resorcinol, technical..... lb.	1.75 — 1.85
Resorcinol, pure..... lb.	2.25 — 2.30
Salicylic acid, tech., in bbls. (110 lb.)..... lb.	.21 — .23
Salicylic acid, U. S. P..... lb.	.22 — .24
Salol..... lb.	.85 — .95
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 — .16
Sulphanilic acid, crude..... lb.	.30 — .35
Tolidine..... lb.	1.25 — 1.35
Toluidine, mixed..... lb.	.40 — .45
Toluene, in tank cars..... gal.	.25 — .28
Toluene, in drums..... gal.	.28 — .31
Xylidines, drums, 100 gal..... lb.	.40 — .45
Xylene, pure, in drums..... gal.	.40 — .45
Xylene, pure, in tank cars..... gal.	.45 — .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 — .35
Xylene, commercial, in tank cars..... gal.	.30 — .35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.23 — \$0.25
Beeswax, refined, light..... lb.	.25 — .27
Beeswax, white pure..... lb.	.45 — .47
Carnauba, Florida..... lb.	.61 — .62
Carnauba, No. 2, North Country..... lb.	.28 — .30
Carnauba, No. 3, North Country..... lb.	.16 — .17
Japan..... lb.	.18 — .18
Montan, crude..... lb.	.07 — .08
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03 — .03
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.02 — .02
Paraffine waxes, refined, 118-120 m.p..... lb.	.03 — .03
Paraffine waxes, refined, 125 m.p..... lb.	.04 — .04
Paraffine waxes, refined, 128-130 m.p..... lb.	.04 — .05
Paraffine waxes, refined, 133-135 m.p..... lb.	.05 — .05
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 — .06
Stearic acid, single pressed..... lb.	.09 — .09
Stearic acid, double pressed..... lb.	.10 — .10
Stearic acid, triple pressed..... lb.	.11 — .11

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5 20 —
Rosin E-I..... 280 lb.	6 30 — 6.40
Rosin K-N..... 280 lb.	6 50 — 6.70
Rosin W. G.-W. W..... 280 lb.	6 80 —
Wood rosin, bbl..... 280 lb.	6 25 —
Spirits of turpentine..... gal.	.69 —
Wood turpentine steam dist..... gal.	.67 —
Wood turpentine, dest. dist..... gal.	.65 —
Pine tar pitch, bbl..... 200 lb.	7.00 —
Tar, kiln burned, bbl. (500 lb.)..... bbl.	12.50 —
Retort tar, bbl..... 500 lb.	12.50 —
Rosin oil, first run..... gal.	.40 —
Rosin oil, second run..... gal.	.44 —
Rosin oil, third run..... gal.	.47 —
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.80 —
Pine oil, pure, dest. dist..... gal.	1.50 —
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 —
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 —
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 —
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.35 —
Turpentine, crude, sp. gr. 0.900-0.970..... gal.	1.20 —
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.35 —
Pinewood creosote, ref..... gal.	.52 —

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41 —
70-72 deg., steel bbls. (85 lb.)..... gal.	.39 —
68-70 deg., steel bbls. (85 lb.)..... gal.	.38 —
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30 —

Crude Rubber

Para-Upriver fine..... lb.	\$0.17 — .17
Upriver coarse..... lb.	.11 — .12
Upriver caucho ball..... lb.	.14 — .14
Plantation first latex crepe..... lb.	.18 — .18
Ribbed smoked sheets..... lb.	.16 — .17
Brown crepe, thin, clean..... lb.	.15 — .15
Amber crepe No. 1..... lb.	.17 — .17

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0 09 — \$0 09
Castor oil, AA, in bbls..... lb.	10 — 10
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	11 — 12
Cocoonut oil, Ceylon grade, in bbls..... lb.	10 — 10
Cocoonut oil, Cochin grade, in bbls..... lb.	11 — 11
Corn oil, crude, in bbls..... lb.	.07 — .08
Cottonseed oil, crude (f. o. b. mill)..... lb.	.05 — .05
Cottonseed oil, summer yellow..... lb.	.07 — .07
Cottonseed oil, winter yellow..... lb.	.07 — .07
Linseed oil, raw, car lots (domestic)..... gal.	.71 — .73
Linseed oil, raw, tank cars (domestic)..... gal.	.65 — .65
Linseed oil, in 5 bbl lots (domestic)..... gal.	.74 — .76

Olive oil, Denatured.....	gal.	\$1 40	—	\$1.60
Palm, Lagos.....	lb.	.07½	—	.07½
Palm, Niger.....	lb.	.05	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.06	—	.06½
Peanut oil, refined, in bbls.....	lb.	.10½	—	.10½
Rapeseed oil, refined in bbls.....	gal.	.86	—	.88
Rapeseed oil, blown, in bbls.....	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07½	—	
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.05½	—	

FISH

Light pressed menhaden.....	gal.	\$0 40	—	\$0 41
Yellow bleached menhaden.....	gal.	.42	—	
White bleached menhaden.....	gal.	.44	—	
Blown menhaden.....	gal.	.80	—	

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	1.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	
Blanc fixe, dry.....	lb.	.05	—	.05½
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.16
Chalk, domestic, extra light.....	lb.	.05	—	.05½
Chalk, domestic, light.....	lb.	.04½	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04½	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07½	—	.08
Graphite, Ceylon chip.....	lb.	.06	—	.06½
Graphite, high grade amorphous crude.....	lb.	.02½	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05½
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton		—	10.00
Quartz (acid tower) 1½ @ 2 in., f.o.b. Baltimore.....	net ton		—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton		—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.65	—	
Shellac, orange superfine.....	lb.	.71	—	
Shellac, A. C. garnet.....	lb.	.45	—	.46
Shellac, T. N.....	lb.	.69	—	
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	35.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$35.00-50.00		
Carborundum refractory brick, 9-in.	1,000	1250 00		
Chrome brick, f.o.b. Eastern shipping points.....	net ton	75- 90		
Chrome cement, 40-45% Cr ₂ O ₃	net ton	45- 50		
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	 55		
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	40- 50		
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	40- 50		
Magnesite brick, 9-in. straight.....	net ton	90		
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	100		
Magnesite brick, soaps and splits.....	net ton	110		
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	45- 55		
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	45- 55		
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	45- 55		

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00	—	\$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.15	—	.16
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.16	—	.17
Ferromanganese, 76-80% Mn, domestic.....	gross ton	80.00	—	85.00
Ferromanganese, 76-80% Mn, English.....	gross ton	80.00	—	85.00
Spiegeleisen, 18-22% Mn.....	gross ton	32.00	—	35.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50	—	
Ferrosilicon, 10-15%.....	gross ton	50.00	—	55.00
Ferrosilicon, 50%.....	gross ton	80.00	—	85.00
Ferrosilicon, 75%.....	gross ton	145.00	—	150.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45	—	.50
Ferroumium, 35-50% of U, per lb. of U content.....	lb.	6.00	—	
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00	—	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$8 00	—	\$ 6 90
Chrome ore, Calif concentrates, 50% Cr ₂ O ₃	unit	45	—	50
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	45	—	50
Coke, foundry, f.o.b. ovens.....	net ton	4 50	—	5 00
Coke, furnace, f.o.b. ovens.....	net ton	3 25	—	3 75
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15 00	—	16 00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	15 00	—	
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20 00	—	22 50
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01½	—	.011
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.25	—	.30
Manganese ore, chemical (MnO ₂).....	gross ton	60 00	—	65 00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55	—	.60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30 00	—	
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.14	—	.14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.14	—	.14
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12	—	.13
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15	—	
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	3.00	—	3.50
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00	—	3.50
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50	—	2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25	—	2.50
Vanadium pentoxide, 99%.....	lb.	12.00	—	14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50	—	
Zircon, washed, iron free.....	lb.	.03	—	

Non-Ferrous Metals

New York Markets

Cents per lb.

Copper, electrolytic.....		13.00
Aluminum, 98 to 99 per cent.....		28 00@28.5
Antimony, wholesale lots, Chinese and Japanese.....		5½@5½
Nickel, ordinary (ingot).....		41.00
Nickel, electrolytic.....		44.00
Monel metal, spot and blocks.....		35.00
Monel metal ingots.....		38.00
Monel metal, sheet bars.....		40.00
Tin, 5-ton lots, Straits.....		33.00
Lead, New York, spot.....		5.00
Lead, E. St. Louis, spot.....		4.85
Zinc, spot, New York.....		5.35
Zinc, spot, E. St. Louis.....		4.85

OTHER METALS

Silver (commercial).....	oz.	\$ 60½
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50@1.55
Cobalt.....	lb.	4.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00-75.00
Iridium.....	oz.	250.00@300.00
Palladium.....	oz.	65.00@70.00
Mercury.....	75 lb.	46.00-47.00

FINISHED METAL PRODUCTS

Warehouse Price
Cents per Lb

Copper sheets, hot rolled.....		20 50-20 75
Copper bottoms.....		28.00-28.25
Copper rods.....		19.25-20.00
High brass wire.....		18.25
High brass rods.....		15.25
Low brass wire.....		20.25
Low brass rods.....		20.25
Brazed brass tubing.....		29.00
Brazed bronze tubing.....		34.25
Seamless copper tubing.....		22.00
Seamless high brass tubing.....		21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York			
	Current	Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	8 50@ 9 00	18 50	10 00	10 50
Copper, heavy and wire.....	8 00@ 8 25	16 50	9 50	9 50
Copper, light and bottoms.....	7 00@ 7 50	14 50	9 00	8 50
Lead, heavy.....	3.25@ 3.50	7.25	4.00	4.00
Lead, tea.....	2.15@ 2.30	5.25	3.00	3.00
Brass, heavy.....	4.25@ 4.50	9.50	7.00	10.00
Brass, light.....	3.00@ 3.25	8.00	5.00	5.50
No. 1 yellow brass turnings.....	4.00@ 4.25	9.50	5.50	6.00
Zinc.....	2.00@ 2.50	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by ½ in. and larger, and plates ½ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.50	\$3.23	\$3.23
Soft steel bars.....	2.50	3.00	3.13
Soft steel bar shapes.....	2.50	3.13	3.13
Soft steel bands.....	2.85	3.83	3.78
Plates, ½ to 1 in. thick.....	2.50	3.30	3.23

*Add 10c per 100 lb. for trucking to Jersey City and 15c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

ANNISTON—The Poland Soap Works, recently organized, is arranging for a lease of a local building for the establishment of a new plant for the manufacture of soap and soap powders in bulk. It is proposed to develop an annual capacity of about 3,000,000 lb. of material. Carter D. Poland is president, and O. L. Williams secretary-treasurer.

MOBILE—W. A. Benson and associates are organizing a company for the establishment of a new local plant for the manufacture of paints, varnishes, etc. A building has been acquired and machinery will be installed at once. The initial output will be on the basis of about 2,000 gal. per day.

Arkansas

TEXARKANA—H. K. Tutty, New Orleans, La., and associates are organizing a company to establish a local pulp mill.

Arizona

BISBEE—The new ore reduction mill, now in course of construction at the property of the Copper Queen Mining Co., is estimated to cost close to \$4,000,000 with machinery and equipment. It will be one of the largest plants of its kind in the country.

PRESCOTT—The Big Ledge Copper Co. is arranging for a stock issue to total about \$500,000, the proceeds to be used for general operations and financing.

California

LOS ANGELES—The National Airless Tire Co., Grosse Bldg., manufacturer of rubber tires, has preliminary plans under way for the erection of a new 3-story plant at Norwalk, Cal., 100x250 ft. A. C. Martin, 430 Higgins Bldg., is architect. C. H. Braden is secretary and general manager.

SAN FRANCISCO—The Pacific Coast Steel Co., Rialto Bldg., is having plans prepared for the erection of a new 1-story plant at South San Francisco to be 80x400 ft.

BURBANK—The Crystal & Colored Glass Co. has awarded a contract to W. Lee Ray, Burbank, for the erection of a new 1-story plant, 70x130 ft., at First and Cypress Sts.

SAN MATEO—The Minerals, Metals & By-Products Co., Denver, Col., has selected property owned by the Howard Estate Co., on the San Mateo Bay shore, comprising about 1,385 acres of land, as a site for the erection of its proposed new metallurgical plant. Present submerged land on the tract will be reclaimed. The new works are estimated to cost in excess of \$1,000,000 with machinery. L. C. Rogers is president.

Florida

CANAL POINT—The Florida Sugar & Food Products Co. is planning for the erection of a large sugar mill on a local tract of land. The company has an aggregate of 8,000 acres of land. The new plant will have an initial capacity for handling about 5,000 tons of sugar cane per month. F. E. Bryant is head.

Illinois

CHICAGO—The Waterway Paper Co., Kedzie Ave. and 32d St., has plans under way for the erection of a new 1-story plant on Kedzie Ave., 80x180 ft., estimated to cost about \$175,000. Frank D. Chase, Inc., 645 North Michigan Ave., is engineer.

CHICAGO—The Atlas Copper & Brass Mfg. Co., 2734 High St., is taking bids for the construction of a new 1-story plant addition, 50x125 ft., to cost about \$21,000. Louis Ehle, 3810 B'way, is architect.

Indiana

SOUTH BEND—The International India Rubber Corp., 310 West Ewing Ave., has

had plans prepared for the erection of a 2-story and basement addition to its plant. W. W. Schneider, 120 South Main St., is architect.

Maryland

BALTIMORE—The Holdtite Mfg. Co. has taken out a building permit for the erection of a new 1-story plant, 50x132 ft., for the manufacture of rubber specialties. It will be located at Warner and Ostend Sts. Stanislaus Russell, 11 East Lexington St., is architect.

BALTIMORE—Plans for the new plant of the Gwynns Falls Paper Co., 517 Calvert Bldg., have been completed and it is expected to call for erection bids at an early date. The plant will be located at Gwynns Falls, near Baltimore; it will be 1-story, brick and concrete, and estimated to cost about \$250,000 with machinery. Joseph H. Wallace & Co., 5 Beekman St., New York, are engineers. George W. Davis is head.

BELLEVUE, MD.—William H. Valliant is reported to be planning for the rebuilding of his fertilizer manufacturing plant and lime works, destroyed by fire May 10, with loss estimated at about \$250,000 with machinery.

BALTIMORE—Swindell Bros., Bayard and Russell Sts., manufacturers of glass products, have acquired property on Russell St., 100x165 ft., in the vicinity of their plant, to be used in connection with general operations. It is said that a new building will be located on the site, but this has not been confirmed.

Massachusetts

TAUNTON—The Presbrey Stove Lining Co., Wier Village, manufacturer of refractory products, has awarded a contract to Franklin D. Williams, Taunton, for the erection of a new 2-story plant building to cost about \$25,000. It will replace a portion of the works recently destroyed by fire with loss of about \$125,000.

Missouri

KANSAS CITY—A. W. Estrabrook, 729 Holmes St., has broken ground for the erection of a new 2-story and basement chemical laboratory and manufacturing works on Holmes St., 40x60 ft. William Jewell, 417 Rialto Bldg., has the construction contract.

ST. LOUIS—The Herman Oak Leather Co., 4020 North Main St., has awarded a contract to Arthur Dorr, 4145 Manchester Ave., for the construction of the proposed 2-story and basement addition to its plant, 24x70 ft., to cost about \$25,000. L. C. Herman is head.

New Jersey

TRENTON—The Magnetic Pigment Co., Cass St., will make extensions and improvements in its plant to cost about \$12,000.

TRENTON—The Star Porcelain Co., Muirheid Ave., has filed plans for the erection of a new 1-story plant addition.

NEWARK—The Interstate Smelting & Refining Co., 29 Commercial St., has acquired property at Hawkins St. and Plum Point Lane for proposed future additions to its plant. Erection of proposed buildings will be deferred, it is said, for a few months.

VINELAND—The Doerr Glass Co., manufacturer of chemical and scientific glassware specialties, has completed the erection of additions to its plant to be used for the manufacture of glass tubing, rods and kindred articles.

LYNDHURST—The Butterworth-Judson Co., Newark, N. J., manufacture of chemicals, dyestuffs, etc., has disposed of its local plant to the Goodwin Reid Co., also of Newark, which will use the works, it is said, for kindred manufacture. The property consists of buildings aggregating about 20,000 sq. ft. in floor area, located on a two-acre tract. The plant at one time was occupied by the Renslau Chemical Co.

NEWARK—The National Cork Products, Inc., recently organized, has leased the 2-story factory at 357-9 Ogden St., near Carlyle Pl., for the establishment of a new plant for the manufacture of cork special-

ties. Possession will be taken at once and necessary equipment installed. D. D. Lehrman is vice-president.

New York

BROOKLYN—The J. Lackner Co., 308 Seventh Ave., manufacturer of paper specialties, has revised plans under way for the erection of a 2-story addition to its plant, 85x97 ft., to cost about \$19,000.

NEW YORK—The Standard Oil Co., 26 B'way, has arranged for a bond issue of \$20,000,000 to be used in part for extensions to its oil refineries, and general operations. The company operates a large refinery at Constable Hook, Bayonne, N. J.

BUFFALO—The Williams Gold Refining Co., 2978 Main St., has awarded a contract to the Hydro Construction Co., Mutual Life Bldg., for the erection of a 1-story addition, 50x63 ft., to be used for general manufacture. It will cost about \$15,000. R. V. Williams is treasurer.

North Carolina

SALISBURY—The Paul Rubber Co., recently incorporated with a capital of \$250,000, has plans under way for the erection of the first unit of its proposed new local plant for the manufacture of tires, to be 2-story, 60x160 ft., with 1-story building adjoining, 60x100 ft., estimated to cost about \$35,000. The company has a tract of 7½ acres of land, and the initial buildings will be supplemented by other structures at a later date. W. H. McConnell is head.

Ohio

CLEVELAND—The Hinde Paper Co., recently organized with a capital of \$1,000,000, is planning for the erection of a new local plant for the manufacture of fiber board products. The company is headed by James J. Hinde, one of the founders of the Hinde & Dauch Paper Co., Sandusky, Ohio, manufacturer of corrugated paper specialties.

Oklahoma

GRANFIELD—The Motor Oil & Refining Co., recently organized, is planning for the erection of a new oil refinery at Chickasha, Okla., with initial daily capacity of 500 bbl. of crude oil. It is proposed to build a compounding works, adjacent to the main refinery, for the production of lubricating oils. R. C. Williamson is president, and R. R. Ryule secretary and treasurer.

Pennsylvania

DU BOIS—The Independent Sanitary Mfg. Co., 218 Lexington Ave., Buffalo, N. Y., manufacturer of sanitary metal products, has plans under way for the erection of a new foundry on a local site. Cundall, Powell & Mosher, 80 West Genesee St., Buffalo, are architects.

YORK—Fire May 12 destroyed a portion of the plant of the American Phosphorous Co., with loss reported at about \$12,000.

PHILADELPHIA—The Federal Container Co., 25th and Locust Sts., manufacturer corrugated paper containers, etc., has acquired property on Paschall Ave., near 56th St., 130x325 ft., for the erection of its proposed new 2-story plant, 82x302 ft., estimated to cost about \$150,000 with equipment.

Tennessee

CLEVELAND—The Kyva Ferro-Manganese Corp., Winchester, Ky., has acquired the electric furnace plant of the Tennessee Manganese Co., Cleveland, with daily capacity of about 10 tons, and will operate the plant in connection with its manganese property developments in this section. The plant will be used for the production of ferromanganese, ferrosilicon and kindred products. W. B. Lindsay is president.

Texas

TEXARKANA—The Diamond Sugar Chemical Co., recently organized, has leased a local building for the immediate establishment of a new plant for the manufacture of chemical specialties. Machinery, including laboratory equipment, will be installed. Clifton T. Spear, Box 378, is president and manager.

BRIDGEPORT—The Phoenix Clay Corp. has inaugurated the erection of a new plant for the manufacture of brick and other burned clay products. The company is reported to have acquired the plant of the Bridgeport Brick & Tile Co., and with this acquisition will develop a total daily output of over 125,000 bricks. C. W. Martin is president.

West Virginia

FAIRMONT—The Federal Carbonic Co. has perfected plans for the erection of a new local plant for the production of carbonic acid gas and kindred products. E. A. Bailey is president.

Capital Increases, Etc.

THE ELLISON BRASS MFG. Co., Jamestown, N. Y., has filed notice of increase in capital from \$60,000 to \$250,000.

THE MARTIN VARNISH Co., 2520 Quarry St., Chicago, has filed notice of increase in capital from \$100,000 to \$250,000.

THE HOUSTON PAPER Co., Houston, Tex., has filed notice of increase in capital from \$30,000 to \$50,000.

THE WILLIAMS SUBMARINE COMPOUND Co., 21 State St., New York City, has filed notice of change of name to the Williams Scaling & Paint Co.

THE DE LUXE INK & DYE Co., Chicago, has filed notice of increase in capital from \$40,000 to \$400,000.

THE RELIANCE FOUNDRY Co., Richmond, Ind., has filed notice of increase in capital from \$30,000 to \$60,000.

THE CONNECTICUT ZINC CORP., Wyandank (Suffolk Co.), N. Y., has filed notice of increase in capital from \$1,000,000 to \$2,000,000.

THE MILLER-LAMBERT CHEMICAL Co., Columbia, S. C., is arranging for an increase in capital to \$25,000. Mayhew Lambert is president.

THE PINES RUBBER Co., Brooklyn, N. Y., has filed notice of increase in capital from \$75,000 to \$200,000.

New Companies

THE NATIONAL ZYLONOID Co., New York City, has been incorporated with a capital of \$500,000 to manufacture celluloid and other composition products. The incorporators are C. H. Louis, M. Dulugasch and W. Polglass. The company is represented by Olcott, Bonyng, McManus & Ernest, 170 B'way.

THE CONSOLIDATED SALT Co. OF CALIFORNIA, Los Angeles, Cal., has been incorporated with a capital of \$750,000 to manufacture salt products, industrial chemicals, etc. The incorporators are Alfred G. Blair, Samuel Merrill, Jr., Pasadena, Cal.; John Coolman, F. H. Owen, Colton, Cal. Manning & Thompson, Los Angeles, represent the company.

THE AETNA CHEMICAL Co., Boston, Mass., has been incorporated with a capital of \$200,000 to manufacture chemical products. Walter F. Clarke is president, and Robert Thompson, 228 Huntington Ave., treasurer.

THE FURNACE LINING MATERIALS Co., 53 West Jackson Blvd., Chicago, has been incorporated with a capital of \$50,000 to manufacture refractory products. The incorporators are C. L. Leesley, F. C. Corley and W. D. Sheperd.

THE EVERFIRE SPARK PLUG Co., New York, has been incorporated with a capital of \$25,000 to manufacture spark plugs, etc. The incorporators are R. and A. Lyons, and J. Hirschman. Hirschman & Roeder, 1475 B'way, represent the company.

THE KELSEY CITY BRICK & SUPPLY Co., Kelsey City, Fla., has been incorporated with a capital of \$500,000 to manufacture brick and other burned clay products. Harry S. Kelsey is president, Fred A. Clarry vice-president and secretary, and James McDonald treasurer.

THE HURST OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$5,000,000 to manufacture petroleum products. The incorporators are J. T. Hurst, Jerome B. Frank and S. M. Haskins. Gibson, Dunn & Crutcher, Los Angeles, represent the company.

THE MAGIC DYE-SOAP Co., 75-77 West Van Buren St., Chicago, has been incorporated with a capital of \$100,000 to manufacture soaps and affiliated products. The incorporators are Robert B. Whiting, T. N. Daggert and M. A. Jeffers.

THE MAXWELL CHEMICAL Co., Dallas, Tex., has been incorporated with a capital of \$25,000 to manufacture chemicals and chemical byproducts. The incorporators are P. P. Roberg and Henry Exall.

THE CONTINENTAL LEATHER GOODS Co., Newark, N. J., has been incorporated with a capital of \$100,000 to manufacture leather products. The incorporators are Max Olsham, Irving Wexler and Louis J. Cohen, 207 Broad St.

THE WILSON SPECIALTY Co., New York City, has been incorporated with a capital of \$100,000 to manufacture chemicals and chemical compounds. The incorporators are W. Wilson, S. Senate and J. J. Kraus. L. I. Isquith, 299 B'way, represents the company.

THE STANDARD RUBBER CEMENT Co., Stoughton, Mass., has been incorporated with a capital of \$10,000 to manufacture rubber cement and kindred products. The incorporators are M. S. Azulay, E. M. Azulay and J. C. Eccles.

THE SUPERIOR GLASS APPARATUS Co., 6 Van Wagenen Ave., Newark, N. J., has filed notice of organization to manufacture chemical glassware. Emil Sella, 288 Broad St., heads the company.

THE PLACERITA PETROLEUM Co., Los Angeles, Cal., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are John K. McGregor, W. J. Van Houten and Amos Campbell. George R. Wickham, Hermosa Beach, Cal., represents the company.

THE ONE-Co. VARNISH WORKS, New York City, has been incorporated with a capital of \$20,000 to manufacture paints, oils, varnishes, etc. The incorporators are N. and S. Kent and S. Blumenthal. Kent & Kent, 287 B'way, represent the company.

THE SHULTZ MFG. Co., Binghamton, N. Y., has been incorporated with a capital of \$75,000 to manufacture paper and paper products. The incorporators are J. F. Murphy, J. B. Rushmore and A. J. Prie, 4 East Howard St.

THE STAZON MFG CORP., Brooklyn, N. Y., has been incorporated with a capital of \$5,000 to manufacture cleaning products, chemical compounds, etc. The incorporators are B. H. Fry, M. L. Einstein, Stern & Reubens, 149 B'way., represent the company.

THE HERIOT LIME Co., Birmingham, Ala., has been organized to manufacture hydrated lime and other lime products. The company is headed by W. B. Heriot and J. S. Bailey.

THE WENGER-ARMSTRONG CORP., 608 South Dearborn St., Chicago, has been incorporated with a capital of \$50,000 to manufacture petroleum and petroleum byproducts. The incorporators are Ernest A. Wenger, Archer S. Armstrong and Edward R. Tiedebohl.

THE BRADLEY MOTOR OIL Co., New York City, has been incorporated with a capital of \$20,000 to manufacture refined oil products. The incorporators are H. A. Bradley, L. Wienecke and S. Root. I. Witkind, 299 B'way, represents the company.

THE AMARILLO PAPER Co., Amarillo, Tex., has been incorporated with a capital of \$20,000 to manufacture paper products. The incorporators are Benjamin Hirschland and J. S. McKnight.

THE BLYTHE CHEMICAL Co., Brooklyn, N. Y., has been incorporated with a capital of \$5,000 to manufacture chemicals and chemical byproducts. The incorporators are A. Falk, K. Hart and D. Geiger, 286 Fifth Ave.

THE GECK LABORATORIES, INC., New York City, has been incorporated with a capital of \$20,000 to manufacture chemicals and chemical byproducts. The incorporators are F. A. Geck, J. S. Scheuer and H. H. Jacobs. Joseph & Zeamans, 1834 B'way, represent the company.

THE PENN PAPER Co., Erie, Pa., has been incorporated with a capital of \$50,000 to manufacture paper products. John F. Young, 604 East 21st St., is treasurer.

THE MARYLAND OIL Co., 16 St. Paul St., Baltimore, Md., has been incorporated with a capital of \$250,000 to manufacture refined oil products. The incorporators are William B. Henkel, Wirt A. Duvall, Jr., and M. P. Kenly.

THE HUNTINGTON-MAIN OIL Co., Los Angeles, Cal., has been incorporated with a capital of \$300,000 to manufacture petroleum products. The incorporators are Torrance C. Welch, Pasadena, Cal.; C. C. Dicey and H. M. Farris, Los Angeles.

THE T. G. EGAN REFRACTORY ENGINEERING Co., Brooklyn, N. Y., has been incorporated with a capital of \$10,000 to manufacture refractory products. The incorporators are T. G. Egan, I. P. Morris and M. H. Lewis. H. S. Dudner, 11 B'way, represents the company.

THE BIG X OIL CORP., Bigheart, Okla., has been incorporated with a capital of \$100,000 to manufacture petroleum products. The incorporators are E. B. Gray and E. M. Coffey, Bigheart.

THE LA ESTRELLA CASTILE SOAP Co., New York, N. Y., has been incorporated with a capital of \$5,000 to manufacture soap and kindred products. The incorporators are G. Korn, A. P. Fernandez and M. M. Simon, 805 B'way.

THE PLANIA CARBON CORPORATION, 26 West Randolph St., Chicago, has been incorporated with a capital of \$100,000 to manufacture carbon products. The incorporators are Fred W. Hartmann, George H. Webster and William R. Darnall.

THE INTERNATIONAL CORRUGATED BOX Co., New York City, has been incorporated with a capital of \$15,000 to manufacture corrugated paper products. The incorporators are S. and D. Honigstock, and A. I. Menin, 1 Madison Ave.

THE AUTO PAINT Co., Newark, N. J., has been incorporated with a capital of \$50,000 to manufacture paints, varnishes, etc. The incorporators are George W. Nuse, Maurice R. H. Bowman and David J. Hall, Newark.

THE MINERAL PAINT MFG. Co., Los Angeles, Cal., has filed notice of organization to manufacture paints, oils, etc. Frank L. Buchanan, East 55th St., heads the company.

THE CANYON PETROLEUM Co., Room 1208, 36 South State St., Chicago, Ill., has been incorporated with a capital of \$1,000,000 to manufacture petroleum products. The incorporators are John Kabany, George D. Leonard and H. M. Meyers.

THE STANDARDIZED CHEMICAL Co., Room 1330, 122 South Michigan Ave., Chicago, has been incorporated with a capital of \$25,000 to manufacture chemicals and chemical byproducts. The incorporators are E. Craig, Frank F. Perner and Joseph H. Hazen.

Manufacturers' Catalogs

GENERAL MACHINE Co., Newark, N. J., has issued a booklet on Ball Thrust Bearing Overhung Agitating Devices and Chemical Equipment.

THE DE LA VERGNE MACHINE Co., New York, calls attention to three new publications, on Municipal Power Plants, De La Vergne Oil Engineer, Type SI, and The De La Vergne Diesel Oil Engine.

THE ELECTRIC FURNACE Co., Salem, O., has issued a book of photographs of Bailey electric furnaces in brass foundries and rolling mills in the United States and also in foreign countries, which is known as Booklet 10-B.

THE SULLIVAN MACHINERY Co., Chicago, Ill., announces three new publications. Bulletin 72-E, on Drill Sharpening Machines, describes the new Class B light weight drill sharpener, as well as the standard Class A machines, with especial references to the making of genuine double taper bits, etc. Bulletin 77-B, on Angle Compound Air Compressors, includes mention of the company's single stage or duplex angle machines for low pressure. Bulletin 77-A illustrates Sullivan mine car compressors, which are operated by electric motor.

THE FILES ENGINEERING Co., INC., Providence, R. I., has issued a booklet entitled "Files Stoker" which describes a hand-operated stoker and gives some interesting data regarding the stoker and efficient fuel burning.

THE NORTON Co., Worcester, Mass., has issued a booklet on "Grinding in the Railroad Shops."

W. S. ROCKWELL Co., New York, calls attention to Bulletin 223, which illustrates and describes various types of burners for the use of oil and gas fuel for industrial heating. Bulletin 224 is on "Form Value of Energy in Relation to Its Production, Transportation and Application."

THE MAHR MFG. Co., Minneapolis, Minn., has issued sheet 523, describing a style "T" self-contained kerosene torch for use in foundry and machine shops and chemical plants.

THE VIDETTO-RUANE MACHINERY Co., Pittsburgh, Pa., recently issued a new bulletin covering portable belt conveyors. These conveyors are known as the Atlas brand and range in size from 18 to 24 in. belt width. They are used for loading and unloading box cars and gondolas and for piling various materials in and about the plant. They may be driven by gasoline engine or electric motors and are equipped with a swivel axle for placing the wheels in any position in regard to the direction of travel of the belt.

THE PITTSBURGH REINFORCED BRAZING & MACHINE Co., Pittsburgh, Pa., has published a circular on its new high-pressure oxygen compressor which has just been placed on the market. It is illustrated in front and side view.

THE AMERICAN ENGINEERING Co., Philadelphia, Pa., is distributing a pamphlet entitled "Are Mechanical Stokers a Good Investment?" Interesting pen and ink illustrations are given.

FULLER-LEHIGH Co., Fullerton, Pa., calls attention to Catalog 700, on "Fuller Pulverized Coal Equipment for Locomotives." This booklet illustrates and describes pulverized coal-burning equipment which is the result of six years of trial, research and development, together with sixteen years' experience in design and application.

HENRY VOGT MACHINE Co., Louisville, Ky., has published a booklet on "Vogt for Better Refinery Equipment." The Vogt paraffine wax plant equipment is briefly outlined, and illustrations and descriptive matter are given of other Vogt equipment, including chilling machine, refrigerating machine, paraffine wax press, auto truck tank, water tube boiler, horizontal return tubular boiler, sectional steel boiler casing, stills for oil refineries, drop forged steel valves and fittings, and sectional shaking and dumping grates. Copies will be sent upon request.

THE CHICAGO FLEXIBLE SHAFT Co., Chicago, Ill., has issued Catalog 80, on "Stewart Porcelain Enameling Furnaces." This catalog describes porcelain enameling methods and furnace construction, from both the metallurgical and the practical shop standpoint, and is a compilation of exceptionally useful information. Many interesting illustrations are given.

THE TERMINAL ENGINEERING Co., INC., New York, calls attention to Publication R229. It contains a description of a truck which can handle the problems of short haul transportation in a new way. It is a combined outdoor and indoor machine, permitting the haulage of goods from any floor of any building to any floor of any other building within reasonable distance. Loads are carried on separate platforms, eliminating loading and unloading delays.

THE WHEELER CONDENSER & ENGINEERING Co., Carteret, N. H., has issued Bulletin 114, on "The Lillie Evaporator," which is for waste waters and solutions generally. In this bulletin are described in considerable detail the features peculiar to the Lillie evaporator and several installations for sugar work, distilling water, and for evaporating many kinds of chemicals, solutions and waste waters. A perspective diagram is also given of the triple-effect and auxiliaries recently installed at the power station of the Chile Exploration Co., Tocopilla, Chile. A copy will be sent to responsible persons upon application.

THE P. H. & F. M. ROOTS Co., Connersville, Ind., has issued a folder on "Gas Exhausters and Boosters."

THE READING IRON Co., Reading, Pa., has issued Bulletin 2, in which is described the structural differences between wrought iron and steel and their relation to the field of welded pipe. It is written in a style that will interest the layman as well as the engineer.

THE BRITISH ALUMINUM Co., New York City, has published an interesting booklet on "The Casting of Aluminum."

C. B. ROBERTS ENGINEERING Co., Boston, Mass., has issued an attractive catalog entitled "A Modern Refinery," which is well illustrated.

THE LANCASTER IRON WORKS, INC., Lancaster, Pa., has issued a bulletin on steel plate construction.

THE J. G. WHITE ENGINEERING CORP., New York City, is distributing a folder entitled "Achievement." It gives information about and illustrations of power developments, hydro-electric developments, transmission systems and other important engineering projects in this and in foreign countries.

THE BACHARACH INDUSTRIAL INSTRUMENT Co., Pittsburgh, Pa., has issued a folder which shows its new quarters at Pittsburgh, Pa. The products of the company are given in a two-page folder and consist mainly of gas meters, air meters, pressure recorders, draft recorders, Pitot tubes and orifices, CO₂ indicators, manometers and engine indicators. Manometers and engine indicators are new products and are described in pamphlets G and M. The manometers may be arranged for their pressure, draft or differential pressure. The engine indicator described in pamphlet M may be furnished for revolutions up to 1,500 per minute.

THE MONO CORP. OF AMERICA, New York City, calls attention to a new departure in combustion control devices which is described in an illustrated bulletin, called the Duplex Mono, which is unique in that it automatically analyzes and records the combined percentages of three combustible

gases (CO, CH₄, H₂) during all such times as any or all of these appear in the flue, while it also produces a continuous record of the percentage of CO₂. Both records are on one chart.

HARRIS BROS. Co., Savannah, Ga., and Chicago, Ill., call attention to two bulletins. Bull. NS-1 gives a list of machinery, equipment and supplies which the company has purchased from the National Shipbuilding & Dry Dock Co., while Bull. 505, entitled "Water Tube Boilers," illustrates and describes new boilers which have been purchased from the Government and which were built under rigid Government inspection.

THE COMBUSTION ENGINEERING CORP., New York, has issued an attractive catalog, Bulletin C2, on the Coxe Stoker. This catalog is a revised edition of the old Coxe stoker catalog with supplementary text and revised line drawings.

THE POWER SPECIALTY Co., New York, which has been conducting an investigation into the requirements of oil-heating apparatus in refinery work, with a view to developing a more efficient type of still, has published the results of its investigation in a forty-page bulletin, in which is included descriptions of oil-heating apparatus, drawings of installations, a discussion of the flow of fluids in pipe lines and curves, tables and other data of interest to refinery engineers and superintendents.

JOSEPH T. RYERSON & SONS, Chicago, Ill., has issued a 96-page book on the heat treatment of alloy steels, entitled "The Ryerson Handbook on Alloy Steels." This book, written in an interesting non-technical style by G. VanDyke, manager of the alloy steel department, includes chapters on quality, method of manufacture, elements and the part they play, how to buy and select alloy steels, shop equipment, furnaces, quenching equipment, heat measurement, heating, cooling and quenching, drawing, annealing, testing heat-treated steel, case-hardening or carbonizing and general remarks, together with pen and ink sketches. The book will be sent upon request to buyers and users of alloy steel.

THE WHITE Co., Cleveland, O., announces a new publication entitled "White Trucks in the Oil Industry," which gives in 50 pages pictures and stories illustrative of the prominent part motor trucks are taking today in the development of the oil industry.

THE QUIGLEY FURNACE SPECIALTIES Co., New York City, has published a 16-page booklet on Q-alloys.

New Publications

OUR NEW PLACE IN WORLD TRADE is the title of a booklet recently published by the Guaranty Trust Co. of New York City.

RAW WATER DISTILLING PLANTS FOR PRODUCING DISTILLED BOILER FEED MAKE-UP WATER, by Joseph Price. Compliments of the Griscom-Russell Co., New York.

REPORT OF ACTIVITIES OF THE DIVISION OF INDUSTRIAL HYGIENE AND ENGINEERING for 1918 and 1919, published by the Dept. of Labor and Industry, Harrisburg, Pa.

UN SOUNDNESS IN STEEL AND FUNDAMENTALS ESSENTIAL TO SOUNDNESS, with appendix on Ingots and Ingot Molds, by Emil Gathmann and George Dornin, and published by the Gathmann Engineering Co.

COMMERCIAL POSSIBILITIES OF THE UNION OF SOUTH AFRICA. A survey of the recent industrial expansion and the mineral and agricultural resources of a market presenting great possibilities for American enterprise. Issued by the National Foreign Trade Council, India House, Hanover Sq., New York City. Copies will be sent free upon application to O. K. Davis, secretary.

PLATINUM is the title of a publication recently issued by the South American Gold & Platinum Co., New York and Buenaventura, Colombia.

RAIL REPORTS, which is Bulletin 9, has been published and sent with the compliments of the Titanium Alloy Manufacturing Co., Niagara Falls, N. Y.

OVERHEAD EXPENSES—HOW TO DISTRIBUTE THEM IN GOOD AND BAD TIMES, published by the Fabricated Production Department, Chamber of Commerce of the U. S.

REPORT ON CORROSIVE ACTION AND NATURE OF PRODUCTS FORMED WHEN CARBON TETRACHLORIDE EXTINGUISHER LIQUIDS ARE APPLIED TO FIRES. Published by the Underwriters' Laboratories, Chicago, Ill.

MESABI SINTER, PLANT, PROCESS AND PRODUCT OF THE MESABI IRON Co., Babbitt, Minn. Compliments of Clement K. Quinn & Co., Duluth, Minn.

PAPERMAKING MATERIALS. Reprinted from the *Paper Trade Journal* by Arthur D. Little, Inc., Cambridge, Mass.

U. S. TARIFF COMMISSION PUBLICATION: Suggested Reclassification of Chemicals, Oils and Paints. A report to Congress suggesting a reclassification of Schedule A and of related provisions of the Tariff Act of Oct. 3, 1913.

COAL-TAR DYES, for which import licenses were granted during the fiscal year 1920, by Charles S. Hawes. Published by the U. S. Department of State, War Trade Board Section, Washington, D. C.

CHROMIUM ORE, by W. G. Rumbold, published by the Scientific and Technical Department, Imperial Institute, London, England.

ANTIMONY. Published by the Imperial Mineral Resources Bureau, London.

ALUMINUM AND BAUXITE. Published by the Imperial Mineral Resources Bureau, London.

COBALT. Published by the Imperial Mineral Resources Bureau, London.

ZINC. Published by the Imperial Mineral Resources Bureau, London.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold a meeting at Rumford Hall, Chemists' Club, New York City, on June 10.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN IRON AND STEEL INSTITUTE will hold its nineteenth general meeting in the Hotel Commodore, New York, on Friday, May 27. There will be three sessions: A forenoon session beginning at 10 o'clock daylight saving time (9 a.m. Eastern time); an afternoon session at 2; and a banquet in the evening at 7.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY OF MECHANICAL ENGINEERS is holding its spring meeting at the Congress Hotel, Chicago, May 23 to 26.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20. Technical sessions are scheduled as follows: Tuesday, on Preservative Coatings and Textiles; Wednesday, on Cement, Concrete and Road Materials; Thursday, on Ceramics, Lime and Gypsum, on Petroleum Products and on Testing Methods; Friday, on Metals.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-eighth annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., the week beginning June 20.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

CHEMICAL & METALLURGICAL ENGINEERING

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A consolidation of
ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

ALAN G. WIEGAND
R. S. MERRILL
CHARLES N. HILDRETH
Associate Editor
CHESTER H. JONES
Industrial Editor
J. S. NEGRE
Managing Editor

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New York, June 1, 1921

Number 22

Plan to Make New Tariff Duties Immediately Effective

FEW pieces of legislation have aroused as much discussion as has Representative LONGWORTH'S resolution to make the provisions of the permanent tariff bill immediately effective as soon as it is reported to the House by the Committee on Ways and Means. The object of the resolution is to prevent large losses of revenue to the Government while the bill is under discussion, due to the fact that when the proposed higher rates of duty become known importers will promptly bring in large quantities of goods. This loss of revenue has always been recognized and regretted, but hitherto Congress has been unwilling to give immediate effect to legislation prior to its formal consideration and enactment. Evidence is not lacking that this precedent will still be followed, although a determined effort will be made to adopt Mr. LONGWORTH'S plan. It is admitted by all who favor the protective tariff that this would be of incalculable benefit to American manufacturers, but doubt is expressed as to the Senate's accepting the plan, although it is customary in Great Britain, France, Italy, Canada, Australia and other countries.

Experience shows that it requires from five to nine months for tariff legislation to take its regular course through Congress. During this period, as Representative LONGWORTH points out, the loss of revenue resulting from artificially stimulated imports will run into hundreds of millions of dollars "at a time when the Government is in need of revenue as never before, and when the resulting damage to American industries will be incalculable." In similar vein is Secretary HOOVER'S comment in a letter to the Committee on Ways and Means, in which he says:

"It seems to me desirable that the new tariff should be made legally effective upon the introduction of the bill. This is the custom in many countries. It prevents a large amount of speculation. Of even more importance, however, is the fact that during the period of discussion there is always a flood of goods in anticipation of the tariff. This decreases the revenue and renders the position of our commercial community extremely difficult."

This is not the first time that the Committee on Ways and Means has been confronted with this problem. In April, 1917, it sought the advice of the Tariff Commission on the subject and was advised that there could be no valid objection to making the tariff effective on the day on which it is reported to the House provided certain rights of importers are safeguarded. The commission was of the opinion that the proposed taxes should not be collected at once, but that importations could be continued under regulations determined by the Secretary of the Treasury whereby importers could give bond insuring payment of such duties as might finally

be enacted. Further, the rights of those who have made, prior to the date fixed, contracts for the sale of taxable imported articles should be protected either by authorizing them to recover from the purchaser an amount equal to the increased tax or by reimbursing them for their losses accruing on contracts on account of the increased duties. The first method was recommended by the Tariff Commission as being in the interest of the Government. With suitable safeguards for importers, it seems right that tariff changes should be made without advance notice to the public, as such notice creates abnormal buying by importers to the detriment of domestic industry and loss of revenue to the Government. If Mr. LONGWORTH'S resolution should be adopted the legislation would put the selective embargo on dyes into almost immediate effect.

For the Improvement Of Society Meetings

SOMEHOW—and frankly we confess that we do not know just how—a change is needed in the conduct of the divisions and sections at the great meetings of the American Chemical Society. Too many papers are presented, and many of them are not worth it. The opportunity for adequate and enlightening discussion in a great many cases is not available. In the Division of Physical and Inorganic Chemistry at the Rochester meeting there were sixty-four papers, and in order to be fair to each speaker his time was limited to ten minutes. But even if it is fair to give each author his fractional portion of the time available such an allotment is not right. What is needed is some kind of a sifting process, so that only important papers are read, and for these there should be plenty of opportunity for discussion. We think, too, that the chairman of each division should avail himself of his high-handed privileges, and cut off discussion that is not germane on the ground that it is out of order. Then if the speaker believes that he has something important to say he can appeal from the decision of the chair.

Censorship is needed, and it may be that for the main portion of these divisional assemblies papers should be presented only on invitation. This would not prevent contributions from unknown authors, because any member would be free to advise the chairman or secretary of the division that he had a paper on a given subject, and accompany it with a digest of its contents and a statement of the time needed for its delivery. Then the officers of the division could determine whether to accept it or not.

One of the leading chemical thinkers of the day said lately that the real meetings of the society take place in hotel lobbies, and suggested that it might be desirable to have rooms set aside and times fixed for dis-

cussions on certain subjects under informal rules, inasmuch as hotel lobbies are inconvenient places for talk. On the other hand, one of the most valuable privileges of these meetings is the opportunity that everyone present has to see and converse with the one authority or person he wants to meet, and the very fact that these miscellaneous assemblies in the lobbies are without specific purpose gives the questing visitor a better chance to find his man than he would have under more definite planning.

At the spring meeting in Rochester last April, generally speaking, the discussions were more important than the papers, and this state of facts is desirable rather than otherwise. Unfortunately this discussion is not recorded and published by the society. But while we would rather praise than find fault with the conduct of the divisions we think most serious minded members will agree that papers are getting too numerous and that many of them are not worth the time they consume at a general meeting.

The American Electrochemical Society prints and distributes in advance the papers that are to be read at its meetings, whereupon usually a mere abstract is given at the session, although the discussion which follows is based on information because the auditors are assumed to have read those that interest them beforehand. To print such a vast number of papers and to send them to 15,000 members of the American Chemical Society would inflict upon it a bill for printing and postage that would soon deplete its treasury, so that methods which are possible for smaller groups could not be carried out here.

The solution of the problem must be found and agreed to by the vice-presidents and secretaries in charge of the various divisions, and we know full well how difficult it is to effect changes in methods of administration after these have almost become conventions through years of practice. We believe, however, that before the year is out some improvement in this respect may be proposed. It is a hard task, and we are not closing our eyes to the difficulties; at the same time we desire to press rather urgently upon the officers of the various divisions the need of reform in the order and selection of papers presented.

Cracking Brass

By Corrosive Reagents

ELSEWHERE in this issue is presented an abstract of an important paper by Messrs. MOORE and BECKINSALE and Miss MALLINSON on "Season-Cracking of Brass." While the conclusions as to season-cracking confirm ideas commonly held by American metallurgists, it is especially important as a contribution to the scant data on what might be called "corrosion-cracking," a phenomenon thought by the authors to be identical with "season-cracking," but induced after a very short lapse of time by the action of special reagents.

Such studies cannot very well ignore the more general problem, "What is the mechanism of failure in metals?" Only by knowing how and why can we take steps to prevent unexpected failure. Without knowing how and why one can only accept unlooked-for fractures as the normal risks of life.

A consideration of the mechanism of metallic fracture brings one immediately to the important work at the English National Physical Laboratory of WALTER ROSENHAIN, who has probably done as much as any other

man to substantiate the idea that crystalline grains are cemented together by a film of non-crystalline or amorphous metal, thin sheaths whose atomic arrangement is very confused, corresponding to neither of the abutting grains nor to any definite intermediate orientation. Consequently even the purest metal is a complex aggregate, and its behavior will depend largely upon the relative amount and individual properties of the two phases and their mutual arrangement.

Crystal grains may be made to grow to such size as to comprise the entire cross-section of a wire or small test-piece, and their properties are thus capable of determination. Crystals support moderate loads in an elastic manner indefinitely. If the proportional limit is passed, ductile crystals deform by breaking into block-like fragments, which appear to wheel or slide instantly into new positions and then freeze into greater stability. The piece acquires a permanent set, but automatically has become harder and stronger. Increasing the load still further causes ultimate failure along crystal or gliding planes rather than at the boundaries—that is, rupture is transcrystalline rather than intergranular.

In view of the minute amount of amorphous material in a metal, its properties are known mostly by inference and by experiments suggested by the properties of such well-known amorphous materials as glass, pitch, beeswax or celluloid. Though apparently solid, amorphous material is thought of as merely an undercooled liquid possessing high viscosity. It may yield slowly under relatively low, long-continued stresses; its breaking strength depends upon the time the load is imposed. On heating, it loses strength rapidly. Depending upon the relation between temperature and viscosity, some amorphous materials like pitch yield slowly under continued stress even in the winter time. At normal temperatures, however, amorphous metal is harder and stronger than the crystal itself—rupture is normally transcrystalline. Similar hard, strong amorphous material is doubtless generated at the boundaries of crystalline blocks formed during plastic deformation—hence the hardening and strengthening induced by cold-work.

Such in brief is the amorphous theory, which has done yeoman duty in explaining many bizarre facts. Yet it should be noted that some metallurgists are as irreconcilable to the idea of amorphous intergranular cement as are certain Senators to the Versailles Treaty. LE CHATELIER, HEYN and HATFIELD are their leaders. One may or may not like their ideas, but these dissenters at least must be given credit for forcing their opponents to search out and marshal all their supporting facts. A very useful function for dissenters, truly, for we are all too prone to accept without question the plausible words of authority!

Yet a critical supporter of ROSENHAIN's theory would be inclined to question MOORE, BECKINSALE and MALLINSON's statement that "it does not appear to be necessary to ascribe peculiar mechanical properties to the intercrystalline substance in order to explain the phenomena of season-cracking." They have shown that mercury and ammonia react with amorphous material, destroying its strength. Hence corrosion-cracking, like season-cracking, is essentially an intergranular rupture. However, spun cups made from cold-worked brass do not crack as readily as the same cup from soft brass, despite its undoubted excess of amorphous material. The authors think that this is due in part to absorption of the reagent by the amorphous material in the crystalline

slips, thus diffusing the selective weakening. This assumes that the bulk of the new amorphous phase formed by cold work is at crystalline slips rather than grain boundaries—an undemonstrated point, to say the least. Yet, if there is no difference in amorphous material existing at crystalline boundaries and slips, then rupture should be both across and between the grains, because mercury absorption, and consequent weakening, should occur in amorphous metal existing on both kinds of surfaces. But corrosion-cracking is always intergranular.

An aggregate of atoms is either amorphous or not amorphous. Degrees of non-crystallinity are not readily distinguishable. Yet why does mercury or ammonia always seek out the structureless material at the grain boundaries, and never cause rupture in that existing within the crystal, unless the former has certain special properties denied by the authors?

Further Comment on Occupational Diseases

REFERRING to our recent comment on Prof. BASKERVILLE'S report to the American Chemical Society for the Committee on Occupational Diseases, we note in the *Journal* of the Society of Chemical Industry of April 30, 1921, some additional observation by Dr. STEPHEN MIALL.

"Broadly speaking," he says, "constant exposure to any chemical compound is likely to be injurious to health, particularly if it is likely to give rise to dust, fumes, or gas, and . . . an abundant supply of fresh air is the best method of protecting the health of the workers . . . All forms of dust and fumes are bad. Constant exposure to coal dust and tar causes what is known as pitch-makers' cancer, tar being the main irritant in this case. The manufacture of marmalade causes injury to the skin by the peeling of oranges and lemons, fine silica dust affects the lungs in a particular way, etc."

Sometimes excellent measures of prevention do not cure, as was the case of prohibition by the Swiss Government in 1879 of the use of yellow phosphorus in making matches. The workers then felt that they could dispense with all precautions where the alleged "harmless" red phosphorus was used, and the poisonings became more frequent than before. It was necessary to alter the law.

Cases of poisoning by carbon monoxide, nitrous fumes and ammonia are increasing in Great Britain, and yet these cases are almost all due to ignorance of the dangerous character of the fumes on the part of the workers. There is no difficult chemical problem in preventing this form of poisoning. A fatal case of benzene poisoning was noted following "improvements" which decreased the ventilation, and an analysis of the air showed two to ten parts of benzene in 10,000 parts of air. No other cases followed after the ventilation was increased.

Turpentine poisoning produces kidney disease and seems to predispose the worker to gout. Persons who are susceptible to the smell of a newly painted room have attributed the illness to white lead or to other causes. It is hardly believable that a volatile lead compound is given off as a gas or emanation from lead paint, and the experience of the past twenty years indicates turpentine as the delinquent.

Autopsies of fatal cases in New South Wales showed

in analyses of livers from 0.1 to 0.9 grains of cadmium per pound with merely a trace of lead. Dr. MIALL believed these occurred in the zinc-smelting industry of that region. The symptoms of cadmium poisoning include kidney disease, constipation and loss of appetite. Zinc is a general protoplasmic poisoning and in the higher animals it causes muscular contraction and kidney disease. Copper, tin, nickel and manganese have injurious properties, but cases of poisoning by them are rare.

White lead has been a fruitful producer of disease. About thirty years ago there were many preventable cases of lead poisoning in Great Britain, amounting in the white lead industry itself to about 400 cases a year, in making china and earthenware 200 cases and in printing, glass, shipbuilding and other industries about 400 more, making over 1,000 in all. Restrictions as to improper use, removal of dust, substitution of an insoluble lead silicate for white lead in the glazes of china and earthenware, rules for wearing overalls, etc., have caused a steady decline. Indeed the number of cases has decreased from over 1,000 cases annually to eleven cases in 1898 and twenty-one in 1919. It is said that lead poisoning is not caused by particles of lead swallowed by the worker, but rather by even more minute particles floating in the air inhaled into the lungs and so getting into the system. The headache complained of by painters is more likely to be caused by turpentine than lead. Diagnosis is difficult, and poisoning by cadmium, turpentine, arsenite of copper and other agents is often erroneously classed as due to lead.

Resignation of A.I.M.E. Secretary

MEMBERS of the American Institute of Mining and Metallurgical Engineers will learn with surprise and regret of the resignation of BRADLEY STOUGHTON, who has been secretary of the Institute since 1913. Mr. STOUGHTON is retiring in accordance with his personal conviction, which has been known to some of his more intimate friends and associates, that the office of secretary of the Institute should not be a permanent one and that too long a tenure of office is likely to create relationships that cannot be terminated agreeably. Past events, not only in the A.I.M.E. but also in other national technical and engineering societies, lend abundant support to the sentiment that retention of a secretaryship by one incumbent for more than ten years is likely to lead to undesirable complications. Mr. STOUGHTON'S resignation is to be accepted at the convenience of the board. When he retires it will be with the good will of all members of the Institute who have had occasion to come in contact with him. During his tenure of office the Institute activities have increased in number and complexity. The membership has increased from 3,500 to over 9,000. Local sections have grown in number from four to twenty-six; technical committees have multiplied until they now number eighteen. The growth in volume of transactions is known to all the members and the public activities and traveling that have fallen upon the secretary are matters that even most remote local sections of the Institute have recognized. The period has been a notable one in the development of engineering societies as factors in the national welfare, and Mr. STOUGHTON can derive no small satisfaction from his personal contribution to this development.

Readers' Views and Comments

Measuring the Flow of Gases

To the Editor of Chemical & Metallurgical Engineering

SIR:—My attention has been called to the article in your May 4 issue by Prof. C. R. Hayward on a device for measuring the flow of gases. This device consists of a differential gas flow-meter in connection with a pipe line. The statement is made in the article that by using plugs with different sized openings in the differential manometer it is possible to calibrate the apparatus with air so that the exact flowage of any quantity of any gas may be read from curves based upon this calibration.

Prof. Hayward does not mention the fact that these calibration curves as determined by the use of air are not applicable for the measurement of any other gas unless it has very closely the same molecular weight as air possesses. This is, of course, for the reason that the amount of gas flowing is inversely proportional to the square root of its molecular weight. It will therefore be apparent that apparatus of this sort standardized against air would be useless, let us say for a benzene-air mixture, unless recalibrated with a mixture of benzene and air, since the molecular weight of benzene is nearly four times that of air. It is also possible to calculate from the amount of air flowing under given conditions, using the curve derived from a test with air, the flowage that would occur with any other gas under given conditions, provided the molecular weight of this gas is known. It seems to the writer that the article was misleading in that it would suggest that the use of the air calibration curves is universally applicable to all gases.

Cambridge, Mass.

R. G. KNOWLAND,
Consulting Chemical Engineer.

To the Editor of Chemical & Metallurgical Engineering

SIR:—There have been published at various times in the literature devices and means of measuring the flow of gas which do not give accurate volumes.

In a recent article by C. R. Hayward in Vol. 24, No. 18, of CHEMICAL & METALLURGICAL ENGINEERING with reference to the measurement of gases, we note that no corrections to the volume as read from a predetermined chart are mentioned regarding the density and temperature variations which may be encountered.

If a brief summary of the fundamental equation be considered concerning the flow of gases through small openings, it will be readily observed that from Torricelli's theorem the velocity of a jet of gas is

$$V = \sqrt{\frac{2p}{d}}$$

Where V = velocity.

p = differential or difference in pressure
on the two sides of the orifice.

d = density of the gas.

It is obvious that the velocity and consequently the volume of gas passed is inversely proportioned to the square root of the density of the gas.

Since the orifice meter is calibrated with air (sp.gr. = 1.0) and at some definite temperature (T_1 absolute), then to account for other temperatures and specific gravities, the final volume as obtained from the curve

must be multiplied by the following factor, which considers change in gravity and flowing temperatures of the gases metered.

$$\text{Factor} = \frac{1}{1} G \times \sqrt{\frac{T_1}{T_2}}$$

Where G = sp.gr. of gas (air = 1.0).

T_1 = absolute temperature base or orifice.

T_2 = absolute flowing temperature.

Inasmuch as numerous investigators are constantly using various forms of flow-meters and considering the importance of accurate measurement of gas, this correction may prove very useful.

ROBERT N. DONALDSON.

ROSS MCCOLLUM.

Bakersfield, Cal.

Who Is a Chemist?

To the Editor of Chemical & Metallurgical Engineering

SIR:—It must be evident to a thoughtful employer of chemists that the letter of "Chemically Trained Worker," on "Who Is a Chemist?" published in your April 6 issue, must have been written in a mediæval frame of mind. To be sure, the advertisement in the New York Herald, which "Chemically Trained Worker" cites, is not a model of clearness, but when the advertiser stated that "no special experience" was necessary, he revealed himself at least as a very practical person.

"Chemically Trained Worker" is one of those who still bows down before the fetish of "experience." There are actors who have been spouting blank verse for twenty years, but who will never play Hamlet acceptably. They have "experience." There are chemists who likewise have had twenty years' experience but who are utterly useless in a laboratory.

Give me a young man with aptitude and in a few months I will give him all the experience that he will require. Experience without aptitude is worthless. In the term "aptitude" I include imagination, resourcefulness and ingenuity—all of them worth far more than the "experience" that still hypnotizes employers. I would rather take a young man who was graduated with honors from a good technical institution and whose professors assure me that he has the qualities that I demand than one of those hard-shelled "experienced" routineers who will never make any contribution to the literature of his profession.

New York City.

WALDEMAR KAEMPFERT.

Cost of Nitrogen Fixation in Norway

To the Editor of Chemical & Metallurgical Engineering

SIR:—With reference to the article in your March 23 number, page 531, and comment in the April 20 issue, page 681, your attention is called to Molinari's General and Industrial Chemistry, 1912 edition, pp. 304-307, which substantiates Mr. Jensen. There is also an article in the General Electric Review for January, February and March, 1917, called "Literature of the Nitrogen Industries," which is very valuable and bears out in reference to the Birkeland-Eyde process the remarks of Mr. Jensen.

J. W. W. OW.

Springfield, Vt.

American Oil Chemists' Chicago Meeting

Progress Shown Through Reports of Committees—Dr. C. L. Alsberg's Address on Organization of Research in the Federal Service—Barrow-Agee Laboratories Wins Silver Cup on Check-Meal Contest—Engineering Papers, Committee Reports and Officers Elected

THE twelfth annual meeting of the American Oil Chemists' Society, which until this year has been known as the Society of Cotton Products Analysts, was held at the Congress Hotel, Chicago, Ill., on May 16 and 17, the two days just preceding the silver anniversary convention of the Interstate Cottonseed Crushers' Association meeting at the same location. This organization is perhaps without exception one of the liveliest aggregations of chemists in the United States, as shown in these annual meetings where discussions and debates are carried on without restraint. Doubtless this is accounted for by the fact that all the members are interested in one subject—namely, the oil industry.

PAPERS PRESENTED

J. W. Bodman delivered an excellent treatise on "The Manufacture and Grading of Distilled Fatty Acids," outlining the process of double distillation, showing diagrams of apparatus and giving actual operating figures. The diagram of a plant in operation showed a cast-iron fatty acid still about 9 ft. in diameter, 24 ft. in height over all, with copper conduits connecting the dome with the barometric condenser. Copper on an average is more satisfactory than aluminum because it is much easier to obtain coppersmiths for repair than it is aluminum workers at the present time. Receiving eggs are located beneath the barometric condensers and rotary vacuum pumps are connected to the end of the system to draw the vapors through. Normal charge placed in the still is about 15,000 lb. of fatty acid. Superheated steam is supplied from an outside source. One pound of steam distills 2 lb. of fatty acid at the rate of 1,500 to 2,000 lb. of fatty acid double distilled per hour.

By covering the still with 85 per cent magnesia a fuel saving of one-quarter of the total amount burned was effected. Eighty-five per cent double-distilled fatty acid was recovered from foots. No chemical control is used at the present time for determining when the pitch is finished, but the judgment of the operator is relied upon. Something of the importance of the industry of distilling fatty acids may be derived from the fact that in the United States in 1919 the amount of fatty acids distilled was 7,428,000 lb., while in 1920, 89,516,000 lb. was distilled.

Future improvements contemplated involve the elimination of separate heat for superheating the steam and the employment of the latent heat of vaporization as it passes from the still for this purpose.

It has been said that entrained coloring matter cannot be removed from the vapors by any mechanical device, but this has been accomplished by the design of two pear-shaped separators. Vapors are whirled tangentially against the corrugated interiors, giving a scrubbing action. These have been successfully tried out and will do much to increase the yield of white stock in the future.

Recent operating figures show that on a plant of this type the cost per day for actual operation is \$88.32, with an addition of \$62.50 per day overhead, including interest, insurance, depreciation, etc. The total cost per hundred pounds of double-distilled fatty acid is 65c.

In discussing the grading of fatty acids Mr. Bodman spoke of the various features involved, as to whether the analyses shall be made by reflected or transmitted light, stating that transmitted light as read through a 1-in. cube is probably the best method to be settled upon. He made a special plea for getting away from the indeterminate method of grading acids good, fair and poor, which means nothing.

ORGANIZATION OF RESEARCH IN THE FEDERAL SERVICE

Dr. C. L. Alsberg, chief of the Bureau of Chemistry, gave a short talk on the proposed reorganization of federal research, referring to some of the nonsensical proposals for this reorganization and some of the principles which should govern it.

In discussing what the function of the federal research should be we must consider what is going on at the present time. Congress appropriates money only for things which can be turned into dollars and cents. This is wrong, but it is the actual condition. The primary function of government is to carry on fundamental research which may not be evaluated in the generation in which the work is done. Only the Federal Government can afford to carry on certain types of work which is beyond the pocketbooks of the corporations, because it takes large sums of money for fundamental research and these are available only to the Government. Industries also cannot afford to spend the time required to develop a particular project.

No one can predict the value of definite fundamental researches at the start of the work, yet many pay big, as in the case of the development of the telephone and wireless in the electrical industry. There is no systematic research being carried on today, the work being done hit and miss. Investigation of thermodynamics is much more important than the value of making certain sirups from sweet potatoes, but the money cannot be obtained for the former.

So long as the Federal Government does not recognize the need of fundamental research the Government organization should be patterned after the industrial research laboratory rather than the organization of the university research laboratory.

Canners, for instance, deal with farming and plant industry, the work being divided into agriculture, manufacturing and marketing. What is the use, for instance, of forcing the canner to deal with three separate Government departments instead of one department which understands his whole problem? The commodity should then be handled in one department. There is no logic in such a division as now exists caus-

ing endless duplication and overlapping of the work. Industrial bureaus should have the right to employ any kind of technic in solving the problem for which Congress appropriates the money. We must get away from the idea of a bureau of one science and have one department on each product or industry. We cannot separate production, utilization and standardization, and so must have regrouping according to commodities instead of sciences as long as the Government insists on practical results.

In regard to the regulatory laws which must be administered by scientific men, they are of a corrective rather than a criminal nature, and decisions handed down must be constructive. Such will be the case if the laws are administered by a department familiar with the particular industry in question.

Our Government is not doing its duty in regard to fundamental research, and this is because the public is not asking for it. Consequently we are passing through a difficult period. Industries are hostile because of fear of inventive competition. This will be removed if the Government carries on more fundamental research than that which is immediately useful. The organization would be especially effective for industries composed of numerous small companies and not so necessary as in the case of the electrical industries which are controlled by a small group, for instance.

RANCIDITY: ITS CAUSE AND PREVENTION

Robert H. Kerr, of the Bureau of Animal Industry, outlined the organization for handling samples at the bureau in analyzing for spoilage due to rancidity and other causes. The other causes involve decomposition of insoluble proteins by bacterial action. Literature on rancidity is incomplete, no systematic study ever having been published.

Fats change due to a shifting of atoms in the glyceride molecules and polymerization; due to reaction with water, and the entrance of oxygen forming an infinite variety of products. There is really little known of the organic compound formed with oxygen.

Rancidity is distinguished from sweetness by common methods—namely, odor, taste and a definite Kreis test.

The bureau has spent considerable time on research as to the development of rancidity and found that it does not occur without the admission of oxygen. If there is no oxygen present a fat never becomes rancid. Four bottles of cottonseed oil placed in a dark room for ten years, three sealed with glass stoppers and one with cork, showed the oil in the three with the glass stoppers to be in perfect condition at the end of that time, while oxygen leaking through the cork had made the contents of the fourth bottle become rancid.

Light helps rancidity. Oils placed in blue bottles will become rancid quicker than those in brown, due to the actinic rays. Heat promotes rancidity, as demonstrated in refrigeration sample comparisons. Moisture aids rancidity. So do certain metals, chief among which are copper, zinc, tin and aluminum. Sterilization has no effect on rancidity, an unsterilized fat becoming rancid as quickly as one which has been thoroughly treated. Glycerides of unsaturated acids become rancid quickly. Foreign earths used for bleaching promote rancidity. All fullers earth has oxidizing power.

No case of rancidity refutes the theory that oxidation

is the cause of it. The present practice for the prevention of rancidity of oils in tank cars, etc., is sound and cases of rancidity, where they occur, are due to departure from standard practice. The main thing is to keep tank cars, packages and containers filled and tightly sealed.

OTHER PAPERS

Papers read by title only were: "Observations on the Use of Solvent Extraction in the Vegetable Oil Industry," by Glenn H. Pickard, and "The Wording and Impracticability of Certain Parts of the Rules Covering the Oriental Oils."

COMMITTEE REPORTS

The chief work of the two days' meeting was devoted to reports of numerous committees involving vital facts and findings relative to the vegetable oil industry. All discussions were permitted only when a motion was before the house, which had the effect of securing prompt action and warm discussion. President Porter admitted of no straying from the main issue.

The membership committee, reporting 263 members, recommended an elimination of the requirement for membership which involves that a member have at least five years chemical training. The members voted down this recommendation, preferring to keep up the bars and maintain the high standard of the society.

Herbert S. Bailey, editor of the Chemist Section of the *Cotton Oil Press*, the official publication of the society, urged the members to enter a plea for more advertising for the annual issue.

CHECK-MEAL WORK

Dr. F. N. Smalley made numerous recommendations for the check-meal work for 1921-22 having to do with the mechanism of the contest for the silver cup awarded for the best analysis of certain samples each year. The suggestion that the announcement of the winners and awarding of certificates shall be made only at the next annual meeting was voted down by the members, since it was considered that publicity was necessary to earnest competition.

CO-OPERATION IN RESEARCH COMMITTEE

Reporting the findings of the co-operation in research committee, P. S. Tilson referred to the outline published by Herbert S. Bailey in *CHEMICAL & METALLURGICAL ENGINEERING*, vol. 23, No. 10, Sept. 8, 1920, p. 441, as a brief but apt outline of the situation. Members that are eligible may apply to the National Research Fellowship. Mr. Tilson is anxious to place a list of research problems for the universities to work upon and to raise \$25,000 from the membership for a co-operation plan like that carried on by the Mellon Institute and Massachusetts Institute of Technology.

MOISTURE COMMITTEE

W. D. Richardson, of Swift & Co., reporting on the work of the moisture committee, stated that drying tests made showed that during drying there was decomposition of the oils evolving small quantities of water, and that oxidation took place, adding to the weight by absorbed oxygen. The best that can be done is to adopt a standard oven and procedure. Blueprints of a jacketed oven where a glycerine water mixture was used in the jacket and heated by electric coils were submitted. This oven has been tried out for several

years by Swift & Co. and found to be inexpensive and satisfactory. It is further provided with a condenser at the end of the system and has produced very concordant moisture figures. The drying time employed was four hours at 102 deg. C. on the inside of the oven. Volunteers to use it in next year's check-meal contest are desired. It is needless to try the distillation process of drying, because the committee has found it useless.

COLOR OF COTTONSEED OIL AND MEAL COMMITTEE

Dr. David Wesson, reporting on the work of the color of cottonseed oil and meal committee, told of twelve new instruments for this determination which are being completed at the Eastman Kodak Co., Rochester, N. Y., and a second apparatus which is being designed by the Bureau of Standards. The latter depends on the amount of light transmitted to a definite wave length through a definite column of oil. The sample has to be placed in a special trough and measurements are governed by the distance between prisms immersed in the oil. The committee will hold a meeting at the Bureau of Standards for investigating this instrument during the summer. In this connection Dr. Priest, of the Bureau of Standards, described the mechanism and mathematics of the instrument involving the kind of light, the properties of the material, and the character of the observer. The advantages of this instrument are universal validity, and standardability.

BLEACH TEST AND FULLERS EARTH COMMITTEE

The bleach test and fullers earth committee has checked the standard method of analysis and agrees to no change. The interstate rules bind the members to the use of English fullers earth, since the domestic is not so good for bleaching, but everyone is after the matter to discover the proper material.

DAMAGED SEED AND SEED ANALYSIS

The damaged seed and seed analysis committee reported that questionnaires were sent to the commercial chemists of the South for standardizing reports, and rules were proposed. The results should be reported as yield of 1,900 lb. of available seeds. The damaged seeds should be reported by count and not by weight. The percentage of damaged seeds should not be taken into consideration when figuring the yield.

AMMONIA COMMITTEE

The ammonia committee in reporting on questionnaires stated that of the replies sent out eighty-six answers were received, sixty-three of which used the Gunning mercury method, twenty the Gunning copper method and the remainder the Kjeldahl method. All but seven replies used some form of trap bulb in the analysis. Arrangements have been made for the General Chemical Co. to prepare a standard supply of ammonia sulphate and ammonia carbonate for distribution in checking samples.

OIL CONSTANTS COMMITTEE

L. M. Tolman, reporting for the oil constants committee, stated that an active effort would be made during the coming year to get a large collection of authentic samples for the Bureau of Chemistry to work upon for building up a set of analyses of American oils. The name of this committee was changed from the oil constants committee to the oil characteristics committee.

The report of the soapstock committee is given complete on page 43 of the May issue of the *Cotton Oil Press*.

SAMPLING COMMITTEE

E. R. Barrow, in a lengthy report of the findings of the sampling committee, presented drawings to show various types of designs to be considered for standard use in sampling in tank cars. The American Oil Chemists' Society 1920 sampler, and the Fash sampler, were recommended for special consideration. During the discussion on this report Dr. Wesson insisted that the purchaser should be allowed to empty the tank car and mix the contents before sampling instead of taking the core of the cars as is now done. The solution seemed to be that the shippers should take samples while loading the car and the purchaser while unloading. The report was finally referred to the chemists committee.

BUSINESS MEETING

Dr. David Wesson presented a code of ethics for the adoption of the society which each member should sign, involving the following points: (1) Purpose of the code to define rules of professional conduct. (2) Conduct to be in accordance with the highest ideals. (3) To uphold the standing of the profession with the public. (4) To behave as a gentleman and exalt the vocation. (5) To refrain from unreasonably low charges for professional services in order to advertise. (6) To refuse to lend name to questionable enterprises. (7) Differences and disputes between members to be referred to the governing committee. (8) To do nothing contrary to law and public welfare. (9) That it is unprofessional to advertise in any way except by legitimate business cards and its insertion in proper section of advertising mediums. (10) To serve only one client in each case. After some discussion the code was adopted by the society with the exception of No. 9.

The officers elected for the coming year were: President, C. P. Cluff, American Cotton Oil Co., New York City; vice-president, L. M. Tolman, Wilson & Co., Chicago; secretary-treasurer, Thomas B. Caldwell, Law & Co., Wilmington, N. C.

BANQUET

On Tuesday evening the members enjoyed an informal banquet at the City Club quarters, 315 Plymouth Court. The principal speaker of the evening was Dr. W. Lee Lewis, head of department of chemistry of Northwestern University and chairman of the Chicago Section of the American Chemical Society. His talk was replete with an unusual number of witty anecdotes, while the serious part was devoted to research at the university with reference to the Hoskins-Wileš plan for the promotion of scientific research as outlined on page 689, vol. 24 (April 20, 1920), of *CHEM. & MET.*

Other speakers of the evening were Dr. David Wesson, who told some unusually good stories and was followed by L. M. Tolman, who made personal references to all the members at the speakers' table. Dr. F. N. Smalley made the presentation speech for the silver cup on the check-meal contest, which was awarded to the Barrow-Agee Laboratories for the best work carried on over a period of three years. Herbert S. Bailey acted as toastmaster. The meeting closed with a vote of thanks to the chairman of the local entertainment committee, Dr. L. M. Tolman, for taking care of the members during their stay in Chicago.

Drill Steel From Hollow Ingots

A Definite Effort to Produce Hollow Drill Steel With a Decarbonized Interior Surface by Inserting a Mild Steel Tube in the Ingot Mold, Plugging It With Sand, Casting the Steel and Subsequently Rolling to Size

BY P. A. E. ARMSTRONG
Vice-President, Ludlum Steel Co.

HOLLOW drill steel is made by various methods: (1) The drilled billet with a sand-filled core, the general method used in this country. (2) The drilled, pierced, or the drilled and pierced billet, not sand-filled, is rolled down over a projectile or ball much the same as in ordinary pipe manufacture. System (2) is employed largely in Sweden. In Sheffield, England, the general scheme is sand-filling. Swedish hollow drill steel is particularly good and has a world-wide reputation for excellency.

It does not follow, however, that steels made by other methods are not efficient, because they are.

DECARBONIZED CENTERS IN SWEDISH BARS

In the Swedish material, a peculiar condition is present. The hole is badly decarbonized by the method of manufacture and the extent of this decarbonization varies in bars of different makes. Fig. 1 shows a polished and etched cross-section of very good grade Swedish hollow drill steel that is totally decarbonized $\frac{1}{10}$ in. deep, and the carbon varies from the carbon of the bar down to iron or carbonless ferrite through another $\frac{1}{10}$ in. Owing to difficulties in illumination, the altered structure is not so prominent as under visual examination.

Fig. 2 shows a much lighter decarbonized zone, being only about $\frac{1}{40}$ in. thick, but with certain radial cracks running from the hole into the bar. In this photograph it will be noted that the body of the steel is very dirty. There are a large number of slag inclusions which follow somewhat the original form of crystallization.

Fig. 3 shows another section of Swedish hollow drill steel with about the same amount of decarbonization as Fig. 2, but with larger radial cracks, carrying the local decarbonization in more markedly than in

Fig. 2. The zone of graded carbon content is about three times the width of that in Fig. 2.

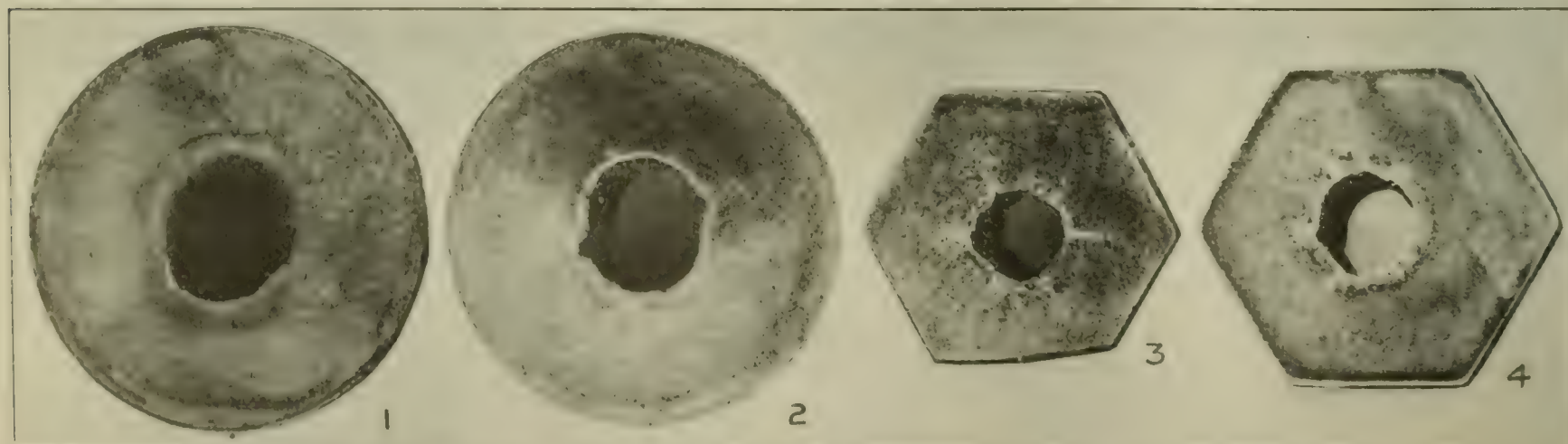
Fig. 4 is another sample of Swedish hollow drill steel, much about the same as the others, only with a little heavier decarbonization. All of the bars shown in Figs. 1 to 4 inclusive have been rolled either on a projectile or without one, but they were not rolled with sand in the hole and represent the general run of Swedish hollow steel.

Fig. 5 is a piece of 0.85 carbon, 1 per cent chromium steel rolled from an ingot cast around a mild steel tube. The mild steel lining has a thickness of about $\frac{1}{10}$ in. and there are no cracks from the tube into the metal. There is a slight, but very slight, grading in carbon content between this tube and the metal. The reason for this is that chromium present in steel as an alloy prevents to a very large degree the carburizing of adjacent iron by saturation. I do not say that it is not possible to carburize mild steel by saturation because of the chrome alloy, but merely say it is more difficult than when the chromium is not present.

Fig. 6 shows a piece of 0.85 plain carbon steel having the mild steel tube core, cast and rolled in exactly the same way as that in Fig. 5, yet there is very little of the carbonless iron remaining. A very complete saturation has taken place, which shows very distinctly the difference brought about by the chromium.

INFLUENCE OF DECARBONIZED LAYERS ON HARDENING

A question that seems worthy of deep consideration is this: Is this decarbonized core an advantage or a disadvantage? If it is an advantage, why not duplicate this by controlled practice and not haphazard means of manufacture? If it is a disadvantage, then why is it that steel of this character has such a good reputation for being a good grade hollow drill steel? There is nothing in the steel that can be discerned microscopically or by analysis that proves it to be superior



FIGS. 1 TO 4. ETCHED CROSS-SECTIONS OF SWEDISH HOLLOW STEEL SHOWING MACROSTRUCTURES

Fig. 1. First-class hollow steel rolled over a mandrel. Decarbonized zone $\frac{1}{10}$ in. thick.

Fig. 2. Less clean hollow steel rolled over mandrel. Decarbonized zone $\frac{1}{40}$ in. thick.

Fig. 3. Badly cracked steel with thick region of graded carbon content.

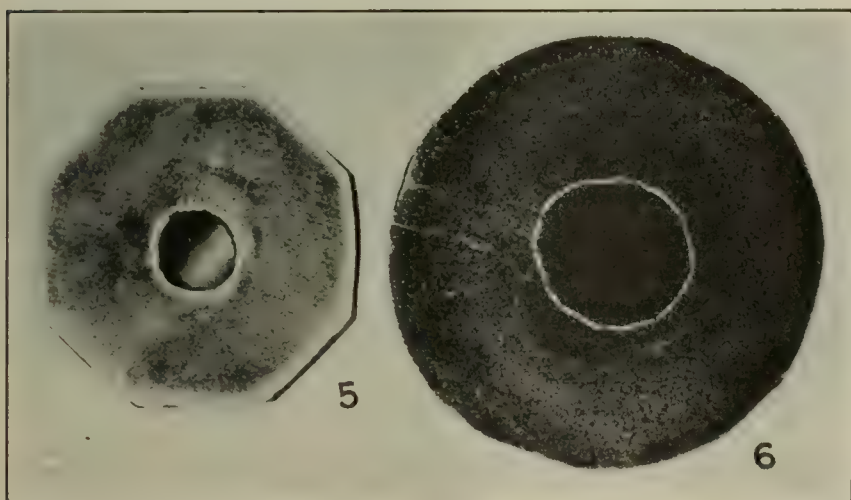
Fig. 4. Heavily decarbonized rod of hollow drill steel.

to hollow drill steel of good manufacture made by methods that prevent decarbonization of the hole. Therefore it is fair to assume that the decarbonized wall of the hole is an advantage. On investigating this subject we found that hardened bars with this decarbonized hole do not become so intensely hard on the inside, neither are they so prone to cracking. Bars with radial cracks are of course bad, no matter what the system of manufacture.

LITTLE EXTERIOR DECARBURIZATION

Attention is drawn to the fact that the decarbonized hole shown in the photographs, particularly in Fig. 1, has much greater decarbonized rim in the hole than at the exterior of the bar. This probably may cause some wonder. I believe it is due to the fact that on reheating the bars and rolling them through the various mills the oxide is broken off the bar. When the bar is reheated it is subject to a fresh scaling and is not affected by the scale already adhering to the bar which in itself would set up decarbonization. Therefore, the exterior of the bar has to withstand only the decarbonization arising from the furnace gases and later the adhering scale from that heating; whereas the inside of the tube is affected by adhering scale at all times, adding to the decarbonizing effect of the reheating. The scale is partly reduced by the carbon in the bar, and as the scale is thicker the action is more pronounced.

The mild steel or decarbonized iron inside the hole acts as a damping effect when hardening is produced.



FIGS. 5 AND 6. HOLLOW STEEL ROLLED FROM CHROMIUM AND CARBON INGOTS CAST AROUND A MILD STEEL TUBE

This effect can probably be readily appreciated when the fact is remembered that if a piece of, say, 1 per cent carbon steel be rough-turned so that all decarbonization is removed from the outside of the bar and this be heated up to just above the transformation point and quenched in water of, say, 70 deg., the bars will come out hardened in spots in a non-uniform manner. Some places will be hard; others will not. If a further length of the same steel be rough-turned and then ground and polished, this bar, subjected to the same heat-treatment and same speed of cooling, will come out quite file hard all over and not at all spotty. The reason for this is that the rough-turning holds the steam arising from the heated metal in contact with the water, and thus causes certain zones to cool at a slower rate than those places where the steam which is generated was quickly removed.

In the case of the polished bar, there is no roughened exterior to hold steam pockets, and the steam, as generated, quickly rises to the surface of the cooling fluid and the bar is uniformly hardened over its entire surface. If this bar, which is polished, were covered with a thin tube, then the hardening would not be very pronounced underneath the tube. This of course would vary with the thickness of the tube and whether or not the tube was in good contact with the bar. Such a condition can artificially be produced by decarbonizing the surface of this polished bar. If this decarbonization is carried to a fair depth, say $\frac{1}{2}$ in., the bar will not be of maximum hardness underneath the decarbonized area after being quenched in water. The thicker the zone the less will be the hardness, and for the same reasons which prevent one from uniformly hardening a piece of similar carbon steel right through to the center when quenched from just above the transformation point. Another way of saying this is that the speed of cooling is only fast enough for a certain amount of penetration or depth of hardness. To harden right across the cross-section, alloy steels have to be resorted to, which have a greater lag to transformation.

HOLLOW STEEL FROM HOLLOW-CAST INGOTS

Hollow drill steel made by casting the metal around a tube and mechanically working the hollow ingot down to the required size (filling up the hole with sand and later removing same after rolling) will have an artificially produced equivalent decarbonized core which will be free from any such tendency toward splitting and driving in radial cracks as has been noticed in the photographs. The surface of the inside of the tube will be comparatively smooth, giving a uniform cooling rate to the inside of the bar, again reducing the tendency for a radial crack to start.

One of the reasons why the carbonless walls of the tube of the bars made by this method do not crack in manufacture is because the mild steel tube is not the result of a decarbonized steel highly impregnated by oxygen and oxides and having a number of microscopical holes where the carbon of the carbides last resided. These holes are places of weakness which may or may not weld up, depending on whether the interior of these microscopical cavities is coated by an oxide layer or filled with gas, either from the gas occluded in this steel or that which has penetrated from the furnace atmosphere. Decarbonized steel is, in my opinion, less strong than mild steel which has been originally made in low carbon and worked down to the required size.

The method employed by the Ludlum Steel Co. in the manufacture of hollow drill steel is to insert a high-grade low-carbon mild steel tube, suitably cleaned by sandblast, into an ingot mold and cast the hot metal around the tube. We fill up the tube with some air-excluding material so as to prevent oxidization and scaling of the inside of the tube, generally using a high-grade sand for this purpose. The ingots are then rolled in the usual way down to the finished bar. The bars are cut up to required length and the sand extracted by a special method, which is very speedy and extremely effective.

SEGREGATION IN HOLLOW-CAST INGOTS

Segregation is a thing which must happen in all steel solidification and this is responsible for a certain mechanical weakness in the finished bar. If the segregation can be so located as to have very little mechanical

effect, it would be desirable to make the ingots in that manner.

Casting hollow ingots by the tube method is particularly fortunate in this respect. As the segregation which is bound to occur will be concentric with the hole and its maximum occurrence is about midway between the exterior of the ingot and the tube wall, this area is very large in circumference, comparatively speaking, and the segregation is comparatively small because the distance between the tube and the ingot mold is small. This thin layer of segregation will be most noticeable at the top of the ingot. It can have no effect or at most very little effect upon the bar, as the segregates do not, under any circumstance, creep through to either the exterior or the interior wall of the ingot. Segregation is not removed at all in the pierced billets from solid ingots and is only very indifferently removed in the case of the drilled billet. Furthermore, even if segregated impurities are removed by using only the butts of the ingots, and drilling the billets, there is still carbide segregation to contend with. This will run in straight or nearly straight lines, parallel with the wall of the ingot or the line of freezing.

The inside of the hole of a drilled billet must, therefore, necessarily be the weakest place in the billet, resulting in a weak bar. Progressive fracture is easily started from one of these many sources of weakness.

INFLUENCE OF CRYSTAL SIZE ON QUALITY OF STEEL

Crystal size is of great importance. In a general way the smaller the ingot the better the steel. With a small ingot, the crystals are not very large, the crystallites or colonies of crystals not very far-reaching, and the speed of cooling from the liquid to the solid state fairly rapid.

In a 24-in. ingot, for instance, the crystallites are likely to be quite large and likewise the individual crystals forming them. Crystallites are also apt to have a uniform direction for quite substantial distances, depending entirely upon the temperature and the speed of cooling. If the steel is cast hot enough and quickly enough, a fractured ingot will show a complete diagonal structure, the crystallites growing out like columns until they touch one another, leaving room for no equi-axed crystals in the center of the ingot. If the temperature is lowered, the equi-axed zone is larger, and the pine-tree growth, which is the crystallite formation, is less.

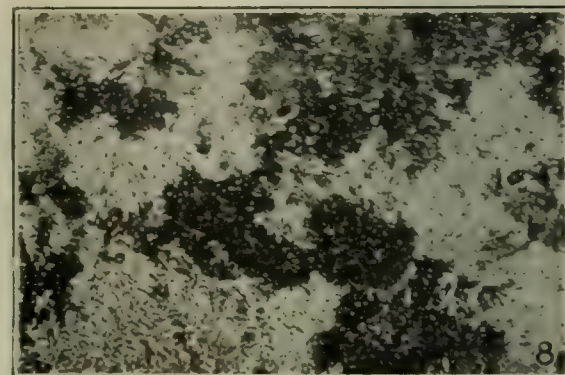
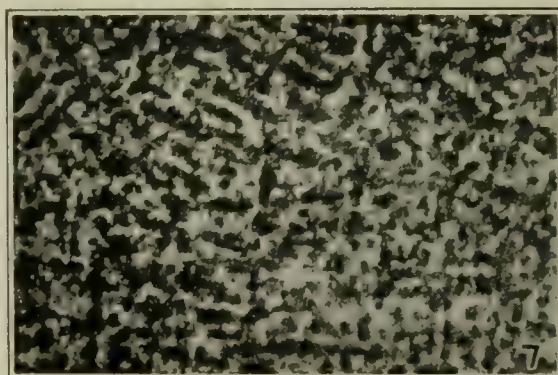
A small ingot, although capable of producing a very high-grade steel, is very prone to this columnar structure, even though the temperature of casting be kept down, and there comes a time when the ingots are very small, say 2 in. square or round or whatever shape is desired, when it is almost impossible to cast the steel in such an ingot without producing pine-tree growth complete to the center, and an ingot which is therefore known among workmen as "scorched." An ingot of about 7 in. size can be cast so that it is quite free from excessive pine-tree growth. Crystal formation, however, will be larger in a 7-in. ingot, cast solid, than where the 7-in. ingot is cast with a tube in it, as in the latter case one has all the advantages of a 2-in. square ingot with none of its disadvantages—the sand-loaded core takes up the heat and prevents crystallite

growth, besides preventing the formation of large crystals.

The speed of cooling after solidification is slower in the hollow ingot than it is in the solid ingot, therefore the granulation, which takes place after the crystals have formed from the liquid metal, is apt to produce larger grains than in the solid ingot. This is not a detriment. The original crystal size is of much more importance. The size of the grains due to this granulation constantly varies in response to mechanical work and subsequent heat-treatment.

I have found that the size of the grains arising from the granulation of the crystals does not grow larger than the size of the original crystal. Instances arise and should be carefully noted where the crystal boundary is broken and two crystals will appear as one, merely because the solution potential of both crystals are the same and therefore etch uniformly to the external boundary of the two crystals. This is more noticeable when these adjacent crystals have approximately the same orientation.

Two very interesting photographs, Figs. 7 and 8, appear to show conclusively that the casting structure remains in the finished bar. The analysis of this sample is: Carbon, 0.90 per cent; vanadium, 0.25 per cent; manganese, 0.30 per cent. This steel was heated to 1,340 deg. F., a temperature just about its known transformation point, held for some time and then quenched in water. The piece was 1½ in. round made from a 7-in. square ingot, having a very fine structure in the broken fracture, extremely tough and,



FIGS. 7 AND 8. STRUCTURE OF VANADIUM STEEL ROD.
PICRIC ACID ETCHING

Fig. 7. Magnified 30 diameters.

Fig. 8. Same region magnified 400 diameters.

generally speaking, a very excellent piece of steel and for the tool for which it was used it gave some extraordinarily good results. Fig. 8 shows the structure as magnified 400 diameters, very fine, peculiar form of sorbite with troostite. Fig. 7 is the same piece magnified but 30 diameters. Here can clearly be seen the cast structure, which has remained in the bar right from the ingot. I believe that this piece of steel, generally speaking, will not have a crystal larger than the governing boundaries of the crystal from original casting. Naturally the crystals in this cross-section, which is at 90 deg. to the direction of rolling, will be smaller in that direction than when originally cast, although their total volume will be approximately the same.

Fig. 9 shows a piece of 3-in. square steel which was rolled out of a 10-in. ingot. It is a high-alloy steel and particularly prone to the formation of long crystals, meeting others along the diagonals of the section. During the mechanical work the crystal formation has become somewhat distorted. The structure of the bar, as seen by a fresh fracture, shows this piece of steel to have a very fine grain; the polished surface etched in the ordinary way shows the grain size to be small.

The crystal size is not clearly defined at first, but on prolonged etching the crystal structure of the ingot is clearly shown, while the grain outlines arising from granulation of the crystal have been entirely obliterated. However, the inherent weakness of this steel is laid bare by the prolonged etching with weak acid. This bar is obviously weaker along the original diagonals. All steels will show the original ingot form in the same manner, no matter how far the working may be carried down; some steels have their crystalline structure more readily disclosed by prolonged weak-acid etching than others. It has often been noted that one bar of steel out of heat or a part of the heat will give very much better physical results than another bar from the same heat or out of a different heat, and this is to a very large degree due to the crystalline formation in the ingots. Fig. 9 very clearly shows the reasons for this condition.

Hollow drill steel made from a hollow ingot accord-

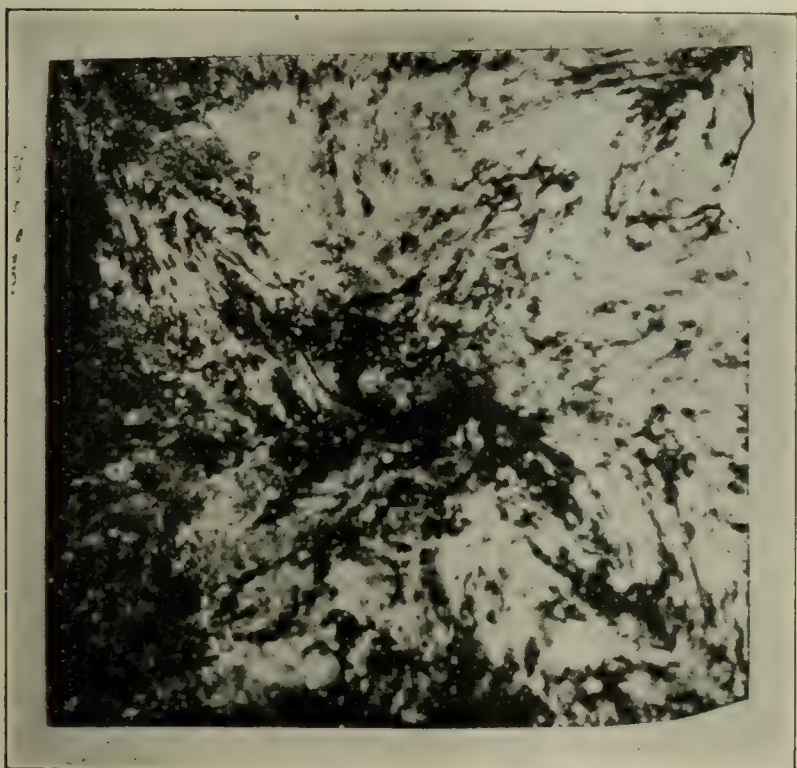


FIG. 9. ENLARGED MACROSTRUCTURE OF $\frac{3}{8}$ -IN. ALLOY STEEL BAR ROLLED FROM A 10-IN. INGOT ENLARGED EIGHT TIMES

ing to our method is, therefore, a little safer to use when overheating has to be contemplated as a possibility, as the ultimate grain growth will be less than a similar sized ingot cast solid, for the simple reason that the crystals were originally smaller. I do not want to infer that hollow drill steel so made can be overheated and that then the steel will give the same satisfaction as if it were not overheated. I am merely contending that it is slightly less harmful, the reasons being as given.

SURFACE SEAMINESS

Surface weakness as shown by seaming and checking on the exterior when working the bars of hollow drill steel, or by cracking in hardening, is in some measure due to the surface stresses of the ingot when cast. We have found out that the temperature of the ingot mold or speed of freezing of the exterior of the ingot is of very great importance in this direction, and much seamy and cracked steel can be laid directly against a too quickly cooled skin. Ingots that are turned or milled all over will not seam very much in working, in fact they are practically free from seams, whereas an ingot rolled without a preliminary machining opera-

tion is full of seams and cracks, some long and some short.¹

It has generally been said that these short seams and cracks in the surface of the bar are the result of elongated depressions in the surface of the ingot and that if an ingot is cast very smooth it should apparently give less surface defects. This is in some measure true, but an ingot cast very hot and having a very smooth skin will crack and seam very badly in the mill. The surface of an ingot poured very cold which is very crinkly, due to the low temperature of the metal, will seam just as badly. The cause of the cracks and seams in one is not the cause of the cracks and seams in the other.

Rough spots on the surface of the very slowly cooled ingot are elongated by mechanical work; roughened places continue to be pressed together, hence seams and cracks in cold-poured metal. In ingots cast very hot the pine trees or crystallites are separated by planes of great weakness at about 90 deg. to the surface of the ingot. These in themselves will cause cracks, the ingot then being known as tender. To draw the happy medium as a basis of our consideration and forgetting extremes, which are really of no moment, when comparing an ingot cast moderately hot so that it is not troubled with excessive dendritic structure and an ingot cast somewhat cooler and having about the same smoothness of surface, there is practically no difference in the amount of seaming and cracking, providing the ingot mold in both instances is cold or nearly so. If the ingot mold is warm, or thinner than usual, there is less surface strain on the resultant ingot and for similar surfaces there are less seams. Ingots cast with a tube in them seem to be freer from these surface stresses and the resultant billets do not have to be chipped or ground nearly as much to produce a bar free of seams and cracks.

INTERNAL STRESSES

The smaller the ingot the less will be the tendency for surface seams and cracks which may or may not develop. Those that do not develop may be thought of as locations of inherent weakness. Steel will shrink about $\frac{1}{8}$ to $\frac{1}{4}$ in. to 1 ft. and the steel as poured into the ingot mold will immediately freeze and contract to, say, one-half of the total shrinkage. As the inside of the ingot then begins to cool at a later time, the solid surface is trying to maintain a larger area than is demanded by the lower layers. The exterior of the ingot must then be crushed or the walls sink in, in which case it is under tension in a direction normal to the surface. If the ingot mold wall is concave the ingot when cooling will come practically straight, therefore the surface of the ingot must be under tremendous compression and just beneath the skin of the ingot or the depth of the first frozen layer the steel must be under tension, being held under constraint by the outermost layers, already in high compression. When the ingot is reheated it does not completely remove these strains, and when subjected to mechanical work the ingot will proceed to "let go" in various places—an action which will readily be conceded as being responsible in some measure for seams, cracks and defects of the character under construction. The smaller the ingot the less the actual amount of shrinkage.

In a hollow ingot cast by the tube method the hole

¹Reference is not made to the seams arising from over-filling or lapping.

is increased in diameter by the freezing. The mild steel tube when heated up to the high temperature imparted by the cast metal is enlarged and continues to be enlarged until it reaches a maximum temperature. It then shrinks while the ingot cools, thereby relieving the exterior surface of the ingot from cracking, or having as much strain as a solid ingot. The mild steel tube will withstand this movement without giving way, whereas an ingot cast hollow but without a tube will not be very good, since the inside of the wall of the tube would be first under tension and then compression, and the metal would withstand these complex forces less well.

The tube method of making hollow ingots for the manufacture of hollow drill steel is a decided departure from the old methods, and the logic of it seems to show that the resultant hollow drill steel should be superior to that made by the older method. Tests made by the Ludlum Steel Co. to date show that such is the case; whether or not our premises are accurate, we believe that hollow drill steel made this way will withstand alternating stresses better than anything that has yet been produced of similar analysis. The reasons why we believe the tube method of hollow drill steel manufacture is superior to the older methods are:

1. Greater freedom from external and internal straining.
2. Because of the inherent small crystal size.
3. Absence of harmful segregation resulting in weakness of the wall of the hole.
4. Less liability for the steel to crack in the inside of the hole during forging or hardening.
5. Toughening effect, arising from the mild steel wall of the hole, limiting the intense hardening on quenching.

Watervliet, N. Y.

Chemical Reaction Affects Casein Glue

Although casein glues are highly water-resistant, they ultimately decompose when exposed to a damp atmosphere for a long time. For many months studies have been under way at the Forest Products Laboratory in an endeavor to discover the cause of this decomposition.

The decomposition study is still far from complete, but the conclusion has been reached that the decomposition of ordinary alkaline casein glues is not due to the action of bacteria or molds. It appears to be due entirely to chemical action of the alkali in the glue. This conclusion is based upon the following observations:

Increasing the amount of alkali in the glue increases the rate of decomposition when the glue is kept wet.

Glues containing no sodium hydroxide, although deficient in some important respects, do not decompose as rapidly as similar glues containing sodium hydroxide.

Cultures of molds and bacteria could not be obtained from decomposed alkaline glues.

Some chemicals which have antiseptic properties are found to improve casein glue, but this improvement is due to their chemical action rather than to their toxic properties.

Glues can be completely decomposed in a short time at temperatures above that at which bacteria can grow.

Further work is being directed toward the production of glues which will resist chemical decomposition and at the same time be impervious to the action of fungi and bacteria as well as moisture.

Rapid Method of Determining Moisture Content of Wood*

The moisture content of pulpwood chips can be found in from seven to ten minutes. A specified weight of wood chips, usually 100 g., is immersed in kerosene in a flask or retort, and the mixture is heated. The water in the chips changes to steam at 212 deg., and goes out through a glass tube in the cork of the flask, is condensed by a water jacket surrounding the tube, and is caught in a measuring glass. The boiling point of kerosene being higher than that of water, all the moisture will be driven off the chips before the oil vaporizes to any great extent. The oil that does go off in the form of vapor is condensed and caught in the same graduate with the water. When the evaporation of moisture is complete, the oil and water are allowed to remain a few minutes until all the water has settled to the bottom of the graduate. The amount of moisture in the wood chips is then found by a direct reading.

This method has been checked for accuracy with the method of weighing samples before and after oven drying, and the variation found to be less than 1 per cent.

Foreign Trade of the Philippine Islands in 1920

The foreign trade of the Philippine Islands in 1920 amounted to \$300,562,138, an increase of about \$64,000,000 over that of 1919. These figures are the highest in the history of Philippine commerce and were attained in spite of the premium on the American dollar, which ranged from 3 to 12 per cent during the year.

The total imports amounted to \$149,438,282.50 and the exports to \$151,123,855.50. In 1919 the imports and exports were valued at \$118,639,052 and \$113,117,826 respectively. The United States contributed 62 per cent, or \$92,289,778, of the imports, and absorbed 69 per cent, or \$105,216,262.50, of the exports.

The biggest item in the year's export trade was cane sugar, which was valued at \$49,619,260, of which \$39,349,934.50 worth was consumed by the United States. Next to sugar was Manila hemp, with a total of \$35,862,000, of which \$20,614,026 went to the United States. Also, the United States absorbed practically all the coconut oil shipped from the Philippines, amounting to \$23,268,886.50, and \$10,546,303.50 of the cigar exports, valued at \$12,721,138.

Significant increases were registered in the import trade. The total value of the automobile imports was \$7,460,683, compared to \$4,802,324.50 for 1919. Cotton and manufactures totaled \$10,117,182.50, as against \$7,409,135 for 1919. The imports of iron and steel products amounted to \$21,879,602, representing a decrease of \$487,985 from that of 1919. Wheat flour importation was \$4,721,076, an increase of \$256,493 over that of 1919.

Potash in Greensand

In the account of the meeting of the Division of Industrial and Engineering Chemistry at the Rochester meeting of the American Chemical Society R. Norris Shreve was reported as stating in his paper discussing the action of lime on greensand (p. 831, CHEM. & MET., May 11, 1921) that analyses of greensand found along the coast of New Jersey showed 3.4 per cent potash. This was an error in transcribing, as the analysis read by Mr. Shreve indicated 7.4 per cent potash in the greensand.

*Forest Products Laboratory Technical Notes.

Commercially Pure Iron in the Basic Open-Hearth*

Notes on the Development of a Metallurgical Process for Producing Substantially Pure Ferrite on a Tonnage Basis, Without Containing an Excessive Amount of Gas—Many Modifications in Rolling Mills and Galvanizing Department Were Necessary to Make Finished Sheets

BY W. J. BECK

Director of Research, the American Rolling Mill Co., Middletown, Ohio

THE first announcement before a scientific and technical body that the manufacture of commercially pure iron had been successfully accomplished in the open-hearth furnace was in a paper¹ which was read at a meeting of the American Society for Testing Materials in 1911. The following significant paragraphs which remain equally true today are worthy of repetition:

The industrial history of the country has been characterized during the last ten years by so many important changes and developments that, taken as a whole, they may well be considered as marking a new industrial epoch. These changes may be defined in part as social and political, and in part as purely technical evolution. Thus we find extraordinary change and activity following in the wake of the great movements for conservation of natural resources and government control of the quality of foods, drugs, and other staples which enter into interstate commerce. The day when a complacent public would buy any material offered for sale, with little or no regard for specification and with implicit faith in every word printed on a label, has probably passed, never to return. Quantity rather than quality has heretofore marked the industrial supremacy of the United States, but the signs of the times point to the fact that hereafter the maximum quantity consistent with a standard of quality will be the slogan of the progressive producer.

Europe has long been looked upon as the home of research and conservation, and it is only comparatively recently that America has been brought to a thorough realization of the necessity of re-ordering her ways if she is to take her place in the upbuilding of the industrial future of mankind. It is satisfactory to note that the wave of conservation is sweeping along all the lines of industry, and the ruthless waste formerly so common in manufacturing methods is rapidly disappearing. Almost all new countries, especially if bountifully supplied with natural resources, have had this experience. It is the natural result of rapid growth which leads to a disinclination to consider apparently minor details until forced to do so by stern necessity. The movement for the conservation of our forest products, which is comparatively new in this country, is old and well known in Germany, and it is now very generally conceded that this country has taken up the study of the conservation problem none too soon. It is but natural in this great wave of economy the conservation of iron should have become such an all-absorbing subject. There can be no question but that this important commodity is directly and indirectly the greatest force for civilization that exists.

It cannot be questioned that there has always existed a demand for the purest obtainable irons. This demand has held steadfastly in the face of rapidly developing steel-producing processes. The steady importation of Norway and Swedish irons throughout our entire metallurgical history up to the outbreak of the war in 1914 is sufficiently indicative of this fact. These foreign irons, however, that had to be laboriously worked down by a charcoal or puddling process, were not suited to

the large-scale tonnage operations which are made imperative by American conditions of labor and industry. It is natural, therefore, that our metallurgists should have been led to the consideration of adapting the open-hearth steel furnace to the manufacture of iron of at least an equal degree of purity as those types which were imported from overseas.

Before progress along this line could be made, however, grave manufacturing risks had to be faced without much foreknowledge as to whether a successful, workable and salable product could be finally achieved. Every open-hearth man knows what is implied in raising the temperature of a bath two hundred degrees above the normal practice and maintaining this temperature until the carbon and manganese are run down to practical traces.

DEVELOPMENT OF THE PROCESS

The undertaking of pioneer work in this direction was certainly not altogether promising. Ledebur, the great German authority, had clearly stated in his compendious work on iron metallurgy that any such operation with the open-hearth furnace would be in vain if not freighted with disaster. In 1903, however, a very distinguished American metallurgist, H. H. Campbell,² made an attempt at an open-hearth pure iron, and finished with carbon 0.025, manganese 0.040. Campbell did not follow up this step, however, and summed up his opinions in the following brief comment: "These heats were made in a basic open-hearth furnace and their regularity both in chemical and physical character shows that we are dealing with a normal and definite metal and not with an accidental product. They were purposely made with the lowest possible content of manganese and it seems positively certain that the metal must be saturated with oxygen." It is evident from the foregoing that so eminent an open-hearth man as Campbell thought that in carrying manganese down to 0.04 the procedure had gone as far as possible and that only an overburned metal was the result.

This then was the history of the effort to produce very low carbon-manganese metal in the open-hearth furnace when the American Rolling Mill Co. first turned its earnest attention to the problem. The very first experimental heats were made in a 35-ton furnace, and they were nursed and watched with the most anxious care day and night. Continuous progress in the art was made until finally it was proved possible to reduce the five ordinary impurities of iron (carbon, manganese, sulphur, phosphorus and silicon) to the point at which in the aggregate they did not exceed fourteen-hundredths of one per cent. At the same time special methods had to be studied to attain the maxi-

*Paper read before the American Iron and Steel Institute, at New York, May 27, 1921.

¹"The Manufacture of Pure Irons in Open-Hearth Furnaces," A. S. Cushman, *Proc.*, American Society for Testing Materials, vol. 11, 1911.

²The Manufacture and Properties of Iron and Steel (1904), p. 482.

imum degree of degasification and the proper deoxidation.

The idea of a commercially pure iron was perhaps but a natural development or evolution of the effort to supply quality sheet metal products. It was believed at the inception of this work that increased purity would lead to increased rust-resistance.

Ingot iron made in an open-hearth furnace differs from the older irons in having a typical crystalline structure, a more definite critical temperature range, and more particularly in being essentially free from slag.

In the first heat an attempt was made to produce a metal containing not over 0.05 per cent manganese. It was done at the risk of losing the heat and the ladle, but it was felt that such a drastic step was necessary in order to determine if it were possible to make such a product in an open-hearth furnace. Care was used in the selection of the raw materials for this heat so that the melt would be as low as possible in carbon and manganese. The heat was charged in a 35-ton furnace and the bath of metal melted low in carbon, as it was believed that the lower the carbon could be driven the lower would be the manganese. Regular open-hearth practice was followed with the exception that an additional quantity of iron ore was added to assist in the removal of the carbon and manganese. In addi-



Fig. 1. Casting pit at the open-hearth plant, central works, the American Rolling Mill Co., showing bottom-pour practice.

tion to this an excess amount of lime was charged for the purpose of eliminating as much sulphur and phosphorus as possible.

These early experiments in the open-hearth furnace were made with producer gas as fuel. This fuel was high in sulphur which contaminated the metal and presented a serious obstacle. It was later found that by the use of natural gas this difficulty was largely overcome and it was possible to produce a metal which contained a lower percentage of sulphur.

In order to eliminate as far as possible the impurities in these heats it was found necessary to hold the metal in the furnace longer than is required in ordinary steel practice. In some cases these experimental heats were held in the furnace as much as 50 per cent longer than the ordinary steel heat, with danger to the operators and to the furnace.

On tapping the first iron heat into the ladle it was "wild." The normal amount of aluminum customary in

making steel heats had been used, but in later developments it was found necessary to increase materially the amount of aluminum to insure proper deoxidation and degasification.

In the early development of this iron it was made on a small plant basis, using bottom-pour ingots approximately 8 x 10-in. cross-section and weighing about 900 lb. In this bottom-pour practice (see Fig. 1) it was necessary to line with fireclay runner brick the runners which conducted the metal to the ingot molds.

In pouring the first heat the metal was so hot that the stopper rod burned off and there was much difficulty in pouring the metal. The molds were smeared and much of the metal was lost by pouring into the mold pits. Considerable cutting of the runner and ladle lining also occurred.

The ingots were stripped in the usual manner and sent to the reheating furnace for rolling into sheet bars. Here they were rolled into heavy gage bars without difficulty, and later rolled into 16-gage sheets and sheared to size for galvanizing.

As the next step in the operation the sheets were sent to the galvanizing shop for coating. Here considerable difficulty was found in pickling the sheets on account of the slow solubility of the metal, and also on account of the presence of foreign matter such as fireclay from the runner brick and ladle linings. In galvanizing the sheets further difficulty was encountered in the development of blisters and rough surfaces, which were afterward found to be due to imperfect degasification of the metal.

The analysis of this first heat of ingot iron was: Si trace, S 0.028, P 0.003, C 0.03, Mn 0.04. At that time it was customary to analyze only for these five elements—silicon, sulphur, phosphorus, carbon and manganese—the aggregate of these subtracted from one hundred, which was the basis then used, indicating the iron content by difference.

Several years were required to develop the material, even to the point of making this first heat, and for this reason the final and successful result was the occasion for much congratulation among the workers. A new metal with many unusual properties had been given to the world.

DEGASIFICATION AND HIGH TEMPERATURES

In the manufacture of such pure metal the process of degasification was not understood. It naturally followed that a large number of sheets were produced which contained imprisoned gases. When such sheets were galvanized the expansion of the imprisoned gases caused the formation of blisters up to 12 in. in diameter, giving a product which could not be sold even as wasters, and of doubtful value as scrap. This trouble resulted in a further search for a method to eliminate the gases which were responsible for the blisters. Green saplings were used by plunging them down into the bath of metal in the open-hearth furnace after the heat was melted, in an effort to agitate the metal to help remove the impurities. This slightly reduced the time of finishing the heat, but nothing could be found to substitute for the extremely high temperatures necessary to reach the desired analysis of the metal.

These destructive temperatures shortened the life of the furnaces and very greatly increased the cost of the metal. In fact, it was impossible to make this metal continuously in the furnace because of the cutting action on the linings due to the high iron oxide in the

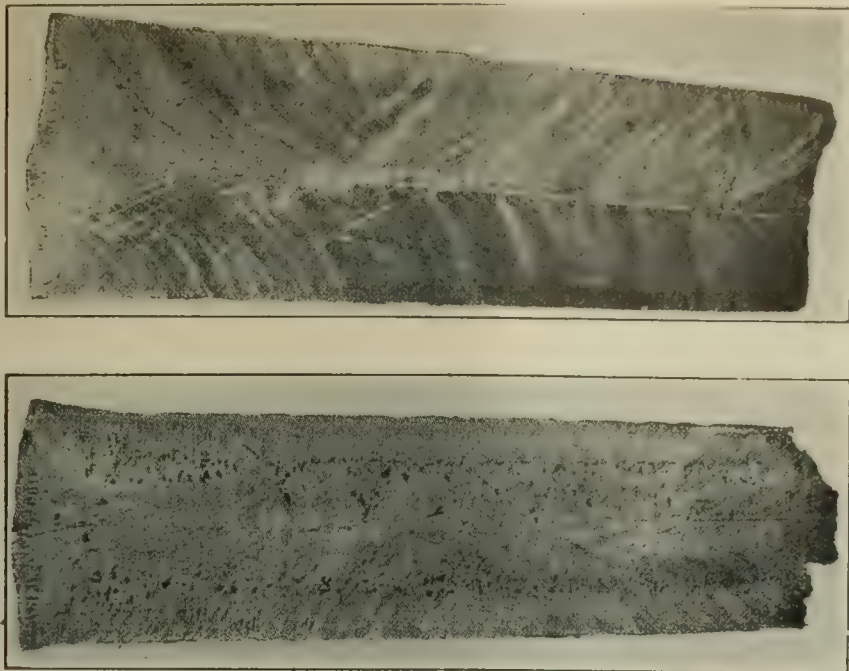


Fig. 2. Photographs of split ingots.

slag. To meet this condition heats of pure iron were alternated with regular steel heats.

The experimental heats of iron produced many unusual and unlooked-for results. One of these heats contained so much gas that nothing but piped ingots were made. In fact, some ingots were piped from end to end with only a thin wall. These had the shape of the molds and weighed but a few pounds, whereas they should have weighed approximately 900 lb. It was an easy matter for a workman to carry one of these shell-like ingots on his shoulder as a spectacular "stunt" for his fellow workers.

Special efforts to secure iron of extreme purity were continued in the open-hearth department during the years 1906 and 1907. Every effort was made to produce a material of high purity. All practical suggestions (and many that were apparently impracticable) were tried. The principal difficulties, however, remained; that of the control of high temperatures necessary in producing this iron and the proper degasification of the metal.

As the experimental work progressed it was found that there were considerable differences in the practice of producing commercially pure iron as compared to steel practice, which materially added to the cost. In the first place, it required several hours longer to make an iron heat than a steel heat, and the final temperature of the metal was 200 deg. F. higher than a heat of steel. Another marked difference was also found between the percentage yield of metal as compared with the percentage yield when steel was made. The percentage of metal produced was several per cent lower in the iron heats because the high temperatures and longer time employed in the manufacture of iron oxidized more of the iron, which was lost in the slag.

It was also found that this high iron oxide content of the slag was responsible for the cutting action on the stopper rods and bricks and that the scorifying action increased as the percentage of iron oxide in the slag increased. It has been found that the iron oxide in this slag is several times greater than the iron oxide in the steel slag. Some of this iron oxide, however, is derived from the iron ore used in oxidizing the carbon and manganese.

In order to emphasize the importance of the selection of raw materials in the manufacture of commercially pure iron attention is called to the fact that there

are certain elements which if they exist in the raw material are not eliminated in the open-hearth furnace. Among these elements which cannot be eliminated are copper, arsenic, antimony, tin, nickel and cobalt.

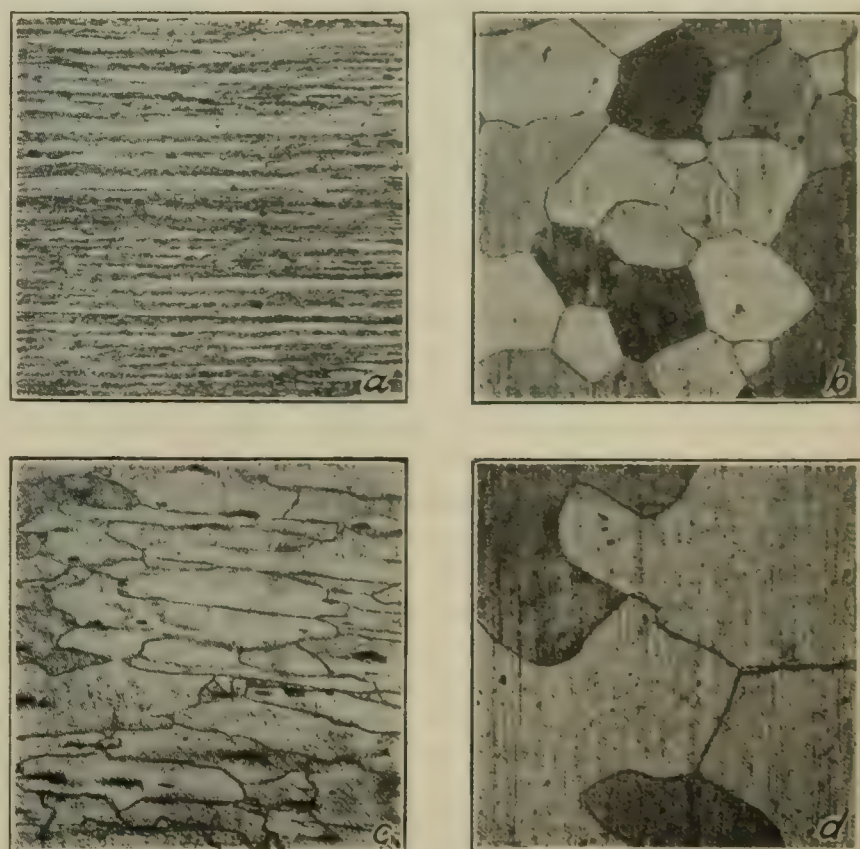
THE CRITICAL TEMPERATURE RANGE

Early ingots were frequently split with a metal saw so that the interior structure and the degree of degasification could be studied. It was found that ingots degasified with a slight excess of either silicon, aluminum or even with the use of a small amount of ferro-manganese may be perfectly sound as far as gas pockets determine this factor. Nevertheless, such material will go to pieces when an attempt is made to roll it (see Fig. 2).

This breaking up of material degasified with an excess of degasifying agents led to the discovery of the fact that pure iron had to be worked within a certain range of temperature; otherwise, it was found to be red-short and could not be rolled. It was also found that not only was the rolling of commercially pure iron affected by the presence of impurities from the degasifying agents, but it was materially affected by the presence of sulphur. The higher the sulphur content the more difficult it is to roll this iron at any working temperature. Being almost pure this iron has, like many commercially pure metals, a critical range at which temperature it cannot be worked. This temperature is about 900 deg. C., but for working conditions it is impracticable to roll at temperatures between 800 and 1,000 deg. C. In the commercial manufacture of this pure iron it is necessary to roll the material above the critical range on the blooming mill and below the critical range on the bar mill, which necessitates cooling tables between the two mills, these cooling tables being unnecessary in steel practice.

This delays mill production and adds materially to the cost of iron.

Because of the tendency of the sheets to weld together at the higher temperatures the sheet bars also must be rolled on the sheet mills at much lower temperatures than employed in rolling steel sheet bars.

Fig. 3. Microphotographs of Armco ingot iron. $\times 100$. (a) Un-annealed, (b) properly annealed, (c) under annealed, (d) over annealed.

The use of the microscope plays a very important part in the final treatment of these commercially pure iron sheets, and special care is necessary in the annealing of the sheets in order that they may serve the purpose for which they are intended. Microphotographs of a sheet as rolled on the sheet mill show, first (see Fig. 3a) the elongated grains and then after proper annealing (see Fig. 3b) the rounded grain structure.

The microphotographs shown in Figs. 3c and d illustrate very clearly the effect of improper annealing upon the structure of the metal. The elongated grains of a sheet annealed near the bottom of the box (Fig. 3c) are due to either insufficient time or to low temperature. The coarse grains, free from strains, of the other microphotograph (Fig. 3d) illustrate the grain growth caused by annealing at too high a temperature.

IMPORTANT USES OF INGOT IRON

Having developed an open-hearth pure iron primarily for its rust-resisting properties, we were gratified to find upon further study that it had many other interesting and valuable qualities, which taken together make a metal for more general use than had been attained by any other ferrous sheet metal product.

The high purity of the metal finally attained is shown by the following average analysis: Si trace, S 0.035, P 0.005, C 0.13, Mn 0.021.

We have found that this pure iron galvanizes in a superior manner to steel. Exhaustive tests have shown that when various grades of steel are galvanized in the same pot and under exactly the same conditions as when galvanizing this pure iron not only will the pure iron take on a heavier coating, but this heavier coating will have less tendency to peel when the metal is fabricated.

We have learned that pure iron goes into solution in molten spelter more slowly than steel; and we have learned that pure iron flux boxes and gears which are immersed in molten spelter will outlast many times similar equipment made from steel. It has been determined by analysis that the iron content of the spelter on steel will average much higher than the iron content of the spelter on pure iron.

Believing that a ferrous metal of such high purity meant rust-resisting properties, we began the study of its behavior under general service conditions. For twelve years the metal has been tested under a great many laboratory and service conditions and the results which have been obtained indicate that it is suitable for many exacting needs where ordinary steel has not proved satisfactory.

The purity of this product and the careful methods used in its manufacture make it more homogeneous than steel, and it therefore flows uniformly when heated to a melting temperature. This characteristic led to its use for many purposes where the cost or efficiency of welded articles depended upon quality of the weld or ease of welding operations. The welding quality of commercially pure iron created a demand for this material in the form of welding wire and rods to such an extent that conversion arrangements were made for the manufacture of large quantities of commercially pure iron welding rods and wire. This material has already largely displaced the welding materials of foreign manufacture previously used in this country. Welding wire made from this metal is used for electric arc welding and gas welding. This iron when drawn into wire has a very low electrical resistance for a ferrous metal. Its conductivity is approximately 50

per cent greater than soft steel, or about 18 per cent of the conductivity of copper.

Another important use of this commercially pure iron lies in its excellent vitreous enameling properties. In the degasification of the metal in the open-hearth process the detrimental gases are practically eliminated. Enameled products made from this iron have a superior finish and are free from blisters, pinholes and other enameling defects.

The average analysis compiled from records covering a period of twelve months gives this iron a purity of 99.865 per cent. This takes into consideration the nine impurities—silicon, sulphur, phosphorus, carbon, manganese, copper, oxygen, hydrogen and nitrogen.

In addition to almost 200,000 tons of ingots which we produced in this country during the past year pure iron made in the open-hearth furnace is being produced abroad and used extensively in Norway and Sweden.

Heat-Treatment of Heavy Forgings

At a meeting of the Washington Chapter, American Society for Steel Treating, May 19, the heat-treatment of heavy locomotive and ordnance forgings was discussed by Lawford H. Fry, superintendent of product, Standard Steel Works, and P. E. McKinney, metallurgist, Washington Navy Yard.

General practice in quenching wristpins, axles, piston rods and connecting rods was described by Mr. Fry and results of experiments were given to show the effects of various quenching media on the properties of both large and small sections. The rate at which heat units are extracted per square inch of surface in quenching is the same for axles as for small test-pieces when using any one of the common commercial media. The hardening effect, however, does not depend upon the rate at which heat units are given up, but on the rate of temperature drop. The following average figures represent the number of heat units (B.t.u.) extracted per square inch of surface per minute by different quenching media:

Air	1.0
Heavy oil	2.7
Cutting compound	3.0
Light oil	3.6
Water	7.0

Vigorous circulation of the quenching bath not only cuts down the time of cooling but may result in superior physical properties.

The importance of "pre-natal" influences in successful heat-treatment of steel was especially emphasized by both speakers. The usual inspection reports covering condition of surface and chemical composition were characterized as inadequate in defining the quality of steel for high-grade forgings and a plea for more general and close scrutiny of melting and forging records by those engaged in heat-treatment was made by Mr. McKinney. Some of the factors having a serious bearing on the final heat-treated product are:

- Method used in refinement of steel.
- Metallurgical control of conditions of slag.
- Methods of introducing ferro-alloys, degasifying agents, etc.
- Condition of metal previous to tapping from furnace.
- Temperature of metal during refining and finishing.
- Size of nozzle used in teeming of ingots.
- Methods of pouring ingots.
- Size of ingot used for given purpose.
- Type of ingot used as regards chilling effect, etc.
- Rate of speed in pouring ingots.
- Temperature of metal entering the ingot.
- Shrinkage of the ingot on cooling.
- Behavior of the ingot during solidification.

The Hydrolysis of Fats by Reagents Made From Cymene

A Study of Fat Hydrolises Reagents of the Twitchell Type—Advantages of Cymene Compared With Benzene and Naphthalene—No Preliminary Acidification Required to Obtain Rapid Hydrolysis—Better Color of Products

BY RALPH H. MCKEE AND LELAND J. LEWIS

THE industrial importance of the sulphonic acids as fat-splitting reagents has become so generally recognized that a study of certain of these acids seemed to present a field for useful investigation. Reagents using benzene and naphthalene have been in general use for the past two decades, but heretofore cymene, as a constituent of this type of compound, has not been utilized.

This investigation of the cymene-stearosulphonic acid as a fat-splitting reagent of the Twitchell type was taken up, as it had been noticed that cymene sulphonic acid is soluble in hydrocarbons and oils as well as in water, that it is an excellent emulsifying agent and that it is more easily and cheaply made than most other sulphonic acids. It was thought that these properties indicated its applicability as a fat-hydrolyzing reagent or as a constituent, in cymene-stearosulphonic acid, of a new Twitchell type fat-hydrolyzing reagent.¹

ADVANTAGES OF CYMENE

This investigation using cymene as a constituent of a fat-splitting reagent of the Twitchell type shows that it possesses the following advantages over the reagents at present employed commercially:

That it is more easily made than the reagents using naphthalene and benzene.

That the reagent can be made at least as cheaply as other reagents on the market.

That a uniform product can be obtained under different conditions of sulphonation.

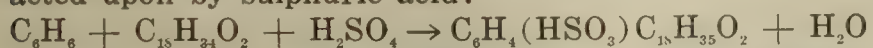
That the fats and oils are split into fatty acids and glycerine more readily.

That the fatty acid resulting from the splitting of the fat or oil is of a lighter color and hence better.

That the crude glycerine can be produced of better quality.

TWITCHELL REAGENT

The type of reagent used commercially was discovered by Dr. Ernst Twitchell of Wyoming, Ohio, who found that aromatic hydrocarbons such as benzene and naphthalene mixed with oleic acid could be sulphonated to form compounds which fulfilled the commercial conditions requisite for fat-splitting reagents.² He writes the following equation when benzene and oleic acid are acted upon by sulphuric acid:



He gives this compound the name of benzene-stearosulphonic acid. This nomenclature is based on the assumption that the oleic acid part, which is unsaturated at the start, has become a saturated radical when the

reaction is completed. However, there is little definite evidence bearing on the character of the linking between oleic acid and the rest of the molecule.

PREPARATION OF REAGENT FROM CYMENE³

Cymene, methyl isopropyl benzene, is a byproduct from the manufacture of sulphite pulp from spruce wood. The crude product was purified in the laboratory by one steam distillation and two dry distillations, giving a colorless liquid with a boiling point 174-176 deg. C.

Two hundred and eighty grams of oleic acid and 140 g. of cymene were stirred by a motor-driven (550 r.p.m.) glass propeller; 300 g. of sulphuric acid (66 deg. Bé.) was added gradually, care being taken to keep the temperature below 35 deg. C. The sulphonation was carried out in a beaker.

The stirrer was made of a glass rod with the end of the rod bent up making an angle to the main rod of 45 deg. This end was flattened in order that the blade part of the stirrer would have a lifting effect on the liquid. Experiments carried out with this simple type of stirrer showed it to have a marked effect on the ease with which sulphonation was effected. This is in line with observations made by McKee,⁴ who demonstrated that the speed of sulphonation is dependent in part upon the character of the stirring.

As the sulphonation was carried on at 30 to 35 deg. C., it was necessary for the reaction to proceed for a fairly long period. After twenty-four hours' stirring, 500 c.c. of distilled water was added and the whole brought to a boil and stirred. This accomplishes two things: It greatly dilutes the excess of sulphuric acid present in the mixture and it breaks up any oxystearic acid esters⁵ that are formed when sulphuric acid acts upon the oleic acid.

The decomposition into oxystearic acid of the oxystearic acid esters is practically complete after the product has been boiling for twenty minutes.⁶ The upper layer which separated on standing was a viscous, dark brown, oily mass and contained the cymene-stearosulphonic acid and any unchanged oleic acid or cymene. The lower layer consisted of the diluted excess sulphuric acid together with a small amount of cymene sulphonic acid. As this is soluble in dilute sulphuric acid, it was discarded with the sulphuric acid. The resulting product is pure enough for use commercially, but for exact work such as the present research purer products should be used.

The purification of the cymene-stearosulphonic acid can readily be accomplished, as it is insoluble in water

¹U. S. Patent Application, Serial No. 461,387.

²Reagents of the Twitchell type are also in use where both the aromatic and fatty acid constituents have been modified. See U. S. Pat. 1,303,779 to R. E. Devine and the Pfeilring reagent, *Seifenfabr.*, vol. 38, p. 425 (1918).

³Method of preparation is similar to that described by Twitchell: U. S. Pat. 601,603, March 29, 1898; and 628,503, July 11, 1899. *J. Am. Chem. Soc.*, vol. 22, p. 22 (1900).

⁴*Science*, vol. 35, p. 388 (1912).

⁵Lewkowitsch, vol. I, p. 225. Edition of 1913.

⁶Twitchell, *loc. cit.*

containing a strong electrolyte of the type of dilute sulphuric or hydrochloric acid and insoluble in petroleum ether or gasoline, while the impurities are extracted by these solvents.

The crude reagent was agitated with 200 c.c. of 2 per cent hydrochloric acid, brought to the boil and then allowed to stand. The lower layer was again removed. This process was repeated three times. The water from the fourth washing was tested with barium chloride solution and found to be free from sulphuric acid.

To remove the organic impurities petroleum ether was agitated with the oily layer. The petroleum ether separated as an upper layer of a brownish color and contained in solution oxystearic acid and unchanged oleic acid as well as cymene. This extraction was repeated three times. The last ether washing was only slightly colored and when a portion of it was evaporated on a watch glass it left but a faint stain.

As presumably all of the foreign bodies not removed by the washing with water are soluble in petroleum ether, it follows that the product obtained was cymene-stearosulphonic acid containing small amounts of water, hydrochloric acid and petroleum ether. Accordingly it was placed in an open dish on a water bath and stirred continuously for twenty-four hours. A test of a portion, by dissolving in water and adding silver nitrate solution, showed the absence of hydrochloric acid, and presumably water and petroleum ether had likewise been driven off.

TESTING THE REAGENT

The product was further tested for purity by determining its sulphur content and its acidity. The sulphur was determined by converting the sulphur into sulphuric acid by burning in an Emerson bomb calorimeter and converting the sulphuric acid so formed into barium sulphate.

Average per cent sulphur found in three determinations, 6.6 per cent. Per cent sulphur calculated for $C_{10}H_{12}(HSO_3)C_{18}H_{35}O_2$ is 6.4 per cent. Considering the character of the material, a closer check was not expected.

If we accept the empirical formulas of the aromatic stearosulphonic acids as given by Twitchell, a compound of the formula $C_{10}H_{12}(HSO_3)C_{18}H_{35}O_2$ would have a molecular weight of 496. Moreover this acid is dibasic. Twitchell also shows that methylorange indicates about half of the acidity, that caused by the sulphonic acid group, and that phenolphthalein neutrality corresponds to the total acidity. A 2 per cent solution therefore should be 0.0806 normal to phenolphthalein. Titrations with standard alkali of a carefully made 2 per cent solution indicated a purity of 99 per cent when phenolphthalein was used as an indicator.

For comparison the standard Twitchell reagents, naphthalene and benzene-stearosulphonic acids, were made and purified in the manner described above and the sulphur and acid values similarly determined. For naphthalene-stearosulphonic acid the per cent of sulphur found was 6.62; calculated for complete purity, 6.54 per cent. Titration gave a normality of 0.0805, while that calculated from the weight taken was 0.0812. Similarly for benzene-stearosulphonic acid 7.4 per cent sulphur was found, as contrasted with 7.3 per cent by calculation. By titration a normality of the 2 per cent solution was 0.0904, as compared to the calculated 0.0911 normality.

Benzene-stearosulphonic acid and cymene-stearosulphonic acid were also made by a slightly modified process where the sulphonation took place at 98 deg. To prepare the cymene-stearosulphonic acid the oleic acid and cymene were sulphonated with 66 deg. Bé. sulphuric acid, using a steam-jacketed enameled kettle. Time, four hours. The product was purified by washing as previously described. The benzene derivative was made and purified in the same way.

Both benzene-stearosulphonic acid and cymene-stearosulphonic acid were dark. However, the cymene-stearosulphonic acid was not carbonized, as it gave a clear yellow solution with dilute sodium hydroxide. The benzene-stearosulphonic acid showed some carbonization. The acid values of benzene-stearosulphonic acid were almost identical with the corresponding reagents made by cold sulphonation. It will later be shown that these products made by hot sulphonation were identical with the corresponding reagents made by sulphonation at 35 deg. C. when tested by being used in the hydrolysis of cottonseed oil.

Cymene sulphonic acid was prepared by adding 24 c.c. of normal sulphuric acid to 3 g. of calcium cymene sulphonate in solution. The filtrate and washings were taken as a reagent to saponify 300 g. of cottonseed oil.

In addition to the six reagents made as described, there was used a seventh reagent, taken from a sample furnished by a soap factory using the Twitchell process.'

DETERMINATION OF THE SPEEDS OF HYDROLYSIS

The hydrolyses were carried on in 1,000-c.c. pyrex beakers. The heat was supplied by electric hot-plates. The agitation was produced by a stirring device similar to that described above. The cottonseed oil used for

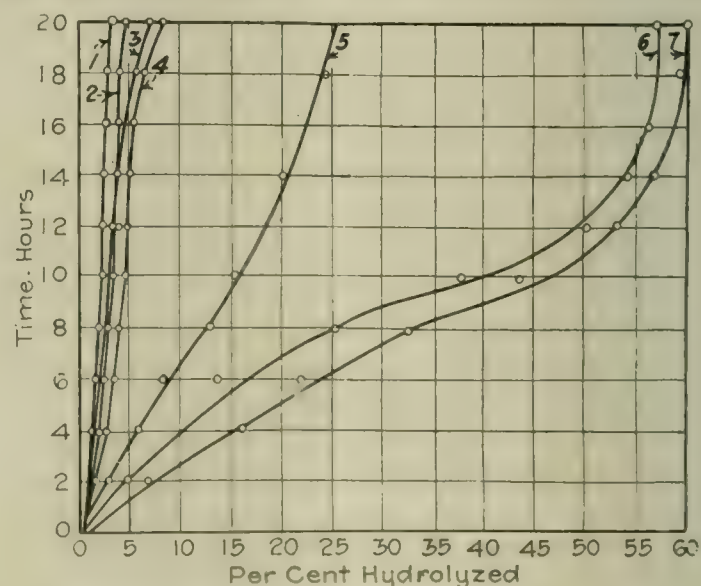


FIG. 1. HYDROLYSIS OF COTTONSEED OIL WITH 1 PER CENT FAT HYDROLYZING REAGENTS WITHOUT H_2SO_4 .

1—"Kontakt" reagent. 2—Cymene sulphonic acid. 3—Benzene stearosulphonic acid (hot sulphonation). 4—Benzene stearosulphonic acid (cold sulphonation). 5—Naphthalene stearosulphonic acid. 6—Cymene stearosulphonic acid (cold sulphonation). 7—Cymene stearosulphonic acid (hot sulphonation).

the hydrolysis tests was a refined commercial oil of light yellow color having a saponification number of 194 and an acid number of 0.5.

Seven 300-g. samples were taken, and to each sample was added 300 c.c. of distilled water. In each case the weight of the reagent was taken, which was 1 per cent of the weight of the fat. The temperatures were kept almost constant around 98 deg. C. At the end of a 2-hr. run the contents of the beakers were allowed to stand a few minutes in order that a sample

"Kontakt reagent," furnished through the kindness of Dr. Ittner of Colgate & Co.

free from emulsion could be taken. The acid number of each oil sample was determined after the method of Sherman,⁸ and from this number the per cent of saponification was calculated. Reagents used:

1. "Kontakt reagent," a commercial reagent.
2. Cymene sulphonic acid. (From calcium cymene sulphonate.)
3. Benzene-stearosulphonic acid. (Hot sulphonation.)
4. Benzene-stearosulphonic acid. (Cold sulphonation.)
5. Naphthalene-stearosulphonic acid. (Cold sulphonation.)
6. Cymene-stearosulphonic acid. (Cold sulphonation.)
7. Cymene-stearosulphonic acid. (Hot sulphonation.)

COMPARISON OF RATES OF HYDROLYSIS WITHOUT SULPHURIC TREATMENT

The rates of hydrolysis are shown in the form of curves in Fig. 1. It is apparent that cymene-stearosulphonic acid to the strength of 1 per cent of the

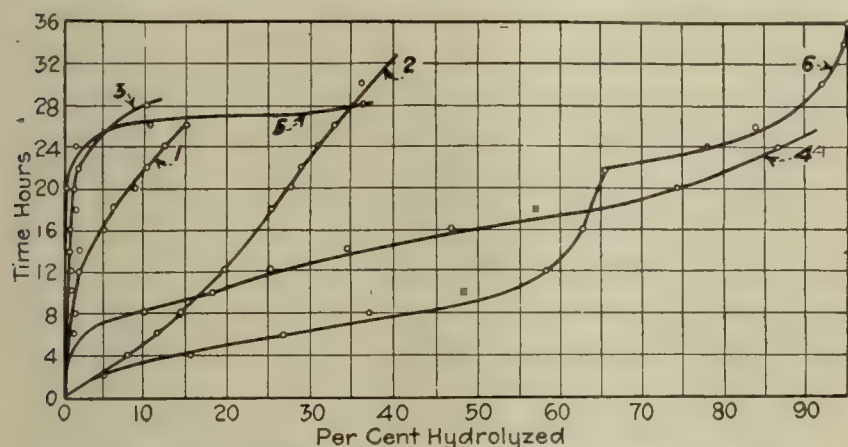


FIG. 2. HYDROLYSIS OF COTTONSEED OIL

Hydrolyzing reagents used: 1—Benzene stearosulphonic acid. 2—Benzene stearosulphonic acid (with H_2SO_4 treatment). 3—Cymene stearosulphonic acid. 4—Cymene stearosulphonic acid. 5—"Kontakt" reagent. 6—Cymene stearosulphonic acid.

weight of cottonseed oil works without the usual sulphuric acid addition, but that the standard commercial hydrolyzing reagents do not work efficiently without sulphuric acid solution. It might be claimed that the method of experiment is scarcely fair to the standard Twitchell type of reagents, as they have been found to work best after the oil or fat has been heated for several hours with dilute sulphuric acid. It is also to be noted that there is but slight difference observed between the acids prepared by cold and hot sulphonation.

COMPARISON WITH SULPHURIC TREATMENT

The data given below are for another series of experiments where the reagents are compared under parallel conditions with cottonseed oil again, but in the presence of a small amount of sulphuric acid, except in the sixth experiment.

Benzene-stearosulphonic acid (hot sulphonation) to an amount of $\frac{1}{2}$ per cent of the weight of the oil. One-fifth per cent by weight of sulphuric acid was added. After the twelfth hour the concentration of the benzene-stearosulphonic acid increased to 1 per cent.

Benzene-stearosulphonic acid. The same reagent and in the same amount as above, but the oil heated to boiling for half an hour with 30 c.c. of 2 per cent sulphuric acid before the reagent was added. This preheating is a step often used commercially.

Cymene-stearosulphonic acid. One-half per cent of the reagent was used together with $\frac{1}{2}$ per cent of sulphuric acid. After the twenty-sixth hour the concen-

tration of the cymene-stearosulphonic acid was increased to 1 per cent.

Cymene-stearosulphonic acid. The same reagent as above with the same amounts of the reagent at the start. After six hours' run the concentration of the cymene-stearosulphonic acid was increased to 1 per cent.

"Kontakt reagent." The concentration of the reagent and of the sulphuric acid at the start were the same as those for the other reagents, but after twenty-four hours' run these were increased to $1\frac{1}{2}$ per cent of the reagent and $1\frac{1}{2}$ per cent of the sulphuric acid.

Cymene-stearosulphonic acid. The hydrolysis of the partly hydrolyzed oil in the previous experiment was continued. The glycerine water was removed at the twentieth hour when the hydrolysis was 65 per cent complete and 1 per cent more of the reagent was added. No sulphuric acid was used.

The results are given in the form of curves in Fig. 2.

CHARACTERISTICS OF THE CYMENE REAGENT

In comparing the rates of hydrolysis of cottonseed oil hydrolyzed by cymene-stearosulphonic acid and certain other reagents, it was noted that the cottonseed oil could be hydrolyzed with 1 per cent of its weight of the cymene-stearosulphonic acid without the addition of sulphuric acid or without resorting to sulphuric acid treatment of the oil. It seemed an important point to determine to what extent the concentration of the cymene-stearosulphonic acid could be reduced and still effect the hydrolysis of the oil. When $\frac{1}{4}$ per cent of the cymene-stearosulphonic acid and 1 per cent of the sulphuric acid are added to cottonseed oil and an equal weight of water, the acid concentration shown by titration is more than twice the concentration that was used when the oil was readily hydrolyzed. But when this concentration was used practically no hydrolytic splitting of the oil took place. When the concentration of the cymene-stearosulphonic acid was doubled, 0.5 per cent, and the sulphuric acid retained at 1 per cent, the rate of the hydrolysis was very rapid; 25 per cent of the oil was hydrolyzed in two hours, 67 per cent in three hours and 87 per cent in five hours. When a weight of cymene-stearosulphonic acid equivalent to $\frac{1}{4}$ per cent of the weight of the oil was used and no sulphuric acid added, the rate of hydrolysis was very slow, but was far more rapid than in the above experiment, where $\frac{1}{4}$ per cent of the reagent was used with 1 per cent of the sulphuric acid.

The great effect of doubling the concentration of the reagent after six hours is shown in the following experiment.

One-half gram cymene-stearosulphonic acid for six hours, $\frac{1}{2}$ g. added at the end of six hours' run. One hundred grams of cottonseed oil used and as usual an equal weight of water: Two hours, 0.5 per cent; six hours, 1.2 ($\frac{1}{2}$ per cent reagent added); eight hours, 10.0; twelve hours, 34.5; sixteen hours, 57.4; twenty-two hours, 86.7.

The fatty layer separated much more readily at the eight-hour and later periods than at the close of the two- and six-hour periods.

The above experimental work leads to the following conclusions so far as cottonseed oil is concerned. Later work indicates that they apply as well to other fats as to cottonseed oil:

In the absence of sulphuric acid the new reagent, cymene-stearosulphonic acid, is much more efficient as

⁸Organic Analysis, p. 147. Edition of 1912.

a hydrolyzing reagent than the commercial reagents commonly used.

A certain minimum percentage of reagent is necessary to bring about hydrolysis at a rate that obtains for commercial efficiency—e.g., $\frac{1}{2}$ per cent of the new reagent based on the weight of the fat taken in the presence of sulphuric acid or between $\frac{1}{2}$ and 1 per cent of the new reagent in the absence of sulphuric acid.

In the presence of $\frac{1}{2}$ per cent of sulphuric acid the new reagent is somewhat more effective than two reagents (benzene-stearosulphonic acid and "Kontakt reagent") now used commercially.

COMPARATIVE TEST ON COCONUT OIL

In order to gain further information as to the respective merits of the two reagents named, previous experiments (*cf.* Fig. 1) seemingly having indicated that the naphthalene compound was somewhat the better of the commercially used reagents, the time factors in the hydrolysis of coconut oil and later in the hydrolysis of tallow were obtained. The coconut oil⁹ used in these experiments had a saponification number of 268 and an acid number of 0.6.

For these comparisons 300 g. of the coconut oil was hydrolyzed with $\frac{1}{2}$ per cent of the reagents and 1 per cent of sulphuric acid. The volume of distilled water was kept as nearly as possible equal to that of the fat. The temperatures were maintained almost constant at 98 deg. C. The data in Fig. 3, curves II and IV, give the comparisons of the speeds of hydrolysis for cymene-stearosulphonic acid and commercial naphthalene-stearosulphonic acid.¹⁰

From the data given above it is obvious that the coconut oil is much more readily hydrolyzed than the

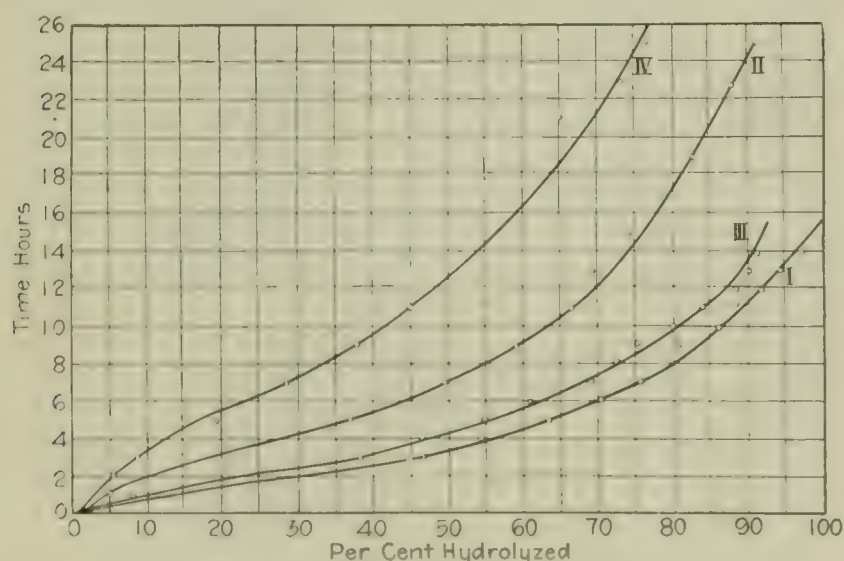


FIG. 3. HYDROLYSIS OF COCONUT OIL

Hydrolyzing reagents used: I—Cymene steorosulphonic acid 1 per cent, H_2SO_4 1 per cent. II—Cymene steorosulphonic acid $\frac{1}{2}$ per cent, H_2SO_4 $\frac{1}{2}$ per cent. III—Naphthalene steorosulphonic acid 1 per cent, H_2SO_4 1 per cent. IV—Naphthalene steorosulphonic acid $\frac{1}{2}$ per cent, H_2SO_4 $\frac{1}{2}$ per cent.

cottonseed oil. One-half per cent of reagent was effective in bringing about hydrolysis without a previous sulphuric acid treatment, while in the cottonseed oil $\frac{1}{2}$ per cent of the reagents seemed to be too small a quantity to effect a ready hydrolysis. The speeds of hydrolysis were greatly increased when the concentrations of each reagent were doubled and the concentration of the sulphuric acid remained constant.

In comparing the hydrolysis of the reagents, it will be noted that the hydrolysis of the oil was more readily

effected with the cymene reagent than with the commercial reagent made from naphthalene and that the difference in this respect was in the neighborhood of 8 to 10 per cent. The fatty acids and the glycerine water obtained where the cymene-stearosulphonic acid was used were of lighter color than these same products obtained by the commercial reagent.

Comparison of the speeds of hydrolysis of coconut oil with 1 per cent cymene-stearosulphonic acid and commercial naphthalene-stearosulphonic acid: 300 g. coconut oil, 300 g. water, 3 g. cymene-stearosulphonic acid

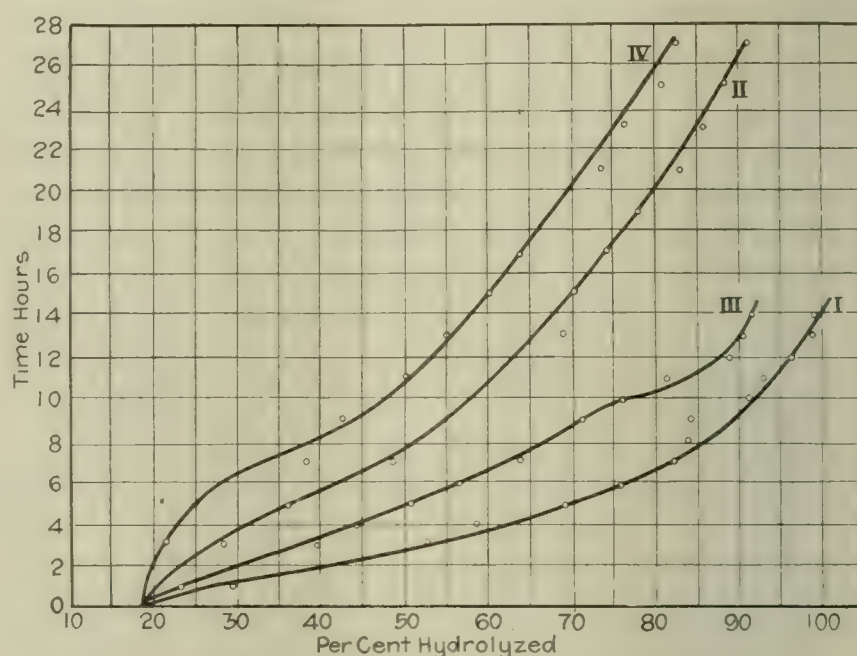


FIG. 4. HYDROLYSIS OF A SOAP GRADE TALLOW

I—Cymene steorosulphonic acid 1 per cent, H_2SO_4 1 per cent. II—Cymene steorosulphonic acid $\frac{1}{2}$ per cent, H_2SO_4 $\frac{1}{2}$ per cent. III—Naphthalene steorosulphonic acid 1 per cent, H_2SO_4 1 per cent. IV—Naphthalene steorosulphonic acid $\frac{1}{2}$ per cent, H_2SO_4 $\frac{1}{2}$ per cent.

(1 per cent), 3 g. sulphuric acid (1 per cent); 300 g. coconut oil, 300 g. water, 3 g. commercial naphthalene-stearosulphonic acid (1 per cent), 3 g. sulphuric acid (1 per cent). See Fig. 3, curves I and III. At the tenth hour glycerine water was removed and $\frac{1}{2}$ per cent reagent and 1 per cent sulphuric acid added.

Curves II and IV of Fig. 4 give a comparison of the speeds of hydrolysis of tallow with cymene-stearosulphonic acid and with commercial naphthalene-stearosulphonic acid. The tallow¹¹ was a commercial soap grade product which contained 18.5 per cent of free fatty acid. At the nineteenth hour the glycerine water was removed and $\frac{1}{2}$ per cent reagent and 1 per cent sulphuric acid added: 300 g. tallow, 300 g. water and $1\frac{1}{2}$ g. commercial naphthalene-stearosulphonic acid ($\frac{1}{2}$ per cent), 3 g. sulphuric acid (1 per cent); 300 g. tallow, 300 g. water, $1\frac{1}{2}$ g. cymene-stearosulphonic acid ($\frac{1}{2}$ per cent), 3 g. sulphuric acid (1 per cent).

Comparison of the speeds of hydrolysis of soap grade tallow with 1 per cent instead of $\frac{1}{2}$ per cent cymene-stearosulphonic acid and with commercial naphthalene-stearosulphonic acid in the presence of 1 per cent sulphuric acid are given by curves I and III of Fig. 4: 300 g. soap grade tallow, 300 g. water, 3 g. cymene-stearosulphonic acid (1 per cent), 3 g. sulphuric acid (1 per cent); 300 g. soap grade tallow, 300 g. water, 3 g. commercial naphthalene-stearosulphonic acid (1 per cent), 3 g. sulphuric acid.

At the tenth hour glycerine water was removed and $\frac{1}{2}$ per cent reagent and 1 per cent sulphuric acid added.

The reagents at both concentrations were effective in bringing about hydrolysis and the cymene-stearosul-

⁹The coconut oil was obtained from Kirkman & Son through the kindness of Mr. Lyford.

¹⁰Sample of reagent received through the kindness of Dr. Twitchell as a typical saponification reagent. Analysis showed a purity of 92.9 per cent based on the calculated acid value.

¹¹A typical soap grade tallow obtained from Kirkman & Son through the kindness of Mr. Lyford.

phonic acid held about the same margin of advantage over the commercial reagent as was shown in the comparison of the speeds of hydrolysis on the coconut oil.

Unlike the hydrolysis in the case of cottonseed oil, which was very slow at the start and which gained speed until nearly 50 per cent was hydrolyzed, with the tallow the hydrolysis was most rapid at the start and the speed fell off as it approached 70 per cent hydrolysis. This would seem to indicate that the free fatty acid present in the tallow at the start was a factor in accounting for the difference in the two reactions. This factor will be discussed more fully in a later section of the paper.

THE DARKENING EFFECT PRODUCED IN THE FATTY ACIDS DURING HYDROLYSIS

The difficulty of producing light-colored fatty acids with reagents of the Twitchell type is one of the most serious drawbacks to the process. In plant practice the utmost care is exercised in excluding air from the fat undergoing hydrolysis until the saponification is complete and the acid neutralized. The darkening of the fatty acid is supposed to be due in part at least to the oxygen in the air. This, while it is the general belief in the plants, needs confirmation.

The color of the fatty acids from parallel runs made in an open vessel with the same concentration of various reagents discussed in previous pages showed wide differences in color. The lightest-colored fatty acids were obtained with cymene-stearosulphonic acid. The curves in Figs. 5 and 6 are from data obtained in comparing the color changes of the fatty acids from coconut oil and from cottonseed oil. A Lovibond tintometer was used to measure the degree of color. The darkening of the fatty acids when the new cymene reagent was used was only about half as great as when commercial reagents were used to effect hydrolysis.

The table gives the color numbers for fatty acids obtained by the three reagents in question. The cell in which the color of the initial and partly hydrolyzed oil was measured was 1 cm. in thickness.

Hydrolyzing Reagent Used	Initial Color of Coconut Oil		At 30 Per Cent Hydrolysis		At 95 Per Cent Hydrolysis	
	Red Scale	Yellow Scale	Red Scale	Yellow Scale	Red Scale	Yellow Scale
A Cymene-stearosulphonic acid.....	0.08	0.40	0.20	1.10	0.80	4.50
B Kontakt reagent.....	0.08	0.40	0.45	2.30	1.60	8.00
C Naphthalene-stearosulphonic acid (Twitchell).....	0.08	0.40	0.65	3.40	2.40	9.50

Similar comparative results were obtained in the hydrolysis of a prime summer yellow cottonseed oil.

Hydrolyzing Reagents Used	Initial Color of Cottonseed Oil		At 30 Per Cent Hydrolysis		At 95 Per Cent Hydrolysis	
	Red Scale	Yellow Scale	Red Scale	Yellow Scale	Red Scale	Yellow Scale
A Cymene-stearosulphonic acid.....	0.20	1.20	0.80	3.60	2.20	12.00
B Kontakt reagent.....	0.20	1.20	1.40	6.00	3.80	16.60
C Naphthalene-stearosulphonic acid (Twitchell).....	0.20	1.20	2.00	6.80	4.60	18.60

CONDITIONS GOVERNING HYDROLYSIS OF FATS AND OILS

While no special attempt was made to determine the ultimate cause of fat splitting by such compounds as cymene-stearosulphonic acid, naphthalene-stearosulphonic acid and benzene-stearosulphonic acid, some observations were made which will be discussed in a

brief review of the several theories on the action of the sulphonic acids in effecting cleavage of fats.

In his Perkin Medal address¹² Twitchell states that even before the discovery of his first catalyst he had stated what properties such a catalyst should possess. These were, namely, that the catalyst should be able to furnish a high hydrogen ion concentration when added

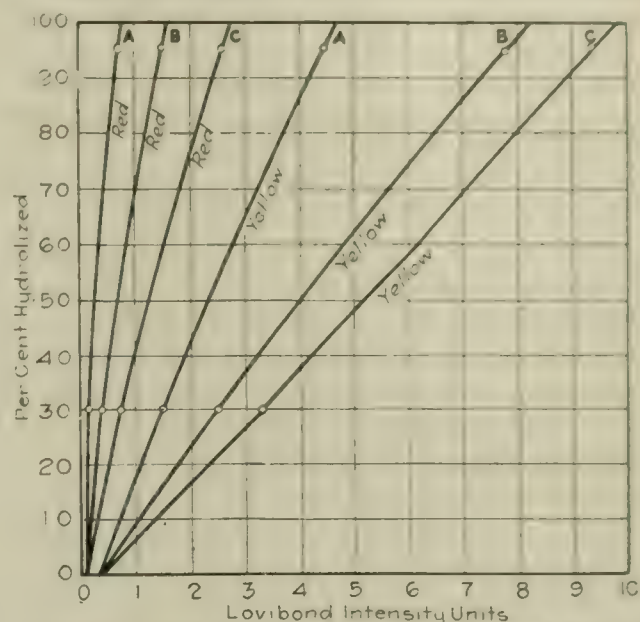


FIG. 5. COLOR CHANGE OF FATTY ACIDS IN COCONUT OIL, MEASURED WITH A LOVIBOND TINTOMETER

Hydrolyzing reagents used: A—Cymene stearosulphonic acid. B—"Kontakt" reagent. C—Naphthalene stearosulphonic acid (commercial).

to a fat and water and in the second place it should be soluble in the fat and soluble in water. Furthermore the reagent must be stable at the temperatures that obtain during the hydrolysis of fat.

The acids benzene-stearosulphonic, naphthalene-stearosulphonic and cymene-stearosulphonic are apparently all dibasic acids dissociating readily in water. One of these acid hydrogens can be approximately determined by titrating against standard alkali using methyl orange as indicator. If phenolphthalein is used as the indicator, both acid hydrogen atoms react and

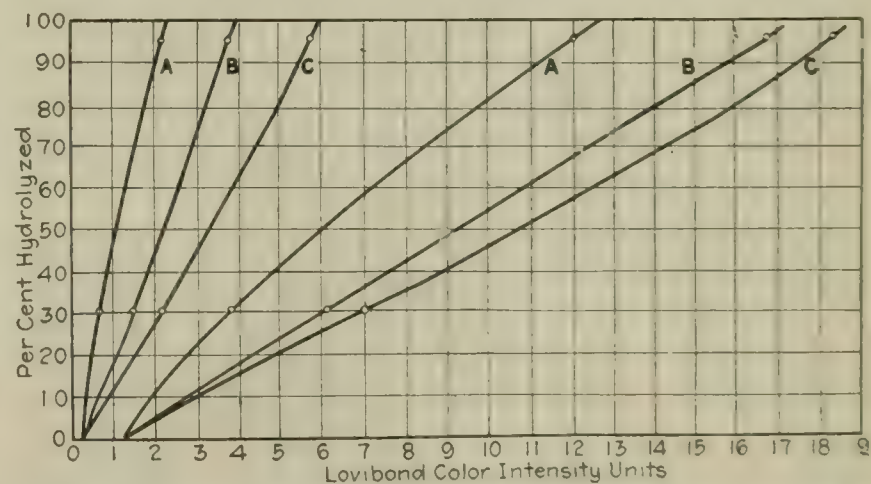


FIG. 6. COLOR CHANGES OF FATTY ACIDS IN COTTONSEED OIL, MEASURED WITH A LOVIBOND TINTOMETER

Hydrolyzing reagents used: A—Cymene stearosulphonic acid. B—"Kontakt" reagent. C—Naphthalene stearosulphonic acid (commercial).

the entire acidity becomes apparent. Tests have shown that they also all meet the other requirements mentioned by Dr. Twitchell, though in somewhat varying degree.

ACTION OF REAGENT

The explanation by Twitchell¹³ for the cause of the catalytic action of the sulpho fatty aromatic acids is in substance that water becomes a solvent for a

¹²J. Ind. Eng. Chem., vol. 9, p. 194 (1917).

¹³J. Am. Chem. Soc., vol. 22, p. 22 (1900).

glyceride when it contains one of these acids. He points out the fact that esters which are soluble in water are easily hydrolyzed by an acid, while those which are practically insoluble in water are hydrolyzed with great difficulty or are not hydrolyzed at all.

There are, however, a number of cases where water-insoluble glycerides are readily hydrolyzed in a relatively weak acid solution and it would seem that the proof is not conclusive that the rate of decomposition of an ester depends upon the solubility in water. Lewkowitsch¹⁴ has shown that tallow (a water-insoluble glyceride) can be hydrolyzed with 4 per cent of sulphuric acid in nine hours at a temperature of 120 deg. C. Furthermore, the autoclave process for decomposing water-insoluble glycerides does not employ reagents which render the fat or oil soluble in water. Examples of this kind seem to indicate that emulsion formation is the necessary step toward hydrolysis and that the solubility of the reagent in both water and oil phases determines the degree of emulsion formation. On this assumption it seemed important to carry out some experiments to determine if possible the factors that assist in emulsion formation and also to ascertain what changes take place in the water phase during a hydrolysis of a fat.

DISTRIBUTION OF REAGENT

Determinations were made to find the distribution of reagent in oil and in water when the proportions of the constituents were about the same as obtains in industrial practice.

The first experiments were carried out with a neutral coconut oil. Two hundred grams of oil and 100 c.c. of a standard solution (10 c.c. equivalent to 53.80 c.c. N/100 NaOH) of cymene-stearosulphonic acid were agitated in a beaker for thirty minutes at 25 deg. C. This emulsion so formed was allowed to stand for one hour. Ten-c.c. portions of the water phase were titrated with N/100 NaOH using phenolphthalein. A difference in the amounts of NaOH required for 10-c.c. portions and of the NaOH required to neutralize 10 c.c. of the original acid solution added gave the amount of the acid which passed from the water phase to the oil phase. Titrations were each made in triplicate using phenolphthalein indicator and the average was taken for calculations.

Ten c.c. of the original acid required 53.80 c.c. N/100 NaOH. Ten c.c. of the water layer after treatment required 51.70 c.c. N/100 NaOH. The acid strength remaining is $51.70 \div 53.80 = 96.1$ per cent. Reagent which passed from the water phase under conditions described above, $100 - 96.1 = 3.9$ per cent at 25 deg. When the experiment was repeated at 60 deg. C., it was found that 8.02 per cent had left the water phase.

Since the presence of fatty acids seemed to increase the speed of hydrolysis in an oil, the above experiments were repeated using 180 g. of coconut oil with 20 g. of oleic acid, the concentration of the reagent remaining the same. It was found that in the presence of oleic acid 5.4 per cent left the water phase at 25 deg. and 11.0 per cent at 60 deg. Accordingly the presence of free fatty acid in the fat or oil serves to make it a better solvent for the hydrolyzing reagent.

A second set of experiments was made with cottonseed oil instead of coconut oil and gave similar results. At 25 deg. 4.2 per cent and at 60 deg. 7.5 per cent of

the acid left the water phase. In the presence of oleic acid in the same proportion as with the cottonseed oil it was found that at 25 deg. 5.9 per cent and at 60 deg. 11.0 per cent of the reagent acid left the water phase.

INCREASE IN IONIZATION

In the light of this work it is apparent that one function of the sulphuric acid is to decrease ionization of the reagent and thereby increase the solubility of the reagent in the oil phase. It is apparent in the above set of experiments that the solubility of the reagent in the oil and fatty acid increases as the temperature rises. Some measurements carried out at a temperature of 98 deg. C. showed that the increase in solubility was apparently a straight line function and that at a temperature which obtains when fats and oils are split by the use of hydrolyzing reagents, 10 per cent or more of the reagent is dissolved in a neutral fat and 10 to 20 per cent (depending on the per cent of fatty acid present) is dissolved in fat containing fatty acid or in a fat after hydrolysis has proceeded for a few hours.

The results obtained at 98 deg. C. were variable and not entirely trustworthy because at that temperature the glycerides were broken up into fatty acids and glycerine and the composition of the original substance was changed. At 25 and 60 deg. the hydrolysis which the oil suffered during one-half hour was almost negligible and the values obtained at these temperatures will indicate approximately how the acid is divided between oil and water phases. This is not true at 98 deg. C.

DISTRIBUTION OF THE ACID

The whole amount of acid which leaves the water phase is not dissolved in the fat to form a homogeneous solution. Part of the acid dissolves in the fat and part forms emulsions which persist for a considerable length of time when the fat and the acid are allowed to remain quiet.

When water extractions of the unemulsified oil were made and were titrated against the standard sodium hydroxide, the acid found did not correspond to the amount which left the water phase. When a layer of emulsion between the fat and water phases seemed to persist on standing, this difference between acid lost in the water phase and acid dissolved in the oil phase was greater than when almost no emulsion was present. It is the opinion of the writers that the solution of the acid has its greatest concentration at the interface between acid solution and fat and that the greater the degree of dispersion of the oil particles in this area the greater will be the concentration of the acid.

EFFECT OF ACID ON REAGENT DISTRIBUTION

Supplementary experiments were carried out in the determination of the distribution of cymene-stearosulphonic acid in the water and oil phases. In these an attempt was made to determine what, if any, effect sulphuric acid had toward driving the reagent from the water phase into the oil phase. Using approximately normal sulphuric acid and the same strength of reagent acid as before, it was found at 25 deg. with cottonseed oil 6.8 per cent of the cymene-stearosulphonic acid left the water phase and with coconut oil 8.7 per cent left the water phase. These values are roughly one and a half to two times the solubility of the hydrolyzing reagent in these oils at 25 deg. when no sulphuric acid was present.

¹⁴Lewkowitsch, *Chemical Technology of the Oils, Fats and Waxes*, vol. 1, p. 84. Edition of 1913.

With increase of temperature the percentage of ionization of dilute sulphuric acid changes but little. With increase of temperature the fat hydrolyzing reagent has been shown to be much more soluble in the fat. Accordingly we would expect the presence of sulphuric acid to be particularly effective in increasing the percentage solubility of the hydrolyzing reagent at higher temperatures. Unfortunately, as explained above, it is not practical to make such determinations at the hydrolyzing temperature.

ESSENTIAL CONDITIONS

It may be necessary, then, to bring about two conditions before an acid will hydrolyze a fat:

The hydrogen ions must be greatly concentrated on the surface of a fat globule.

The fat must be divided until the surface is extremely large in comparison to the mass of the particle to be hydrolyzed.

Nernst¹⁵ states that the hydroxyl ion is 1,400 times more effective than the hydrogen ion in causing saponification. A N/5 solution of sodium hydroxide has practically no action on a neutral fat at room temperature, for a fatty acid can be determined in the presence of a neutral fat by neutralizing the fatty acid in an alcohol water solution with this strength alkali. If the relative activity of the hydrogen and hydroxyl ions in causing saponification is 1 to 1,400, it is obvious that a very extraordinary set of conditions must exist when a fat is hydrolyzed by an acid saponifying reagent of the type that we are studying. In this case a solution of an acid less than N/10 concentration can bring about the rapid hydrolysis of a fat.

Experiments carried out in the laboratory showed that a fat in the form of an emulsion is very much more readily acted upon by an alkali than one which is not in this form. The separation of fat bodies into smaller ones will increase the surface enormously and in this respect it would seem that the speed of hydrolysis¹⁶ is largely determined by the degree of the divisibility of the body that is undergoing hydrolysis.

The presence of a small per cent of free fatty acid seems to aid in the formation of emulsion. It was observed that the addition of oleic acid to a fat undergoing hydrolysis increased its tendency to form an emulsion layer between the fat and water, as was evident from the depth of the layer after the agitation was stopped. This emulsion layer was fairly stable on standing. As shown above, the per cent of acid leaving the water phase was increased when oleic acid was added and when the temperature was raised. In a separate experiment using oleic acid as a solvent it was shown that the sulpho-fatty aromatic acids are taken from the water phase to form true solutions in the fatty layer and in particular in the fat containing fatty acid, also that a considerable part of the reagent goes into the emulsion which is formed. It was further observed that the tendency for the formation of a stable emulsion did not appreciably increase after the fatty acid increased beyond about 10 per cent.

From an examination of the curves on the rate of hydrolysis of cottonseed oil and coconut oil which contained no fatty acids at the start, it will be seen that the speed of hydrolysis was slow at the beginning of the reaction, but increased after fatty acids were formed. The speed after about 40 per cent of the

fat was converted into fatty acids fell off gradually. In the hydrolysis of a tallow which contained 18 per cent fatty acids the speed was the most rapid at the beginning of the hydrolysis.

The fact that an emulsification produced by the various types of fatty acids plays a great part in producing the hydrolysis of the glyceride is in harmony with some recent theories advanced on the nature of emulsifying agents. Harkins, Davis and Clark¹⁷ think that the best emulsifying agents have long molecules with a polar active group at one end of the molecule. (Polar groups COOR—COOH, etc.) For the emulsified particle to be stable the molecules which make the transition from the interior of the drop to the dispersion medium or the molecules of the "film" should fit the drop. Langmuir¹⁸ believes that the organic groups strike inward into the fatty globules while the COOH, SO₃H, etc., are outside in the water phase.

These theories on emulsification may explain why reagents like naphthalene-stearosulphonic acid and cymene-stearosulphonic acid are better hydrolyzing agents than benzene-stearosulphonic acid. If we accept as true the common structural formulas for benzene, naphthalene and cymene, the molecule of a compound like benzene-stearosulphonic acid would not possess the length that is found in the two others and it would therefore be less effective as an emulsifying agent.

In one series of experiments the fat hydrolysis was carried out in the presence of iron. It was found that the percentage hydrolysis was not nearly as high as parallel experiments carried out where glass replaced the iron and also that the surface of the iron had been corroded. It is the general belief in the industry that the presence of iron pipes, etc., in the wood hydrolyzing vat is objectionable both from the effect on the speed of hydrolysis and on the color of the resulting fatty acid. The present case is, however, so far as we know the first case where definite experiments to confirm this general belief have been made.

COST OF REAGENT

In comparing the merits of cymene-stearosulphonic acid with other hydrolyzing reagents, it is necessary to consider cost of materials and other expense arising from the preparation of these.

The raw materials in question are cymene, benzene, naphthalene, oleic acid and 66 Bé. sulphuric acid. Cymene can be purchased and refined at less cost than benzene or naphthalene. The market quotation for benzene of a suitable grade for hydrolyzing purposes is in the neighborhood of 30c. per gal., or about 4c. per lb., and naphthalene is 8c. to 9c. per lb. Cymene can be procured and purified for about 4c. per lb. Oleic acid of a grade desired for this work costs 7c. to 8c. per lb. Sulphuric acid costs approximately \$20 a ton.

On this basis crude cymene-stearosulphonic acid should be prepared in quantity at a cost of about 10c. per lb., the exact cost depending on the care one wishes to take in removing the excess of impurities that are formed or exist in the making of the reagent.

The cost of preparing the benzene or naphthalene compounds would be somewhat higher due to the higher cost of the hydrocarbon and also to the fact that they cannot be sulphonated with the same ease or completeness as can cymene.

Department of Chemical Engineering,
Columbia University.

¹⁵Theoretische Chemie, Vierte Auflage, p. 532.

¹⁶Like sulphonation. Cf. McKee, *Science*, vol. 35, p. 388 (1912).

¹⁷J. Am. Chem. Soc., vol. 39, p. 541 (1917).

¹⁸J. Am. Chem. Soc., vol. 34, p. 1848 (1917).

Season-Cracking of Brass*

Extensive Observation of Season-Cracked Articles Led to Studies of the Action of Corrosive Agents on Stressed Brasses and a Determination of the Minimum Loads Required to Produce Corrosion Cracks—Chemical Action Held to Be Necessary for Season-Cracking

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INFORMATION contained in this very comprehensive and voluminous paper is the result of studies extending over several years, and on a number of different non-ferrous alloys which have failed by season-cracking. Not all of the information is new, by any means; but the paper as a whole is a good presentation of the entire subject.

OBSERVATIONS ON SEASON-CRACKING

Failures in cups spun from a 70:30 brass sheet, 0.07 in. thick (Fig. 1) were first noted. These cups had been covered by a layer of lacquer, which in many cases was unbroken, and the broken metal showed no corrosion whatever. However, they were stored near a mixture

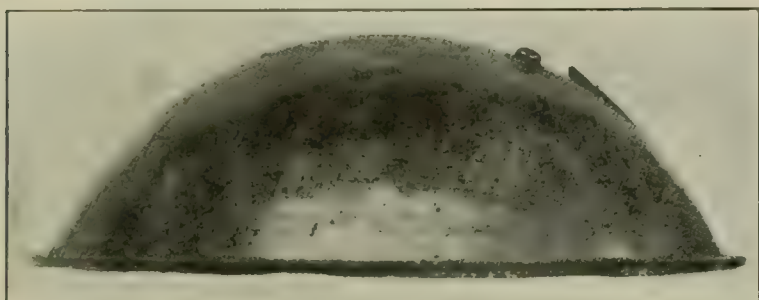


FIG. 1. SPUN VESSEL, 70:30 BRASS, SHOWING SEASON-CRACKS

of materials containing ammonium salts. When examined under the microscope, the metal showed a normal alpha brass structure, and all the cracks examined were intercrystalline. Internal stresses existed in these cups, since strips cut from them spring out of shape.

Empty cartridge cases (Figs. 2 and 3) especially have been affected with this "disease." Cracks usually occur



FIG. 2. SEASON-CRACKS IN INTERIOR OF WALL OF CARTRIDGE CASE

in the wall near the flange, and are ordinarily ascribed to incorrect "heading." After the shell has been placed in position, many longitudinal cracks have developed in the neck of the case. Fig. 4 shows the microscopic appearance of a typical crack in such a case made of 70:30 brass. Rings cut from such a cartridge would

show that the wall was in tension and the base in compression. Microscopic examination shows no distinguishing feature associated with season-cracking, such as crystal size, marked deformation in a crystal or the contour of crystalline boundaries.

A nickel-plated motor horn (Fig. 5) cracked badly where the plating had been polished off. Stress measurements from rings cut from this piece showed the cracks to start in rings having from 22,000 to 17,000 lb. per sq.in. stress, extending themselves toward regions having less stress.

Cold-drawn rods and tubes of various compositions ranging from pure alpha brass through mixtures of alpha and beta to pure beta brass have suffered high losses after storing. Particularly it was found that cold weather following a mild spell would be followed by much damage. Such weather conditions condense moisture on stored tubes, slightly corroding them, thus inducing cracking which exists chiefly in corroded regions. Under the microscope selective corrosion is



FIG. 3. SEASON-CRACKS IN BASE AND WALL OF CARTRIDGE CASE

very noticeable in the beta portion of a compound structure (Fig. 6). It was frequently noted that corrosive discoloration followed down the cracks. On the other hand inclusions were rarely connected with cracks, nor could preference be found for any shape, size or marking in the metallic grains. It was also possible to induce further cracking, in all bars which cracked in storage, by a light pickling followed by an immersion in weak mercurous nitrate. Failures coincided with scorings or surface defects in very rare instances—in fact, this observation applies to all the specimens examined during several years. Using Heyn's method of measuring internal stress—length changes in a sample between scribed lines after portions of the metal had been removed—a season-cracked rod showed stresses equal to 20,000 lb. residing in the outer layers. Uncracked rods which had been stored for a long period,

* Abstract of a paper read before the British Institute of Metals, March 10, 1921.

when studied in the same manner showed no longitudinal stress.

Corroded surfaces of such cracks in bars and tubes studied at Woolwich were green or dull brown in color; when soaked in distilled water a distinct evidence of NH_3 was found by Nessler's solution. No nitrates, however, were found in testing by diphenylamine. It was concluded that smoke from the open fires of green sap wood used in winter to heat the storage shed contained sufficient ammonia to be responsible for this corrosion-cracking. Spun cups known to be highly stressed were held in the fumes from the combustion of green sap wood for a confirmatory test. They were cracked in ten days. Chemical test also showed the atmosphere in the bell jar to contain much ammonia. In fact, ammonia is always found in considerable percentages in rain water from town districts, and therefore should be regarded as a potential source of damage to stressed brasses.

FEATURES COMMON TO SEASON-CRACKING

From all these observations, the authors summarize the following as being common to all season-cracking which has come under their study:

1. The pieces all appeared to be under an initial

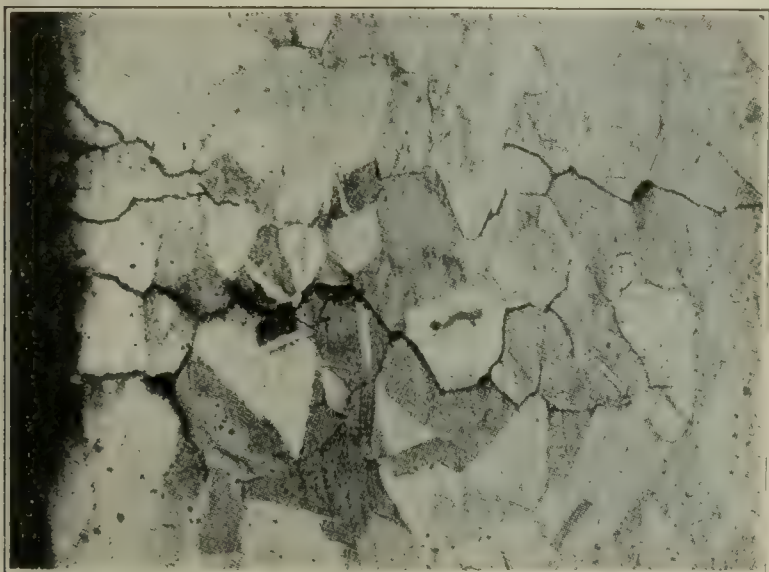


FIG. 4. SEASON-CRACKS IN 70:30 BRASS CORRODED ON THE SURFACE. $\times 100$

stress, not induced by outside load and therefore nearly always internal or residual. Such stresses may probably be induced by strain-hardening.

2. The pieces were all strain-hardened in a differential manner—that is to say, the hardness was greater in one part than in another part. Whether this is an independent cause of cracking or whether it merely sets up internal strain is not known.

3. Chemical action on the surface seems to be necessary. Very frequently defective articles have been corroded sufficiently for a visible tarnish or even a deeper corrosion. On the other hand, some apparently unbroken lacquered or paraffined coatings did not prevent season-cracking. It was later demonstrated that neither of these coatings is impervious to reagents, especially ammonia, which is often the cause of the trouble. Nickel plate seems to be quite impervious to ordinary corrosion agents.

4. Season-cracking seems to be exclusively an intercrystalline failure.

EFFECT OF CORROSIVE SUBSTANCES ON STRESSED BRASS

It had been found by the authors that spun cups made by a smoothly operating manufacturing process could be regarded as having closely similar internal forces.

A lot is usually made from a softened sheet from one ingot. It was found that they invariably cracked in from two to three minutes in a 0.1 per cent mercurous nitrate solution, if the cups were first pickled in a dilute solution of nitric acid (40 volumes per cent of 1.42 HNO_3), quickly and thoroughly washed, and immediately immersed in the HgNO_3 solution.¹

The first appearance of cracking may be noticed under the solution by the disappearance of the slight coating of mercury on the surface, showing yellow lines of brass. It may be possible that this amount of mercury dropped into the opening crack. The yellow line, however, is covered by a bright deposit of mercury after the crack has fully developed. Some free acid accelerates all mercury solutions. Some concentrations

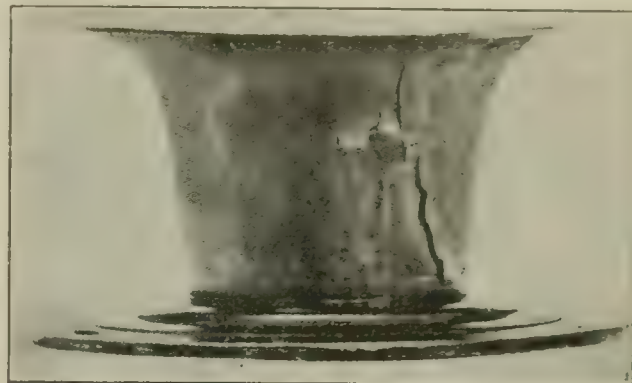


FIG. 5. SEASON-CRACKS IN MOUTHPIECE OF KLAXON HORN

of mercuric chloride plus hydrochloric acid give a dull to black coating of mercury which veils any early cracks. They also act slower.

Whereas corrosion cracking was very easy to induce rapidly in the cups, none appeared after the cups had been annealed 30 min. at or above 370 deg C., whether the cups had been made from a fully annealed brass strip or from the same brass strip after it had been hard

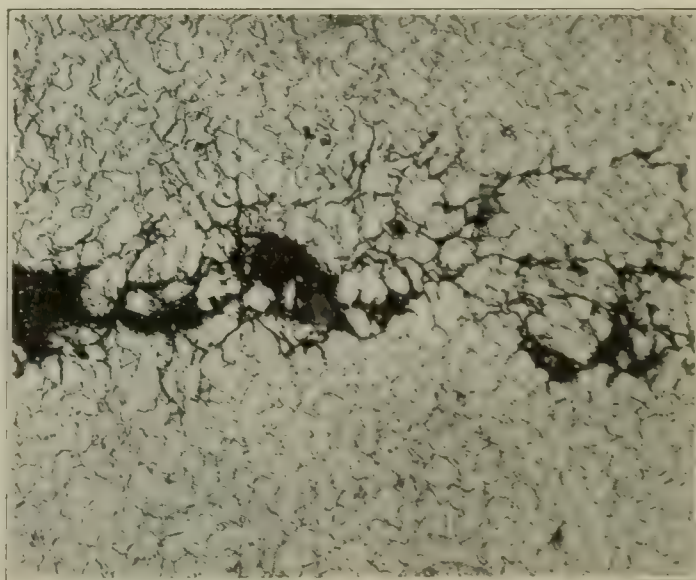


FIG. 6. SEASON-CRACKS IN 60:40 BRASS, FOLLOWING AN INTERCRYSTALLINE PATH. $\times 100$

rolled to Brinell 135. Spun cups were held for one year at 100 deg. C. continuously, and others on alternate days at room temperature, yet they did not break. These same cups broke in a time only slightly longer than the originals after a mercury immersion. It seems therefore that moderate temperature is not in itself sufficient to induce season-cracking, nor are the internal stresses

¹ 1 g. $\text{HgNO}_3 \cdot \text{H}_2\text{O}$ crystals plus 1 c.c. 1.42 HNO_3 made up to 1,000 c.c. with distilled water. Solutions having ten times this concentration will cause a crack in a few seconds in a badly strained brass.

responsible for the phenomenon relieved to any extent at the temperature of boiling water.

Cups made from both soft and hard brass strips and soft (60 Brinell) 96:4 phosphor bronze all crack under various reagents after the light pickling described above. The nature of this induced cracking is very similar if not identical to season-cracking.

Of a number of substances tested, including strongly corroding reagents such as nitric acid, hydrochloric acid, nitrogen peroxide and sulphur trioxide in damp air, none produced cracks except ammonia, ammonium nitrate and mercury deposited from solutions of mercury salts, although the trials were prolonged to severe corrosion and pitting. Mercurous nitrate tests on corroded specimens free from cracks at the conclusion of prolonged exposure to other reagents demonstrated the continued presence of severe internal stresses. Unstressed cups and other specimens were included in the trials; results showed that season-cracking occurred only when the brass was in a state of internal stress.

The authors reach the conclusion that season-cracking is therefore not induced in stressed brass by the mechanical weakening of the surface because of the irregular removal of metal by corrosion, but is brought about by the specific action of certain chemical substances, of which ammonia, its compounds, and mercury are known examples. A number of highly-stressed spun cups have been kept in atmospheres of ordinary purity for four years, yet not one has cracked, a fact which suggests that season-cracking of stressed brass is never "spontaneous," but can only be induced by chemical action of the kind indicated.

A damp mixture of ammonia gas and air, or strong ammonia solutions induce cracks in stressed brass very rapidly; cracks are formed at an early stage in the corrosion in some cases no corrosion is apparent. The action of dry ammonia gas is much slower.

RELATION TO FIRE-CRACKING

In order to discover whether season-cracking had much in common with so-called fire-cracking, various

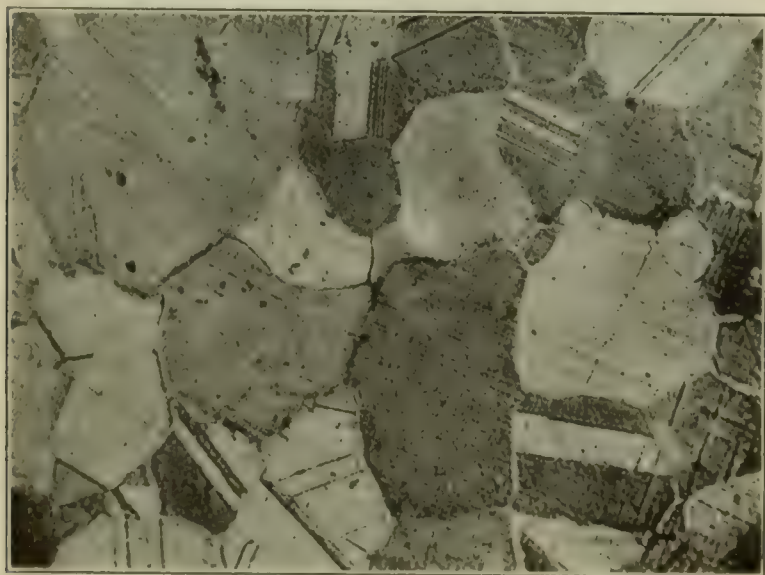


FIG. 7. FIRE-CRACKS IN 70:30 BRASS PRODUCED BY RAPID LOCAL HEATING OF A SPUN CUP. $\times 100$

methods of unequal heating were tried, such as dipping part of a cup in a salt bath at high temperatures, or placing a cup in a hot furnace. The only way in which cracks were produced was by impinging a blow pipe flame at one point of the cup. Fig. 7 shows the intercrystalline character of cracks produced in this way.

Strips of 70:30 brass and of pure copper of various

Brinell hardness from cold-rolling were pickled and immersed in the mercury solutions, then removed and stored in tight chests to prevent evaporation of the mercury. After a longer or shorter time the strips were pulled in a tensile machine. The soft specimens had strength and ductility greatly lowered and the fracture changed from fibrous to fine crystalline. As the hardness of the original strip increased, the strength after long contact with mercury seemed to be less affected and at Brinell 183 the strength and elongation (the latter of which is naturally low in such condition) are but slightly lowered, except in some cases after storage for three months. In other words, cold-worked strips were far less damaged than soft metal.

Strips stored over 0.880 ammonia in air suffered a progressive decrease in strength and ductility with the time of exposure in all hardnesses. After long exposure the material can be crumbled in the fingers.

MECHANISM OF CRACKING IN MERCURY

The nature of some of the breaks suggested that the mercury had merely a surface effect on unstressed test-pieces, so another series of test-pieces, treated in the same manner, were broken by loading them at different rates. The effect of rate of loading was very marked when testing annealed brass: the test-piece loaded in forty-five seconds giving a maximum stress of 20,000 lb. per sq.in., with 23 per cent elongation, while the test-piece loaded in twenty-five minutes broke at 10,600 lb. with 7 per cent elongation. It appeared that free mercury on the surface penetrated the cracks formed in the skin at relatively low stresses, and if sufficient time is allowed, the mercury penetrates through the brass by the gradual extension of cracks into which it flows.

In view of these results it was thought that impact tests on notched bars might throw some light on the depth to which the weakening effect of mercury and of ammonia penetrates in unstressed brass. In none of these tests was the energy absorbed by breakage affected to any marked extent by the mercury or ammonia treatment, the figures remaining approximately constant throughout each series. They confirm the view that in unstressed brass the embrittling effect of mercury or ammonia penetrates only to a comparatively shallow depth even after long exposure, but it will be seen that the depth to which the weakening effect can penetrate is decidedly greater with the latter.

If test-pieces treated in mercury were allowed to stand for seven days and then cleaned of mercury by holding them at 200 deg. C. for forty-eight hours, they had exactly the same tensile properties as the untreated bars.

In order to find the minimum stress which would induce fracture under mercury treatment, a pickled test-strip was given a certain load, then swabbed with the 1 per cent mercury solution for five minutes. The pieces had a hardness of 60 to 170 and thickness up to 0.1 in. No breaks occurred under a stress of 12,000 lb. per sq.in., prolonged fourteen days, which figure may be regarded as the minimum stress which induces accelerated cracking by mercury treatment.

ACCELERATED CRACKS ARE INTERCRYSTALLINE

Some test-pieces were strained and then annealed so as to be made up of a few very large crystals. Crystalline boundaries were then marked by etching or by pencil marks, and the pieces then exposed to mercury or ammonia. After testing in tension the fractures in all

cases were certainly intercrystalline. When fracture was induced by ammonia, the fractured surfaces were accompanied by a characteristic iridescent tarnish; the ammonia seems actually to penetrate the brass. On the other hand, if mercury were taken from the surface of the test-pieces, even after sixty days' exposure, the strength and elongation were reduced approximately 40 per cent, but the fracture was fibrous and entirely different from the intercrystalline nature of the other fractures. It was also absolutely free of mercury, suggesting strongly that the penetration of mercury took place during and not before loading. Furthermore, individual crystals from these broken test-pieces were cleaned of mercury on the surface and very delicate chemical tests showed no mercury (or at least less than 0.00002 g.) in the body of the crystals.

Studies on the amalgams formed by immersion of brasses in mercury showed that during early exposure to mercurous nitrate mercury is replaced in solution by copper and zinc in practically the same ratio as these two elements are contained in the brass. However, immersion in mercury for 320 days gives a preferential corrosion of zinc. It appears that zinc diffuses through the liquid mercury bath and oxidizes on the surface, being replaced by zinc from the alloy. This gives a pitting effect, but there is still no penetration of the mercury into the solid alloy. The disappearance of mercury from the surface of brass in time is due to evaporation of the mercury rather than penetration into the metal. On the other hand, actual separation of the crystals occurred in unstressed brass after sufficiently prolonged action by ammonia.

INFLUENCE OF COMPOSITION

Stressed zinc-copper alloys do not crack under the action of mercury or ammonia if the zinc content is below about 6 per cent; the higher the zinc content the more readily does cracking occur. The authors are convinced that the action of mercury and ammonia is a trustworthy index of the liability of season-cracking, and therefore they would not expect season-cracking in copper or in its alloys with small percentages of zinc. The results of extensive trials with 70:30 brass containing small amounts of manganese indicate that these alloys when stressed crack quite readily or more readily than pure 70:30 brass when submitted to the action of mercury or ammonia. Cracks have also resulted after atmospheric corrosion. Therefore, no indication was found that the presence of manganese reduces the liability to the formation of season-cracks.

Stressed phosphor-bronze is cracked by mercury or ammonia, though much less readily than brass, and may possibly be subject to season-cracking if the conditions are sufficiently severe, but no example of season-cracking of phosphor-bronze in service has come under notice.

SUMMARY OF FACTS

Corrosion of the surface and sometimes of the walls of the cracks is frequently associated with season-cracking, but corrosion effects are not always visible.

Season-cracking may occur in brass coated with continuous protective layers, such as lacquer.

Nickelplating is probably completely effective in preventing season-cracking, if a sufficient and continuous coat of nickel is secured.

Highly stressed articles, capable of developing season-cracks in certain conditions, may be kept for years in reasonably pure atmospheres without showing any sign

of cracking, and there appears to be no reason to expect the development of cracks so long as the condition of the surrounding atmosphere does not change.

Some agency in addition to the presence of initial stress appears to be necessary for the development of season-cracks.

Corrosion does not necessarily favor the development of season-cracks in stressed brass. Very severe corrosion and pitting caused by the prolonged action of various acids and other corrosive agencies had no cracking effect on stressed brass liable to develop season-cracks in other circumstances.

Ammonia has been detected in a water extract of slightly corroded fractures caused by season-cracking in brass etched by atmospheric action only. Reason was found to suspect the presence of small amounts of ammonia in the atmosphere in which the specimens were stored.

It is probable that traces of ammonia in the atmosphere are an important agency, and possibly the main agency, inducing season-cracking of stressed brass.

Ammonia appears to have a specific and selective action upon the intercrystalline material of brass, weakening it sufficiently to cause cracking if in tension. Mercury has a similar but more rapid action.

The cracks produced in stressed brass by mercury or by ammonia are of the same intercrystalline type as season-cracks.

Season-cracks and the similar cracks caused by mercury or ammonia always begin in surface layers which are in tension.

PREVENTION

The important practical question of the prevention of season-cracking by the removal of initial stress has been previously dealt with by the authors.² A suitably controlled low-temperature annealing which will remove stress sufficiently to insure freedom from season-cracking with little or no effect on the hardness appears to be the most effective safeguard against failure by season-cracking and might well be applied to all brass articles made by cold-work operations capable of inducing permanent internal stress.

The wide divergences in composition, structure and physical condition of brass articles which have failed by season-cracking, together with the ease with which stressed brasses of very different compositions or of the same composition but differing in structure may be made to develop "season-cracks" by ammonia treatment suggest that within the limits of, say, 25 to 45 per cent zinc little improvement in resistance to season-cracking is likely to be obtained by changes in composition or treatment if the state of initial stress is not affected. The apparent advantages of harder-worked brass in resisting season-cracking is largely discounted by the higher stresses which are likely to exist in harder brass if steps are not taken to remove them.

Cold-work operations do not necessarily leave high internal stresses in the worked article. Many objects in which the hardness has been greatly increased by cold-work are not internally stressed. Operations may to some extent be controlled to avoid the development of internal stress even when the maximum hardness is necessary, but as a rule it is simpler and safer to remove internal stress by a final low-temperature

²H. Moore and S. Beckinsale, "Removal of Internal Stress in 70:30 Brass by Low Temperature Annealing," *J. Inst. Metals*, 1920 I, vol. 23, p. 225.

annealing than to avoid its development in the cold-working operations. Spinning appears always to produce some degree of internal stress.

It is obvious that stresses present in brass cannot exceed the yield point (regard being paid to the raising of the yield point which may have been brought about by local or general overstrain), and for this reason it is probable that in practice soft brass is unlikely to fail by season-cracking, since the stresses which can exist in it are low. Season-cracking has, however, been frequently observed in brass only slightly hardened by cold-work, but no example has yet come to notice in fully annealed brass.

The distribution of hardness has no necessary influence on internal stress, and cold-work operations which develop a high degree of hardness in one part of an object and leave other parts soft do not necessarily result in severe internal stresses, although they may sometimes induce them. In general it may be stated that internal stress is largely independent of hardness or distribution of hardness, with the reservations that when internal stress arises it is usually developed by operations which at the same time increase the hardness, and that the harder the material the higher is the maximum stress it is capable of sustaining without yielding.

RELATION TO AMORPHOUS THEORY

It is considered by the authors that this study of season-cracking and of the action of mercury and ammonia on stressed brass affords strong support to the hypothesis of an intercrystalline material differing essentially in its properties from the crystals themselves. For example, in the case of a pure alpha brass the intercrystalline material appears to be attacked by ammonia or by mercury much more rapidly than the crystals. The mercury probably alloys with the intercrystalline material, forming a mechanically weak alloy, while ammonia forms a chemical compound possibly of the nature of a cupramine. The apparent presence of an external layer on spun cups and on other cold-worked articles which retards the intercrystalline weakening action of both mercury and ammonia is an interesting confirmation of the view that the intercrystalline material is similar in its properties to the amorphous film produced by surface flow. The operation of spinning would be expected to produce a very definite surface film of Beilby's amorphous phase, and possibly, in addition, a thin lower layer of very severely deformed material containing a high proportion of amorphous phase. If the amorphous material is more capable of combining with or absorbing ammonia or mercury than the crystalline material, it might be expected to exercise some protective action, since the mercury or ammonia would be unable to act on the boundaries of the crystals below until the surface layer had become "saturated." The more rapid apparent disappearance of a thin mercury coating from the outer surface of a spun cup, in comparison with a similar cup from which the flowed surface layer had been removed by pickling before mercury treatment, would confirm this suggestion. The "disappearance" of the mercury coating was probably due in part to absorption of free mercury by the amorphous material in the surface layer. This applies to very thin coatings only; thicker deposits do not disappear except by volatilization, and there is little or no diffusion of mercury to an appreciable depth in brass.

The greater resistance of hard-worked brass to the

intercrystalline weakening action of mercury or ammonia may be explained by the much larger proportion of amorphous phase, much of which is assumed to exist within the deformed crystals. The capacity of hard-worked material for absorbing mercury or combining with ammonia should be much greater if the view be adopted that the amorphous material plays the chief part in such reactions. Since the amorphous phase is much more uniformly distributed in cold-worked brass, the selective weakening action is less concentrated at the intercrystalline surfaces. The more severe the cold-work the less should be the selective action at the crystal boundaries, and this is borne out by the diminished intercrystalline weakening as the hardness increases.

It does not appear to be necessary to ascribe peculiar mechanical properties to the intercrystalline substance in order to explain the phenomena of season-cracking, and the authors are unable to find in the results of their work any evidence indicating that season-cracking is the result of viscous flow of the intercrystalline cement. The undoubtedly intercrystalline character of season-cracks in brass appears to be fully explained by the selective weakening action of a chemical substance on the intercrystalline material. In this particular the authors' view of season-cracking in brass differs from that of Rosenhain and Archbutt,³ although there is agreement in so far as their explanation is also based on the assumption of an intercrystalline material probably identical in its properties with Beilby's amorphous phase found in surface films.

Calcium Silicide as a Deoxidizer

As a deoxidizing agent, calcium silicide, a compound now being manufactured in large quantities in France, is said by the *Ironmonger* to be rapidly gaining in popularity, especially in connection with electric-furnace steelmaking. Calcium silicide, which is a hard, bright, metallic body somewhat similar to ferrosilicon, dissociates when added to the molten metal, and the elements combine with the oxygen present in the bath of metal, and then recombine as calcium silicate, which, as in the ordinary reactions of slag formation, rises to the top. The reaction is a very vigorous one, and the energy liberated in the form of heat when the silicide decomposes is sufficient to bring up appreciably the temperature of the bath of metal. Thus the compound acts not only as a deoxidizing agent, but also as a means of bringing up cold heats to a proper pouring temperature. Another function attributed to calcium silicide is that of a desulphurizer. Under the conditions of the electric-furnace process an appreciable reduction in the sulphur content is said to take place. Its most marked advantage, however, is that it deoxidizes without leaving any harmful inclusions in the metal, and thus insures greater soundness. Calcium silicide, which, though hard, can be readily reduced to powder, gives the best results when added to the molten metal in small quantities, and in this connection the method of inclosing small amounts of the deoxidizer in paper bags and completely burying each one in the ladle of metal is found to be most convenient. For purposes where the carbon does not exceed 0.30 per cent carbon, the best results are said to be obtained by the addition of 10 to 20 oz. of calcium silicide to the ton of metal, while for metal containing more carbon about 30 oz. of silicide to the ton is necessary.

³"Inter-crystalline Fracture of Metals Under Prolonged Stress," *Proc. Roy. Soc.*, 1919, No. A674, p. 15.

Soldering Fluxes

BY A. A. LADON

THERE probably is no operation more commonly used than that of soldering. Almost every manufacturer, shop, garage, power plant, etc., finds everyday use for this process, yet the literature shows an almost absolute lack of information on the subject. As far as the writer's search revealed, there is no published technical or even semi-technical information. The explanation of this may be that the operation is considered too commonplace to deserve study. But this is not the case; a careful and complete investigation would unquestionably yield valuable results.

There are two forms of soldering—hard and soft. Hard-soldering refers to operations requiring a comparatively high temperature, such as brazing and silver-soldering. Passing mention only will be made of hard-soldering, for the purpose of this article is a consideration of soft-soldering. In brazing, the commonly used flux is borax, from which the water of crystallization has previously been driven. A slight amount of ammonium chloride is often added to the powdered dry borax. A widely used brand has the welding materials already mixed, which consists of powdered brass and borax. The brass used has a high percentage of zinc, so that when it melts on the weld the zinc partly volatilizes, leaving a brass of such composition as to give maximum strength.

Soft-soldering is by far the more commonly used. The most satisfactory solder for general purposes contains equal parts of lead and tin and is known to the trade as "half and half." The temperature used is that merely high enough to heat the parts to be soldered to the flowing point of the solder.

These considerations are fundamental and are given merely to bring to one's mind the operations which make necessary the use of soldering solutions.

SOFT-SOLDERING FLUXES

There are many types of soft-soldering fluxes on the market. The old and still commonly used flux is "cut" muriatic acid. Zinc is added to the acid until action ceases. Then the acid is ready for use. The active material is the zinc chloride formed. However, the action of the acid on the zinc is never complete, there always remaining free acid. This naturally makes corrosion bad unless all of the fluid is carefully washed off of the completed work. To lessen corrosion, commercial zinc chloride salt is often used, and while it is less corrosive than acid, still it excites corrosion markedly.

There are many commercial materials on the market known as soldering salts, the active material of them all being zinc chloride. For use, the salt is commonly dissolved in water. Alcohol is a better solvent, for it evaporates more quickly, and does not "spatter" so much.

The corrosiveness of zinc chloride made marketable the various "non-corrosive" fluxes on the market. Unfortunately all of the so-called non-corrosive materials are corrosive in a degree and unless carefully washed away excite corrosion.

The non-corrosive—so called—fluxes are made by mixing zinc chloride in a material not an electrolyte—such as vaseline. They can be mixed by stirring or running them through a common "buhr-stone." A very small amount of water added to the mixture and thor-

oughly incorporated with it has the effect of stiffening it. However, this is better accomplished by the addition of paraffine or the use of a higher melting-point vaseline. Ammonium chloride is often added.

Another useful form of soldering flux is in stick form. The chloride is "dissolved" in the paraffine and melted into shape.

From these statements, one might conclude that zinc chloride is the only active soldering flux. It probably does the quickest work, but there are many others, each with their advantages.

Phosphoric acid, lactic acid, tallow, rosin, glycerine, depending on the metals to be soldered, are good. Rosin is the only flux the writer has been able to find that is really non-corrosive. For ordinary work, it is used dissolved in alcohol. It is slow in action, and the solder does not flow well over the work. Tallow is corrosive on certain metals. Glycerine with slight addition of zinc chloride is very good on german silver.

There are probably a very large number of materials that could be used for fluxes, but zinc chloride—as corrosive as it is—seems to "hold the field."

DIFFERENT FLUXES FOR DIFFERENT METALS

Each metal requires a different flux to obtain the best results. On flat work a different flux should be used than that used on concave or convex surfaces. Each soldering problem has a particular flux that works the best.

The fact that the same flux does not work to advantage on all types of surfaces of even the same metal leads the writer to believe that the present conception of the function of a flux is not wholly correct.

To solder, the surfaces must be clean. Clean surfaces rapidly oxidize and present a very thin coat of oxide. The present theory is that the flux dissolves the oxide film so that the molten solder can alloy itself to the metal, but that is disproved by the fact that slowly oxidizing metals like copper or brass scratched and cleaned carefully in an atmosphere of nitrogen cannot be well soldered, even in that non-oxidizing atmosphere, without a flux.

A drop of molten solder placed on a clean metal remains in almost spherical form. The moment a flux is placed on that drop, the solder flattens out. This indicates that the action of a flux is to decrease the surface tension of the molten metal. This change of surface tension and the solution of the metallic oxides formed are the evident dual purpose of the flux.

There should be a means of decreasing the surface tension of molten metals other than by the use of a corrosive material, and it is the purpose of this article merely to present the possibilities of research on this subject.

Quinine Culture in the Philippines

The feasibility of an extensive culture of quinine in the Philippines is emphasized by Dr. Elmer Merrill, director of the Philippine Bureau of Science, in answering to an inquiry from Ely Lilly & Co. of Indianapolis, manufacturing pharmacist. Dr. Merrill points to the available big areas in Luzon and Mindanao Islands that are highly adapted for quinine culture. At present there is one small quinine plantation in Baguio. This plantation is under the supervision of the Bureau of Forestry and the results obtained from its operation indicate the success of the industry. Climatic conditions in the Islands are believed to be favorable.

Book Reviews

SILVER, ITS INTIMATE ASSOCIATION WITH THE DAILY LIFE OF MAN. By *Benjamin White*; 144 pp., one chart, illustrated. London: Sir Isaac Pitman & Sons, Ltd. Price \$1.

Silver is discussed as a commodity. In the first part of the book the author reviews its mineralogy, mining, metallurgy and marketing, and describes some of the early and modern mine fields. In the second part he discusses the silversmith's art at different periods, and enumerates many of the articles and ornaments into which the metal is manufactured. This portion of the work contains an interesting account of Indian industries, and a review of the evolution of British coinage. The third and last part of the volume is devoted to a discussion of the utility of silver as money, past and present, with dissertations on Indian currency and Chinese monetary problems, and the author's views of the present position and the future prospects of silver as money. The text is illuminated by numerous halftone illustrations, and is amplified with appropriate statistical tables and charts, the one showing the price fluctuations in London since 1832 being of special interest to students of the silver market.

The reader, if a student or engineer, is apt to gain a rather unfavorable impression of the book in the earlier pages, because they cover in an incomplete manner much ground with which he is already familiar. However, as he proceeds faithfully into the second and third parts of the book, his impatience is replaced by interest in the light of the discussions of monetary problems, if these subjects entertain him. To the non-technical reader, or layman, the work is likely to be quite interesting, and its perusal will leave him with entertaining impressions and additional information.

H. J. WOLF.

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OFFICIAL AND TENTATIVE METHODS OF ANALYSIS OF THE ASSOCIATION OF OFFICIAL AGRICULTURAL CHEMISTS. Compiled by the *Committee on Revision of Methods* (R. E. Doolittle, Chairman, B. L. Hartwell, G. W. Hoover, A. J. Patten, A. F. Leeker and W. A. Withers). Revised to Nov. 1, 1919. Published by the Association of Official Agricultural Chemists, Washington, D. C., September, 1920, xii + 417 pp. 18 fig. Price, \$5.

The present volume is the latest revision of the famous "Methods of Analysis of the A. O. A. C." which were originally published as Bulletins 46, 65 and 107 of the Bureau of Chemistry, U. S. Department of Agriculture, and more recently (1916) as a supplementary part of the *Journal of the Association of Official Agricultural Chemists*. All of the earlier editions have been out of print for some time, so the present volume appears at a very opportune moment.

The methods of analysis are given for Fertilizers, Inorganic Plant Constituents, Waters, Tanning Materials, Leathers, Insecticides and Fungicides, Foods and Feeding Stuffs, Saccharine Products, Food Preservatives, Coloring Matters in Foods, Metals in Foods, Fruits and Fruit Products, Canned Vegetables, Cereal Foods, Wines, Distilled Liquors, Beers, Vinegars, Flavoring Extracts, Meat and Meat Products, Dairy Products, Fats and Oils, Spices and Other Condiments, Cacao Products, Coffees, Teas, Baking Powders and Baking Chemicals, Drugs, Soils, followed by seventy-eight pages of reference tables. The book closes with a good index.

The reviewer is in hearty accord with the statement in the preface: "It may be stated without reservation that more elaborate and painstaking effort has been expended on this collection of analytical methods than upon any other set of similar methods in the field of chemical science." Extreme conservatism is practiced in the adoption of a method as "official." This is well illustrated by the fact that the determination of amino nitrogen by Van Slyke's method is still (p. 216) a "tentative" method in spite of the fact that the ease of manipulation and the accuracy of the method

have been established beyond question. On the other hand, this same conservatism causes the retention of statements in "official" methods which are questionable. For example, on page 72, "amido nitrogen" undoubtedly refers to "non-protein" nitrogen and not to the CO-NH₂ grouping alone; likewise "amino" nitrogen in paragraph 12, page 168, does not refer to nitrogen in amino groupings, but to "non-protein" nitrogen.

It is an easy matter for a reviewer to find minor faults in a book. The virtues of the present volume are, however, sufficient to entirely overshadow any faults. The methods are "official" for all agricultural products, especially for all regulatory work where the possibility of judicial proceeding is always present. In court cases these methods are accepted as standard and binding. It is only natural, therefore, that the procedures outlined in these methods should be followed in the "food analysis" courses of our agricultural colleges and universities. The book is well printed on good paper and durably bound in tan buckram. It is such a necessary companion to the food and agricultural chemist that it is to be hoped arrangements have been made so that it will not again be out of print for any considerable period of time.

R. A. GORTNER.

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THE OPEN HEARTH—ITS RELATION TO THE STEEL INDUSTRY—ITS DESIGN AND OPERATION. By *Victor Windett*. Pp. 378; 8½ x 11 in. New York: United Publishers Corporation. First Edition, 1920. Price \$7.50.

This book was originally issued by the Wellman-Seaver-Morgan Co. of Cleveland, Ohio, with no author's name given on the title page. A brief introduction led to the assumption that it is the work of engineers associated with the Wellman-Seaver-Morgan Co., since it states that "the facts given are based largely on their working data . . . constantly enriched by intimate exchange of experiences and records with the best practicing steel makers of the present time." Shortly after publication, however, the title page was changed, showing Victor Windett, one of the company's engineers, as author, and United Publishers Corporation as publisher.

In view of the great influence which one of the founders of the company—the late Samuel T. Wellman—had upon the early introduction and adaptation of the open hearth to the American steel industry, and the excellent labor-saving machinery which has been perfected and marketed by the company, notably the charging machine and ingot manipulator, the Hewlit unloader and the car dumper, one opens this rather imposing book with a feeling that it will undoubtedly contain much information of value to those engineers who have felt that the open-hearth furnace has not progressed as it should in recent years. Operators have apparently been so busy modifying the lines of their furnace to suit changes in fuel, refractories and charges that they have not given the attention to fundamentals which underlie rational improvements in construction. Designing engineers have seemingly been content to construct furnace accessories to fit a building rather than *vice versa*, as long as checkerwork flues, and valves not too far different in size from those in neighboring plants could be tucked into the cellar and kept above ground water. Little material on the essentials of furnace design is available in literature, but surely the Wellman-Seaver-Morgan engineers have it; and a book from them should become a furnace constructors' Bible.

Examination of the book proved a disappointment. Little or no detailed information on the fundamentals of furnace design is included. Even the generalities—often elementary—are confined almost exclusively to furnaces built to that company's design. Other widely known and excellent modifications are dismissed with a short paragraph.

It collects together a very large number of excellent photographs and line drawings, the latter printed in such a manner as to simulate blue-prints. While these drawings are mostly general drawings, many of them contain details which can be put to much use by the expert furnace draftsman content to follow the rule of thumb. A great amount of data has also been brought together on

acceptable operating details, as well as conventional furnace sizes. The book is particularly remiss, however, in discussing why such conditions exist, or what might be expected if these furnace lines were altered, either by design or accident.

On page 97 may be read the following words: "The proper planning of the gas and air ports is an important part of a furnace design. This insures a combustion so controlled as to throw into the bath a maximum of heat by radiation and combustion." How are these important objects to be attained? On page 123 are found sixteen lines on this subject. After noting the scouring action of hot, dusty gases, the book states: "Good practice requires the delivery of the air toward the top of the furnace. This insulates the roof from the intense heat of combustion and prevents excessive oxidation of the metal of the charge, for the oxygen-absorbing flame interposes. The slope of the ports should be such as to secure an intimate mixing of the air and gas at a height of about 3 ft. above the bath." On page 97 the following statement is also made: "Admission of fuel should be directed to obtain complete combustion without the flame impinging upon the roof, bath or ports at the opposite ends." That is about all. The slope and dimensions of the ports may be scaled from some of the blueprints. But is it not possible to figure the path of a certain current of burning gas in a furnace at various temperatures, so that before the furnace is built it would be possible to state whether the flame actually could be forced down so as to "lick" the bottom, as is necessary to "burn it in," and so the flame could lick the bath to provide the maximum heat transfer between flame and molten material? Some of the most astute furnace-men in the country now realize that velocity of air and gas, proper atomizing of fuel or its early and intimate mixture with the air for combustion are major factors in approaching the ideal heating conditions: the earliest possible combustion in the shortest possible time. One might fairly expect a discussion of such tendencies in a book of this kind.

Again, regarding the design of regenerators. The book states on page 124 that in many cases an allowance of anywhere from 65 to 140 cu.ft. of regenerators per ton of rated furnace capacity is needed. With this tremendous difference in practice, one would expect that scientific design would help to obtain an approximate idea as to which extreme was more nearly correct.

The author has the following general statement to make:

1. "As many checker bricks should be put into the chambers as possible to allow storing a maximum amount of heat from the waste gases without an undue increase in gas velocity." What, for instance, is an "undue increase in gas velocity"?

2. "A maximum of surface should be exposed." Could not several arrangements of brick be illustrated showing the amount of surface exposed as varied by the method of packing? Should checker brick be bought which have the best chance for subsequent cleaning and re-use, or brick which have the best ratio of surface to mass?

3. "The disposition of the checkers should be such as to have an intimate contact with the gases and air." Does this mean that there is to be a maximum of interference so as to produce the most eddy currents?

4. "The design must have a uniform volumetric capacity for the flow of air and gases through the various openings in the checkers." Elaboration of this sentence would doubtless clarify its exact meaning.

5. "The material used and the size and structure of the checker bricks must be adequate to carry the superimposed load on them at high temperature." How high, for instance, would a checker brick have to be before it would squat of its own weight when heated uniformly to 1,000 deg. C.?

6. "Means for securing increased velocity of flow at salient points so as to avoid flue dust deposits. This dust glazes over the brick surface and destroys their thermal qualities, in addition to cutting down the cross-section of the passages." The reviewer is of the opinion that most of the "dodges" for securing or controlling the flow of hot gases through a checkerwork are of very indifferent value. If vertical, well-insulated stove-like checkers would be built, instead of the long low ones now common, so that the hot

gases could travel from top to bottom and the air to be heated from bottom to top, a checkerwork not grossly misbuilt tends to balance itself; that is to say, the hot gases seek out the passages, where they can give up their heat at the maximum rate, and on the other hand the cold gases favor locations where they can absorb heat at the maximum rate. In other words, if they are given a chance by correct design, the hot gases reach the cold spots, and the cold gases reach the hot spots. Could any better automatic device be imagined?

E. E. THUM.

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INTRODUCTION TO GENERAL CHEMISTRY. Text Book, by Herbert N. McCoy and Ethel M. Terry. 128 illustrative figures, 629 pages subdivided into 33 chapters. New York: McGraw-Hill Book Co., 1920. Price, \$3.50.

The authors state in the preface, "The choice and arrangement of topics in the earlier part of the book depart noticeably from the familiar order."

The reviewer believes that the reader of this review will best understand the comment when he has a clear idea of the general arrangement of the subject matter. It is for this reason that the "Table of Contents" is given: Chapter I, Introduction—Laws of Gases; II, The Burning of Substances—Oxygen; III, Pure Substances—Elements; IV, The Law of Definite Composition; V, Symbols and Chemical Formulas; VI, Chemical Equations; VII, Acids, Bases, and Salts—I; VII, Water and Solutions; IX, Acids, Bases and Salts—II; X, The Kinetic Theory of Matter and the Molecular Hypothesis; XI, The Atomic Hypothesis and Atomic Weights; XIII, The Halogens and Their Compounds with Hydrogen and Metals; XIII, Chemical Equilibrium; XIV, Hydrogen and Oxygen; XV, Oxidation and Reduction; XVI, Heat and Energy; XVII, The Ionic Hypothesis; XVIII, Applications of the Ionic Hypothesis; XIX, Applications of the Ionic Hypothesis: Reactions Involving Changes of State; XX, Electrochemistry; XXI, Nitrogen and Ammonia; XXII, Nitric Acid and the Oxides of Nitrogen; XXIII, Phosphorus and Its Compounds; XXIV, Sulphur and Its Compounds; XXV, Carbon and Carbon Compounds, Organic Compounds—I; XXVI, Organic Compounds—II; XXVII, Theory of Dilute Solutions; XXVIII, Disperse Systems; XXIX, The Atmosphere and Related Topics; XXX, Some Additional Elements and Their Compounds; XXXI, Classification of the Elements. The Periodic System; XXXII, Radioactivity and the Nature of Matter; XXXIII, Metallurgy.

It is only necessary to glance at this "Table of Contents" to realize that the claim of the authors is well founded. A statement in the introduction further defines the authors' viewpoint—viz., "It is to be assumed that the student taking up chemistry has had at least a one-year high school course in physics." In reading the text, however, the reviewer did not feel that a beginner in chemistry using this text would be so much handicapped by lack of such a course. The authors exercise considerable care in defining any terms or units used, many of which should be understood by a student who had had his assumed course in physics—e.g., in Chapter I the gas laws are carefully developed.

When one reads the text carefully and notes that Chapter VI ends on page 56 and that the student has made an acquaintance with many chemical reactions, the rôle of substances—elements and compounds—in reactions, and the quantitative significance of the chemical formula without being told anything about atoms and molecules, it is quite evident that the first part of the book is a departure. When one looks for his familiar friends oxygen and hydrogen, and finds they are not introduced until Chapter XIV, page 176, he is again struck with the new order of things. This might suggest looking for other old friends, e.g., the metals and their salts. When they are found not only will the authors be given credit with originality for "order and arrangement" in the first part of the book but even more so in the latter part, for if one is conscientious enough in his search he will find them very briefly considered in Chapter XXX among "Additional Elements and Their Compounds" and in Chapters XXXI and XXXIII.

Some other striking departures may be noted. Acids,

bases and salts are considered without reference to the dissociation theory, which follows in a later chapter. Although the gas laws are considered in the first chapter, the kinetic molecular hypothesis is not introduced until Chapter X.

Disregarding our individual views with respect to the arrangement of topics, it must be admitted that the authors have presented the topics in a clear and teachable manner. Chapters IV, V, VI, XIII, XVI, XVIII, XX and XXXII are especially well written. Chapters XXVII and XXVIII give special consideration to important elementary topics hardly mentioned in the ordinary introduction texts in chemistry. The book closes with a very well-arranged chapter on metallurgy.

When one follows the arrangement of topics and considers the method of treatment, he cannot fail to recognize that the authors have a "philosophy of arrangement" and the courage to present it.

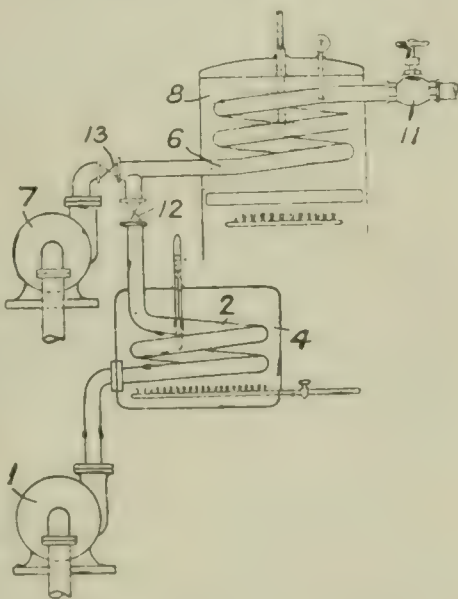
CLIFFORD D. CARPENTER.

Recent Chemical & Metallurgical Patents

British Patents

Complete specifications of any British patent may be obtained by remitting 25c. to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Effecting Chemical Reactions Under Pressure.—Liquids, solids or gases which react at high temperatures under pressure are introduced separately or together, into heated pipes wherein the reaction takes place. The figure shows one form of apparatus in which the reacting materials are respectively forced by pumps 1, 7 into the connected pipes 2, 6 which are provided with valves 12, 13 and are heated in the tank 4 and metal bath 8. The outlet of the product is controlled by the valve 11. (Br. Pat. 156,264; not yet accepted; H. SCHELLENBERG, Wadenswil, Switzerland. March 9, 1921.)



Synthetic Tanning Agents.—Synthetic tanning agents consisting of coupled aromatic compounds, coupled aromatic and aliphatic compounds or coupled organic compounds and vegetable tanning agents are converted into aluminum or chromium salts, which also are tanning agents, by treating the free acids or their salts, or mixtures thereof, with aluminum or chromium compounds, or mixtures thereof. According to examples: tar oil is sulphonated and condensed with formaldehyde, the free sulphuric acid is neutralized by potash, and the product is neutralized by aluminum hydroxide; tar phenols of boiling point 185-200 deg. C. are heated with sodium sulphite and formaldehyde solution, the product is acidified by sulphuric acid and the sulphur dioxide boiled off, and the product finally neutralized by chromium hydroxide; a mixture of naphthalene and phenol is sulphonated and condensed with formaldehyde, the product is diluted, neutralized with lime till only feebly acid, filtered and finely neutralized with basic chromic sulphate; creosote oil is sulphonated and condensed with formaldehyde, and the product mixed with chromium sulphate and caustic soda solution until only feebly acid; a mixture of naphthalene and phenol is sulphonated and condensed with formaldehyde, the product is further condensed with tannin and formaldehyde and finally neutralized by potash and aluminum hydroxide; a mixture of 2:6 naphthol sulphonic acid and glucose is condensed with formaldehyde and the product

neutralized by chromium hydroxide. The products may be used in tanning, alone or mixed with other tanning agents, by any of the usual processes. (Br. Pat. 156,254; not yet accepted; CHEMISCHE FABRIKEN & ASPHALTWERKE AKT. GES., Griesheim-on-Main. March 9, 1921.)

Tannic Extracts.—Tannin-containing materials (wood, bark or leather) has the tannin extracted by alkali solutions. From the filtered extract the tannin is precipitated as an insoluble metal tannate, which is then decomposed by an acid, such as sulphuric or oxalic. A reducing agent such as a sulphite may be added in the alkali extraction to prevent oxidation of the tannin, or the extraction may be performed in a non-oxidizing atmosphere. When treating sawdust or shavings, any alkali-cellulose formed is precipitated by neutralizing the alkaline extract by an acid, before precipitation of the metal tannate. Br. Pat. 156,653; not yet accepted; Mrs. A. RIALLAND, Reunes, France. March 16, 1921.)

Synthetic Resins.—Synthetic resins, homologous with coumarone and indene resins, are obtained by polymerizing with concentrated sulphuric acid the tar oil fractions from carbolic or creosote oils which boil between 190 and 240 deg. C. and are free from coumarone and indene. The starting material is first freed from naphthalene by freezing and then from acid tar oils by extraction with alkali. The products of polymerization are isolated by distillation of the non-polymerized oils; they are useful for the manufacture of varnishes. (Br. Pat. 156,668; not yet accepted; CHEMISCHE FABRIKEN WORMS AKT. GES., Frankfurt-on-Main. March 16, 1921.)

Phenol-Aldehyde Condensation Products.—An initial liquid phenol-formaldehyde condensation product is prepared by the reaction of phenols (phenols, cresols, naphthols) with anhydrous polymers of formaldehyde (para-formaldehyde, trioxymethylene) in the presence or absence of alkaline catalysts; this liquid product is converted into the final insoluble infusible product by addition of liquid organic acids (lactic, acetic formic, ricinoleic, sulphoricinoleic, etc.) or solid organic acids such as oxalic, tartaric, citric, gallic or tannic acid, dissolved in a liquid organic acid together with small amounts of a mineral acid (hydrochloric, oxyacids of sulphur or phosphorus, boric, etc.); the conversion takes place in the cold, or more rapidly on heating. The initial liquid product with the acids added can be used as a varnish, or for glueing together laminæ of wood, wood and fabric, etc. Fillers, such as pumice, sand, glass, emery, asbestos, insoluble mineral bodies, paper pulp, sawdust, cotton, etc., may be incorporated in the mass, or its properties varied by addition of gelatine, glue, naphthalene, rubber, etc. Vessels resisting chemical reagents can be made from the final product, or laminæ or plates thereof can be glued on surfaces by means of the initial product varnish. (Br. Pat. 156,675; not yet accepted; J. BRUHAT, Bois-Colombes, France, assigned to Lorival Mfg. Co. of London. March 16, 1921.)

Vulcanizing Rubber.—Furfuramide and other nitrogen derivatives of furfuryl are used as accelerators in vulcanizing rubber. Several furfuryl derivatives are mentioned in addition to furfuramide, in particular the condensation products of pyromucic aldehyde with ammonia or amines. (Br. Pat. 157,050; not yet accepted; SOC. R. ALLENET & CIE., Deux Sevres, France. March 23, 1921.)

Coating Metals With Aluminum.—In a method of coating iron, steel, copper and other metals with aluminum, the cleaned surface is first coated with linseed or other oil, heated to burn off the oil, and again coated with oil; powdered aluminum, with or without the addition of oil or flux, which may be beryllium nitrate, or of sand or other hard material, is then applied to the surface, and the article is heated to about 1,200 deg. F. After cooling, the oxide which has formed is removed, and the operations are repeated until a coating of the desired thickness is obtained. The surface is finally treated with oil and heated to burn off the oil. A thicker coating of aluminum may be obtained by sweating sheet aluminum on to an aluminum-coated surface obtained as described above. (Br. Pat. 158,010; THOMPSON, LTD., J. THOMPSON and H. E. PARTRIDGE, all of Wolverhampton April 6, 1921.)

Current Events

in the Chemical and Metallurgical Industries

House Committee Approves Appropriations Requested by Hoover

Quite contrary to the usual practice, the Committee on Appropriations of the House of Representatives acceded to the request of the Secretary of Commerce and allowed the full \$250,000 requested for export industries. This fund is to be used principally in an effort to assist the twelve chief export industries, to wit: Cotton and cotton goods, paper and paper products, leather and leather products, chemicals (including dyestuffs), heavy machinery and machine tools, electrical goods, automobiles and accessories, lumber and lumber products, jewelry and silver, metal products, vegetable oils and hardware.

In addition, the committee approved the full amounts which Secretary Hoover asked for the Bureau of Standards as follows: Testing structural materials, \$50,000; industrial research, including elimination of waste, \$100,000; standardization of equipment, \$100,000.

These items are included in the second deficiency appropriation bill, which was reported to the House of Representatives on May 18.

Text of Dye Control Title

The complete text of the dye and chemical control title of the emergency tariff bill, as agreed to in conference, is as follows:

TITLE V—DYES AND CHEMICALS

Sec. 501. (a) That on and after the day following the enactment of this act, for the period of three months, no sodium nitrite, no dyes or dyestuffs, including crudes and intermediates, no product or products derived directly or indirectly from coal tar (including crudes, intermediates, finished or partly finished products, and mixtures and compounds of such coal-tar products), and no synthetic organic drugs or synthetic organic chemicals, shall be admitted to entry or delivered from customs custody in the United States or in any of its possessions unless the Secretary determines that such article or a satisfactory substitute therefor is not obtainable in the United States or in any of its possessions in sufficient quantities and on reasonable terms as to quality, price and delivery, and that such article in the quantity to be admitted is required for consumption by an actual consumer in the United States or in any of its possessions within six months after receipt of the merchandise.

(b) Upon the day following the enactment of this act the War Trade Board Section of the Department of State shall cease to exist; all clerks and employees of such War Trade Board Section shall be transferred to and become clerks and employees of the Treasury Department and all books, documents, and other records relating to such dye and chemical import control of such War Trade Board Section shall become books, documents and records of the Treasury Department. All individual licenses issued by such War Trade Board Section prior to the enactment of this act shall remain in effect during the period of their validity, and the importations under such licenses shall be permitted. All unexpended funds and appropriations for the use and maintenance of such War Trade Board Section shall become funds and appropriations available to be expended by the Secretary in the exercise of the power and authority conferred upon him by this section.

Sec. 502. That this title may be cited as the "Dye and Chemical Control Act, 1921."

Would Investigate Dust Explosions

A bill introduced in the Senate provides appropriation of \$100,000 to conduct further investigations of dust explosions in industrial plants.

Movement of Chemicals Through Canal

An analysis of the commodities which passed through the Panama Canal during March shows the following, of chemical interest, moving from the Atlantic to the Pacific: Nitrate of ammonia, 1,817 tons; silver sand, 2,492 tons; sulphur, 12,350 tons; caustic soda, 81 tons; chemicals, not otherwise specified, 520 tons. The nitrate of ammonia and silver sand originated in Continental Europe and was consigned to the west coast of the United States. The sulphur originated on the Gulf coast and was consigned to Australia. The caustic soda originated in the British Isles and was consigned to the west coast of South America. The bulk of the tonnage of chemicals not otherwise specified originated on the east coast of the United States and was consigned to the Far East.

Among the commodities moved from the Pacific to the Atlantic were the following: Nitrate of soda, 141,026 tons; camphor oil, 717 tons; chemicals (not otherwise specified) 113 tons; indigo, 2 tons; iodine, 7 tons; arsenic ore, 17 tons; manganese ore, 1,000 tons. The nitrate was destined as follows: east coast of United States, 52,215 tons; British Isles, 22,245 tons; other Europe, 39,465 tons; Azores Islands, 15,524 tons; West Indies, 11,577 tons. The camphor oil originated in the Far East and was billed to the east coast of the United States. The same is true of the chemicals which were not otherwise specified. The indigo originated on the west coast of South America and was sent to Cristobal for orders. The iodine was shipped from the west coast of South America and was destined to Continental Europe. The arsenic ore came from the Far East and was billed to the east coast of the United States. The same is true of the manganese ore.

Inventor of Gasoline From Peat Is Arrested. Charged With Fraud

On application made to Judge Lewis J. Smith at Mineola, L. I., by William H. Doolittle of Woodmere, Louis Enricht, of Farmingdale, was arrested on May 24 and released on \$1,000 bail, which he furnished with a certified check. The plaintiff before bringing the action filed a bond with a surety company as evidence of good faith. This action followed a summons and complaint made out by Doolittle, who said that he paid Enricht \$1,000 for 100 shares of capital stock in the Enricht Peat Gasoline Corporation.

Through his counsel, Dudley A. Wilson, Doolittle avers that on Nov. 18, 1920, at Farmingdale Enricht represented to him that he had organized a corporation known as the Enricht Peat Gasoline Corporation, of which Enricht was president, and that "he then and thereupon falsely and fraudulently represented that he was the inventor of a process and apparatus capable of producing gasoline for ordinary commercial usage from peat such as is found in and around the village of Farmingdale and various other parts of Long Island."

Enricht came into prominence several years ago when he announced that he could produce gasoline for 2c. a gal. by the introduction of a green ingredient. He had leading manufacturers of cars calling at his place, including Henry Ford, but nothing came of the green gas proposition.

St. Louis Chemical Plant Damaged by Fire

A fire which caused damage estimated at about \$50,000 started from an explosion in the first-floor laboratory of the Missouri Chemical Works, Inc., 1501 South Second St., St. Louis, on May 18. The plant, which employs about forty men, has been idle for several weeks and only two men were in the building when the fire started.

Program of National Lime Association Convention

The annual convention of the National Lime Association will be held at the Hotel Commodore, New York, June 15, 16 and 17. The foyer of the convention room will be occupied by exhibits of the National Association and of the Eastern Bureau. Details of the technical program follow:

WEDNESDAY, JUNE 15

Lime Production Problems

10 a.m. Assembly and roll call of member companies. Representatives are invited to make comments on the status and outlook of the lime industry in their home sections.

10:30 a.m. Introductory remarks, President Charles Warner.

10:40 a.m. Some New Features in Limekiln Construction. Richard K. Meade, chemical and industrial engineer, Baltimore, Md.

11:15 a.m. Chemical Control the Key to Kiln Efficiency. W. D. Mount, mechanical and chemical engineer, Lynchburg, Va.

12 m. The Fine Art of Lime-Burning. George B. Wood, president and general manager, Rockland & Rockport Lime Corporation, Rockland, Me.

12:45 p.m. Complimentary buffet luncheon.

1:30 p.m. Luncheon address. Standardization—Government Research and Industrial Development. Dr. S. W. Stratton, director, U. S. Bureau of Standards.

2:15 p.m. Quarry Management With Special Reference to Machine Versus Hand Methods. Irving Warner, plant manager, Charles Warner Co., Wilmington, Del.

6:30 p.m. Banquet.

THURSDAY, JUNE 16

Extending the Use of Lime

9 a.m. Symposium on the Special Properties and Merits of Lump Lime. Speakers to be announced.

12:45 p.m. Complimentary luncheon.

1:30 p.m. Luncheon address. The Business Outlook. Francis H. Sisson, vice-president, Guaranty Trust Co., New York City.

2:30 p.m. Delivering the Goods: The Dealer's Viewpoint. Tom Wright, manager, Building Materials Corp., formerly secretary of New York Station Building, Supply Dealers Association, Rochester, N. Y.

3 p.m. The Dependence of Modern Industry on Research. Arthur D. Little, president, Arthur D. Little & Co., consulting industrial chemist, Cambridge, Mass.

3:45 p.m. Why Is a Soil Chemist? or, Getting Facts About Lime on the Soil. Dr. W. H. MacIntire, soil chemist, Agricultural Experiment Station, Knoxville, Tenn.

4:15 p.m. Lime and Lime: The Plasticimeter Demonstrated. Warren E. Emley, U. S. Bureau of Standards, Washington, D. C.

FRIDAY, JUNE 17

Technical Department Accomplishments and Plans

10 a.m. Construction, L. H. Hart, manager.

10:20 a.m. Chemistry, Dr. M. E. Holmes, manager.

10:40 a.m. Agriculture, J. A. Slipper, assistant manager.

11 a.m. District Bureau Work.

Annual Table of Constants Delayed by Printers' Strike

Owing to delays incident to the printers' strike it has been found necessary to advance the date at which subscriptions at the special reduced rates will be received for the forthcoming Vol. IV of the Annual Tables of Constants and Numerical Data of Physics, Chemistry and Technology. Details concerning this volume, subscription rates, etc., were published on page 853 of our issue of May 11.

Members of the American Physical Society and of the four constituent societies of the Division of Chemistry and Chemical Technology of the National Research Council are entitled to a special discount. Subscription blanks may be obtained by addressing the University of Chicago Press, Chicago, Ill.

Dr. Stieglitz Talks on Electron Theory of Oxidation and Reduction

In delivering one of the best talks that has been made before the Chicago Section of the American Chemical Society Dr. Julius Stieglitz gave an extremely interesting exposition on the electron theory of oxidation and reduction, accompanying his talk with numerous lecture table experiments, at Kent Chemical Laboratory, University of Chicago, on the evening of May 20. His remarks are abstracted in the following paragraphs.

Recent developments as to the structure of atoms have brought more light on the subject in question. In reviewing a series of facts that are perhaps familiar to a great many of the members, we may nevertheless enjoy it again as one would delight in viewing an impressive and familiar landscape. We may deal with the electron as an intra-atomic phenomenon rather than an inter-atomic. Long before the present theories were developed the relation of the electron to oxidation and reduction was almost as thoroughly understood as it is now. By numerous experiments we may illustrate chemical action at a distance. These modern discoveries in regard to the electron have simplified the theory of chemical reaction.

In 1897 J. J. Thomson, the noted British scientist, made a fundamental study of oxidation in its relation to the X-ray tube, finding that the atoms of all elements are made up of electrons and that those which are negative in character have a mass $\frac{1}{1800}$, that of a hydrogen atom. Rutherford later discovered that the positive particles have larger mass than the negative. Electrons on the periphery of the structure are the ones which we are concerned with in oxidation and reduction. Experiments of chemical action at a distance demonstrate that the particles or electrons actually pass through the wire, as evidenced by the electric current. It is readily predicted that in the future many electrical methods will replace others in the accomplishment of oxidation and reduction. Current cannot be passed through a solution without having oxidation and reduction of the solution.

In a quantitative discussion of the subject consider the copper:zinc couple. The tendency of copper to give up its ions may be expressed by 10^{-21} , while a much larger tendency on the part of zinc may be expressed by 10^{-17} .

Such tendency on the part of substances to give up ions may be compared with vapor pressure as measured by the wet and dry hydrometer. The difference in temperature in the latter case is the same as the difference in potential in the former. Experiments show that the tendency of copper to give up its ions is not dependent on the concentration of copper in solution but on the concentration of the cupric ion. Activity, then, for oxidation and reduction depends on the concentration of free ions.

To sum up, we find that oxidation consists in the loss of electrons by atoms and that reduction consists in the gain of electrons by atoms. Not only does such action produce current in the wire, but oxidation and reduction may be accomplished by passing ions through the wire to the solution to be treated.

Summer Meeting of New Jersey Clay Workers

The New Jersey Clay Workers Association and Eastern Section of the American Ceramic Society will hold its regular mid-year meeting at Trenton, N. J., with morning and afternoon sessions. It is expected to call the meeting at the Trenton Country Club, as in former years. Prof. George H. Brown, Rutgers College, secretary and treasurer of the organization, is arranging an interesting and instructive program for the day, covering a number of papers on pertinent subjects in the ceramic industry. A large attendance is expected.

Union Bag Plants Closed Down

Plants of the Union Bag & Paper Corporation have been closed down due to walkout of employees, involving about 2,000 men. The newsprint plant of St. Maurice Paper Co., its subsidiary at Three Rivers, Quebec, Canada, employing 600 men, has also been closed. Wage agreements expired May 11.

Mme. Curie's Visit an Inspiration

Public interest in science has been increased immeasurably by the visit of Mme. Curie. This is the opinion of Dr. R. B. Moore, chief chemist of the Bureau of Mines. It has been a special encouragement to research on the part of women. "The American woman," said Dr. Moore, "has been content heretofore to devote most of her study to literature, art and music. As a result of Mme. Curie's visit thousands of women will be encouraged to take up the serious study of science. The country will derive great benefit from directing the feminine mind into channels of research—a mind peculiarly adapted to that kind of endeavor. Mme. Curie's visit has accomplished more in that direction than would a thousand lectures by men of science."

Mrs. Vernon Kellogg, who was in charge of Mme. Curie's activities in Washington, believes that Mme. Curie's visit has brought home to American women the fact that there is a wider field in which they may serve humanity and add to the achievements of civilization. Heretofore, Mrs. Kellogg asserted, research work has been regarded as man's sphere. The visit of Mme. Curie, she believes, will stimulate the desire among women to do scientific work.

The program in Washington was carried through without change. The gathering at the White House when the President presented Mme. Curie with the gram of radium was a notable one. The same may be said for the reception held at the Smithsonian Institution. The assemblage at the Interior Department building, when Mme. Curie dedicated the new cryogenic laboratory of the Bureau of Mines, was limited practically to scientists. On this latter occasion Mme. Curie was presented with a representative specimen of the carnotite ore from which her gram of radium was extracted. She also was given a jar of ore taken from the first shipment of the Colorado ore made in 1898.

National Fertilizer Association to Meet at White Sulphur Springs

The twenty-eighth annual convention of the National Fertilizer Association, which will be held at the Greenbrier Hotel, White Sulphur Springs, W. Va., the week beginning June 20, will have a program of reconstruction and co-operation.

The importance of the coming convention cannot be over-emphasized. The industry has many problems confronting it, which for proper solution must be given serious and immediate consideration.

The program will include addresses and discussions that are of vital interest to the fertilizer manufacturer in view of present business conditions. These subjects will include: more accurate knowledge of costs; chemical and manufacturing problems; better and cheaper methods of sale and distribution; relations of the industry with county, state and federal educators; transportation and freight problems, etc.

The officers of the association are now arranging the details, and promise a meeting that will be of unusual interest and lasting benefit to everyone identified with the fertilizer industry.

The important meetings will be as follows:

Monday, June 20—Soil Improvement Committee (N.F.A.) Subscribers.

Tuesday, June 21—Southern Fertilizer Association.

Wednesday, June 22—National Fertilizer Association—First Session.

Thursday, June 23—National Fertilizer Association—Second Session.

Etching Reagents for Nickel and Nickel Alloys

An interesting development in connection with the etching of nickel and its alloys is the use of concentrated hydrochloric acid. This appears to be the best reagent for producing contrast without pitting of the surface that has yet been tried. It is rather hard to etch nickel and ordinarily the metal pits considerably and a plain etched pattern—that is, one in which there is no contrast between different grains—is the usual result. Etching in concentrated hydrochloric acid for a considerable period, say one hour or more, gives very satisfactory results.

Chicago Chemists Club Hikes Over Dunes

Hiking over the dune district of Indiana at the southern point of Lake Michigan has been a popular pastime with several Chicago scientific men for many years. Never before, however, has such a large party of chemists enjoyed the pleasures of the dune trails as did the official hikers of the Chicago Chemists Club on Sunday, May 15. Arranged by P. N. Leech and guided by the dune authority, Dr. A. J. Cramp, seconded by Mrs. Cramp, about seventy members trailed from Tamarack to Tremont, stopping at one of the large sand blowouts for lunch. The ladies took the short trail, the men the long trail.

From barren wastes to tropical vegetation, from cactus to tamarack, from orchids to pine trees and the cold wind of the lake to the oppressive heat of the swamps the party explored the wonders of the remarkable region. Like the marvels of the Grand Canyon of Arizona, the dunes of Indiana must be visited to be appreciated. The chemists of Chicago were thoroughly initiated to the aggregation of dune boosters. An impromptu baseball game while waiting for the train at Tremont closed a perfect day.

Goodyear Tire & Rubber Co. Reorganization

Edward G. Wilmer, formerly vice-president of the Steel & Tube Co. of America, is the new president of the Goodyear Tire & Rubber Co. His election to that office was announced following a meeting at which the reorganization of the company was completed. He succeeds F. A. Seiberling, whose resignation was part of the program of the new interests identified with the company.

The new board of directors was announced as follows: J. P. Cotton, of McAdoo, Cotton & Franklin; P. W. Litchfield, of Akron; Grayson M. P. Murphy, of New York City; J. R. Nutt, president of the Union Trust Co. of Cleveland; Robert C. Schaffner, of A. G. Becker & Co., Chicago; A. A. Schlesinger, president of the Steel & Tube Co. of America; G. M. Stadelman, of Akron; Ralph Van Vechten, vice-president of the Continental & Commercial Trust & Savings Bank, Chicago, and Mr. Wilmer.

Messrs. Stadelman and Litchfield are to continue with the company as vice-presidents. H. H. Sprinford is treasurer and Charles A. Stillman secretary.

Mr. Wilmer, who is a comparatively young man, will, it was stated, move from Milwaukee to Akron and devote all his time to the affairs of the company. Before becoming associated with the Steel & Tube Co. he was active in the mining industry, being identified with iron ore and coal mining projects.

General Asphalt Co. Annual Meeting

At the annual meeting of the General Asphalt Co., held in Camden, N. J., three directors whose terms expired, Henry W. Biddle, Charles E. Ingersoll and Sidney F. Tyler, were re-elected for terms of three years.

President Arthur W. Sewall told the stockholders that the manufacturing part of the company's business in January and February was only about 20 per cent as large as in the corresponding months of 1920 and in March and April about 33 per cent. So far in May, however, there are indications of some further recovery.

Since the fire at the Maurer, N. J., plant the manufacture of products such as roofings, floorings, etc., has been carried on at the Madison, Ill., plants. Operations at Maurer have been confined to oil refining and the preparation of asphalt. Officials expect to resume manufacturing at Maurer in June.

May Continue Dye Licensing

The statement was made on the floor of the Senate May 23 that the Committee on Ways and Means of the House will recommend that the licensing and embargo provisions contained in the emergency tariff bill be continued for a period of five years. Senator King, in a speech on the floor of the Senate, characterized such legislation as un-American and indefensible on any economic grounds. He declared that it would perpetuate a dye monopoly in the United States.

Corn Products Refining Co. Operating at Slightly Over 50 Per Cent

The Corn Products Refining Co. is now operating something over 50 per cent of capacity, grinding 75,000 to 80,000 bushels of corn a day. Its capacity is about 155,000 bushels a day. As in other lines of business, the company's volume has decreased because of the hand-to-mouth buying policy of the consumer, according to E. T. Bedford, chairman of the board. On the other hand, Mr. Bedford points out that the corn products manufactured by the company are staple food commodities, whose consumption is not subject to wide fluctuations. He expects some increase in business as the year progresses. Inventories are known to be low, and there are no large accumulated stocks which must be worked off.

The company's English plant finds it impossible to get coal, because of the coal strike. The two small German plants are running full and doing a good business. The French plants are now in course of construction. They should be running full by the late summer. Their capacity is 10,000 bushels of corn a day. Demand which these plants will later fill is being cared for by shipments from United States. The extent of foreign business will be governed entirely by the course of the foreign exchanges, any improvement being reflected in better export business.

An idea of the enormous volume of business transacted by the company may be gained from the fact that it sold 400,000,000 separate packages of products last year. The company is an enormous user of tinplate for containers.

Electrochemists to Meet at Lake Placid

The directors of the American Electrochemical Society have decided to hold the fall meeting at Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1. Arrangements have been made to keep Lakeside Club house open for this occasion. Special effort is being made to provide an interesting technical program, including special symposia on non-ferrous electrometallurgy and on electrodeposition, the latter including electroplating, electrotyping and electrolytic refining. The organization of a division on electrodeposition is in prospect.

Members of the society are urged to consider the feasibility of combining a vacation outing with the convention, spending some time at Lake Placid either before or after the dates of the meeting. Full details as to transportation, accommodations, rates, etc., will be mailed to members of the society and published later in this magazine.

Coloring Gem Stones With Radium Emanation

Experiments which hold the promise of giving color to colorless gem stones through exposure to radium emanation are being carried on at the Rare and Precious Metals Station of the United States Bureau of Mines at Reno, Nev. In preliminary experiments, a colorless Colorado topaz was tinted yellow by exposure to penetrating radiation. The coloring, however, was found not to be permanent when exposed to light. Experimental work with a view to making the color light permanent is being continued.

If these later experiments should prove successful and it is found that radium possesses the power to color gem stones, the discovery would increase the commercial value of gem stone material found largely in the West, the market value of which has been lessened on account of the lack of tint deemed essential by gem fanciers.

Phosphate Export Association

The Phosphate Export Association, comprising four member concerns in New York City (International Agricultural Corporation, Coronet Phosphate Co., the Phosphate Mining Co. and Southern Phosphate Corporation) have combined, for the purpose of export trade, with the Florida Hard Rock Phosphate Export Association, comprising five member concerns in Florida and Georgia (J. Buttgenbach & Co. of Dunnellon, Fla.; C. & J. Camp of Ocala, Fla.; Gummer Lumber Co., of Jacksonville, Fla.; Dunnellon Phosphate Co., of Savannah, Ga.; and Mutual Mining Co., of Savannah). Papers have been filed with the Federal Trade Commission under the export trade act (Webb-Pomerene law). The

main office of the combination will be located in New York City, with branches in Savannah, Ga., and London, England.

Phosphate rock is used principally as a fertilizer, either directly, with no further treatment than grinding, or changed to acid phosphate by chemical treatment.

A market for Florida land pebble phosphate and Florida hard rock phosphate has already been established in the United Kingdom, Continental Europe and Japan.

Phosphate exports from the United States in 1920 amounted to 344,896 tons of hard rock, shipped from the ports of Fernandina and Jacksonville, Fla., and 693,355 tons of land pebble, shipped from Tampa, Port Tampa and Boca Grande, Fla.

New Tanning Material

Experiments conducted in recent months at the Laboratoire General des Productions Coloniales, Paris, France, show the value as a tanning material of a plant known as *Acacia arabica*. Investigations indicate that it can be used for tanning either alone or with sumac, quebracho and oak bark. It is said that there is a possibility of the material later replacing Sicilian sumac.

Personal

Dr. CARL L. ALSBERG, chief of the Bureau of Chemistry, Washington, D. C., was elected an honorary member of the American Oil Chemists' Society in session in Chicago May 17.

HAL T. BEANS and THOMAS B. FREAS, who were associate professors of chemistry at Columbia University, and MARIE REIMER, associate professor at Barnard College, have been given the rank of full professors. SAMUEL J. KIEHL, instructor in chemistry, and E. G. MILLER, Jr., associate in biological chemistry, have been made assistant professors. This announcement by the trustees of Columbia University follows closely upon the statement that the chemistry building is to be one of the two buildings erected on the Morning-side campus in the immediate future. It serves also to emphasize the statement recently made by Dr. Nicholas Murray Butler, president of the university, that "the central science just now and the one that is likely to remain the central science for some time to come, is that many-sided body of knowledge called chemistry."

H. M. COOPER has been placed in charge of all analytical coal work of the Bureau of Mines, Pittsburgh, Pa.

R. ADAMS DUTCHER, a graduate of South Dakota State College, has resigned his position in the agricultural biochemistry department of the University of Minnesota to accept the position of chief of the agricultural chemistry department of the Pennsylvania College of Agriculture.

Prof. TREAT B. JOHNSTON of Yale University delivered a special lecture on biochemistry before the Philadelphia Section of the American Chemical Society in Philadelphia on the morning of May 19.

N. D. LAMBERT, formerly assistant superintendent in the New York Mutual Gas Light Co., has joined the Lambert Meter Co. as its chief engineer, secretary and treasurer.

EDWIN E. SLOSSON of the National Research Council was in Chicago recently and delivered a lecture at the University of Chicago.

BRADLEY STOUGHTON, secretary of the American Institute of Mining and Metallurgical Engineers since 1913, has tendered his resignation to be accepted at the convenience of the board of directors.

At the May meeting of the Chicago Chapter of the American Society for Steel Treating, held Monday, May 16, 1921, the following officers were elected for the ensuing year: Chairman, H. F. Wood, metallurgist, Ingalls Shepard Division, Wyman Gordon Co., Harvey, Ill.; vice-chairman, P. A. Lovegren, Standard Forgings Co., Indiana Harbor, Ind.; secretary-treasurer, Harry Blumberg, metallographist, Illinois Steel Co., Chicago, Ill.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, May 28, 1921.

New indications of improvement have been noted in the chemical market during the past week. Conditions, however, still remain quite unsettled, but it is apparent that the pendulum is once more swinging in the right direction and it looks as though a slow but steady improvement in the volume of business may be expected.

There were domestic inquiries for numerous quantities of solid *caustic soda* and these had a strengthening influence on prices in the late trading. Since caustic is considered the actual guide for all of the more important chemicals, it is certain that the rest of the list will follow along the same steady lines. Caustic soda has advanced from \$3.60 per 100 lb. to \$3.85. It is very doubtful if the inquiry could be filled at any lower figure. The textile, soap, oil and other large consuming industries came into the market in better buying spirit than at any other time since last November. Soapmakers around New York purchased tremendous quantities of tallow and oil. Along with caustic soda there has been a heavy demand for *soda ash*, with a decidedly strong market for spot material. Small lot inquiries for *bichromate of soda* kept prices steady at 8@8½c. per lb. *Nitrite of soda* was pushed to 8c. per lb. under better selling early in the week, but lost a little of its firmness and closed at 7½c. *Citric acid* recovered somewhat from its recent slump and displayed a slight spurt that may last during the hot weather. Resale *caustic potash* developed a little firmer tendency and reports were current that soapmakers had purchased several large quantities around the extremely low figures. *Bleaching powder* has moved quite freely to paper mills and bleacheries. The general price has been 2½c. per lb. f.o.b. works, although it is rumored that this figure has been shaded where round lot business was at hand. There was some buying noted on *oxalic acid* for laundry supply houses and textile mills have kept domestic material in a somewhat steady position. The imported variety was held at 16½c. per lb. and upward according to seller and quantity. *Copper sulphate* has shown improved buying from textile mills and agricultural interests, and business, although not up to the standards of the previous year, is gradually coming into proportion to a seasonable average. The general tone was quite steady.

EXPORT CONDITIONS

The export trade is coming along rather slowly. There are some makers who say they are getting better inquiries from South America and that the Orient is just trying the market out with small miscellaneous inquiries, but as far as actual placing of large business is concerned there is not very much to state and the outlook is very uncertain until ways and means are found to extend foreign credits. Most foreign buyers are demanding three to six months' time for payment and this is the fundamental drawback that is keeping American interests away from active competition for the export trade. Soda ash is still attracting most attention for import. June shipments of English ash are offered at \$1.90 N. Y. Oxalic acid is not far below domestic prices when the 1½c. per lb. duty is allowed. The inside German price is said to be 14c. per lb. at German producing points.

It may be stated generally that the tendency of trade is toward expansion. Manufacturers, dealers and jobbers have reduced their surplus stocks in most quarters and there is not as much pressure on prices now as was noted formerly from accumulations. The same condition is practically true in the consuming trade and these two factors combined seem to forecast an early revival of sound business. The placing of large foreign loans and the eventual establishment of foreign credits appear to be reasonably near. A revival in our export trade would add considerably to our domestic business.

Dealers offered spot *carbonate of potash*, 80-85 per cent, calcined, at 6c. per lb. and stated that sales are going through at this figure in a small way. The movement at present is rather quiet and it is possible that a slight concession might be made on a firm order. Resale spot *bichromate of soda*, standard make, is holding firm at the late advance and dealers report a fair inquiry for moderate quantities. Prices range from 8@8½c. per lb., according to quantity and seller. Limited resale offerings of solid *caustic soda* are keeping the spot market in a firm position and the best price heard at the closing was \$3.85 per 100 lb. Dealers quoted the market at \$3.85@\$3.90 per 100 lb., ex-store, and at 4c. per lb., f.a.s. steamer N. Y. The inquiry was rather active, although buyers are showing some hesitation in committing themselves owing to the advanced prices named. First hands quote the market for *chlorate of soda* firm at former prices and report a fair inquiry from the domestic consuming trade. Standard American goods are obtainable at 7½c. per lb. f.o.b. works, for prompt shipment. There were a number of sales of *nitrite of soda* on spot reported at 7½c. per lb. The feeling in this commodity continues firm, with sellers asking up to 8c. per lb. Several interests continue to predict higher prices and are not recognizing the present level with their offerings. Several sellers of imported *prussiate of soda* have advanced the market to 13c. per lb. ex-store N. Y. Other dealers state that 12½@12¾c. can still be done, although they admit that the holdings are becoming smaller and there is a tendency to tighten up offerings in most directions. Light *soda ash* for resale in single bags is held at \$2.15 per 100 lb. Less than carload lots in barrels are moving at \$2.50@\$2.60 per 100 lb. and it is said to be doubtful if much below the inside price could be done on carload lots on account of the limited extent of resale stocks. Small sales of lump *potash alum* are reported at 4c. per lb. Producers named the same price for *ammonia alum* with the usual advance for ground and powdered. The general movement is quiet with small lot sales attracting the most attention. Odd lots of resale *formaldehyde* were offered at 14c. per lb. f.o.b. works. The spot market for prime material appears quite steady at 14½@15c. per lb.

The market on *ethyl alcohol* is reported as easy, while the movement into consuming channels is of a light routine nature with prices quoted at \$4.75@\$4.95 per gal. Competition in *denatured alcohol* is still keen owing to easy supplies and light demand, and prices range from 31@42c. per gallon, depending on formula. Trading in *methanol* holds to light routine lines, with the 95 per cent quoted at 75@77c. per gal. and the 97 per cent at 78@82c. per gal. The market on *shellac* is holding firm and with the prospects of very little in the way of shipments expected the tendency of prices will be upward for a while. The T.N. is in good demand for bleaching purposes and limited supplies are keeping prices on the jump, with the market quoted at 70@72c. per lb.

COAL-TAR PRODUCTS

The tone of the coal-tar products market became more steady with the encouraging news that the emergency tariff bill, having to do with the dye measure to extend protection for three months against dumping, has been passed by both houses and is awaiting the signature of the President. There is a pronounced feeling of security among the leading producers and increased activity was noted throughout the list, whereas a few weeks ago curtailment was the rule. The crude market is steady and some products are becoming more active. *Benzene* is in good demand and supplies are none too plentiful, while prices remain firm at 27@30c. per gal. for the pure grade and 25@28c. for the 90 per cent. *Naphthalene* is easy, with the flakes quoted at 7½@8c. per lb. and the balls at 8½@9½c. *Phenol* is rather quiet, with supplies ranging from 10@14c. per lb.

The demand for intermediates is confined to limited quantities, but this demand seems to be slowly broadening out, reaching among some of the more inactive producers. *Aniline oil* is quiet and prices range from 20@25c. per lb., depending on seller and quantity. Sellers of *beta naphthol* are steady in their views and prices range from 34@45c.

per lb. There is little activity in *dimethylaniline* and prices are quoted at 41@50c. per lb. Consumers of *diphenylamine* show some interest here and there and prices range from 60@70c. per lb. *Paranitraniline* is reported steady at 85c.@\$1 per lb. Producers report a limited amount of routine business passing in *alpha-naphthalamine*, but little in the way of new demand is noted. Supplies are quoted on the basis of 35@40c. per lb., depending on quantity. The consuming demand for *benzidine* is quiet and moving in small lots. Supplies are reported in fair volume and while sellers' views are around \$1@1.05 per lb., shading is being done on firm business. The sulphate is quoted at 75@85c. per lb. The market for *cresol* reflects a more active demand and sellers are steady in their ideas on prices at 16@18c. per lb. The market is reported easy on supplies of *cresylic acid*, although of late a slightly better demand has been noted. Prices have shown practically no change from former levels with the 97-99 per cent quoted at 70@80c. per gal. and the 95-97 per cent at 65@70c. per gal. Producers are firmer in their views on *salicylic acid* and quote 26c. per lb. for the U.S.P. grade. The technical is steady at 22@24c. per lb. The production of *ortho-amidophenol* is confined to only a few factors. The demand is of a light routine nature, although a slight increase in the inquiry is noted. Prices are quoted at \$3@\$3.10 per lb., but a firm order will no doubt bring out lower prices.

WAXES

The market for *beeswax* was practically unchanged, with trading reported as routine only. Crude African held at 16@17c. per lb., with the Brazilian at 24@26c. per lb. Importations of beeswax for the nine months ended with March were officially placed at 1,826,864 lb., which compares with 2,247,286 lb. for the corresponding period one year ago. Traders of *carnauba wax* report a moderate buying interest in futures, but spot inquiries remained quite light. Prices were unsettled, especially on the higher grades. No. 2 North Country closed at 28@30c. per lb., with the No. 3 North Country at 16@17c. per lb. There were sellers of *Japan wax* on the spot market at prices ranging from 18@18½c. per lb., depending on quantity and seller. The market was barely steady in some quarters, while others stated that inquiries were being received in moderate volume. At any rate, trading was quiet and with futures available at concessions the situation seemed to favor buyers. The export inquiry on *paraffine wax* was quiet and with trading in a domestic way also inactive prices were irregular with some traders showing a willingness to shade prices. Exports of paraffine in March amounted to 14,173,706 lb., which compares with 45,753,998 lb. for March, 1920. Exports for the nine months ended with March amounted to 213,617,355 lb., contrasted with 256,905,209 lb. for the corresponding period one year ago. Scale wax, 122-124 deg. melting point, closed nominally at 2½@2¾c. per lb. Refined wax, 128-130 deg. melting point, settled around 5c. per lb.

The St. Louis Market

ST. LOUIS, May 27, 1921.

Business during the past two weeks has assumed a brighter aspect. While individual orders remain small, the demand for chemicals has improved and is one of wider scope. The general tone of the market is optimistic. Business in all groups has been considerably better than in the immediate past and sellers are encouraged over the outlook for the future.

ALKALIS

The market on *caustic soda* is dull with inquiry much below routine, but a little activity in price. *Soda ash* continues to enjoy routine demand, with business confined principally to jobbing lots at \$3 per 100 lb. in barrels, basis 58 per cent. Heavy stocks of *bicarbonate of soda* are being liquidated on basis of the new manufacturing schedule plus freight.

INDUSTRIAL CHEMICALS

Sulphur continued to remain very firm at 2½c. per lb., with usual good demand. There has been no change in *ammonia*

water, 26 deg., and sales during the past two weeks have shown a slight increase. *Sodium hyposulphite* is moving in the routine way. A heavy demand for *zinc stearate* has been evidenced in the past several weeks and with the approach of summer a large volume of business should be expected, hence suppliers should endeavor to keep maximum stocks. The *zinc* market is stiffening and *sulphate* is being quoted 3¼@3½c. lb. f.o.b. producers' works.

DRUGS AND PHARMACEUTICALS

Bismuth preparations continue to be very active. *Cream of tartar* is in fair demand. Very good business has been passing on *iodides*, with a firm market. The demand for *sodium benzoate* is increasing, and prospects for the future are encouraging in view of the preserving and canning season. There has been a decline of 2c. per lb. on *sodium bromide* and 5c. per lb. on *potassium bromide*, which probably has been forced by the low offerings of the foreign producers. *Hard mercurials* have declined recently. The prices of *zinc oxides* remain the same, but the demand for the 5 and 10 per cent leaded by the paint trade has increased sales on these particular grades, while the lead free continues to command a good demand. *Glycerine* was unable to hold its recent advance to 17c. and has dropped back to its low level of 16½c.

ACIDS

Citric acid has not shown the improvement which was expected; in fact, the demand has been very quiet, with no change in price; however, there are distressed lots being offered at considerably below the ruling market figure. *Tartaric acid* has been commanding good demand, with a firm market.

COAL-TAR PRODUCTS

The supply of *benzene* is rather limited, due to a curtailment in production, and the demand is fairly good.

VEGETABLE OILS

Linseed oil has continued its steady advance in the past two weeks and today holds firm at 77c., basis raw, from warehouse in cooperage. The usual differential for direct shipments in carlots prevails and some crushers are booking at the above price to Aug. 1. After a rise to 83c. maximum, *turpentine* slowly declined and today is holding at 69c. with fair demand. *Castor oil* has advanced and today holds at 10½c. in drums or 11c. in barrels.

The Iron and Steel Market

PITTSBURGH, May 27, 1921.

Production of steel has shown a distinct declining tendency in the past week. At no time this year has there been any material increase in the rate. While the present decline is not rapid, it is impressive for two reasons, because it is from an already low rate, say 30 per cent of capacity, and because it is shared alike by the Steel Corporation and the independents. During the first three months of the year the Steel Corporation's rate, which had been above 90 per cent, declined almost continuously and rather sharply, but the independents were operating at a shade better rate at the beginning of April than at the beginning of January. Now the corporation is operating at about 35 per cent or a trifle more and the independents at between 20 and 25 per cent.

All producers are filling orders and specifications, as received, as promptly as possible, and some remarkable records are made. There is scarcely any tonnage at all that is scheduled ahead, and often, indeed usually, when a mill or department starts a week at a certain percentage rate it is not known at what rate it will be working on Friday or Saturday. Thus the producers have no reserve and production promptly follows the rate at which orders and specifications are received.

Buyers are in a corresponding position. They do not order material ahead, but hold back their commitments until the last moment, usually making up an order or specification for a single carload, containing a wide variety of sections or descriptions of material. The matter that is often prom-

inent in a market not overly strong, price guarantee to date of shipment, does not arise, for there is scarcely any interval between the placing of the order and the actual shipment.

PRICES HOLD

The equalized prices developed about the middle of April are holding very well, sales at concessions being very rare in point of numbers, but that condition may be attributed to the character of the business being done rather than to the steel market having any inherent strength. Orders are so small that it is hardly worth while to seek a cut price, and there is usually not sufficient time. Again, the producer has no incentive to cut prices, since there is not enough business offered to give any promise that operations could be swelled by the price-cutting route. In occasional instances an order of exceptional size may go at a concession, but it should be remembered that in the past such concessions have been given in a market that was distinctly strong.

There is no expectation whatever on the part of either sellers or buyers that the present steel prices will hold through another buying movement, one of anything like ordinary proportions. It is generally accepted that the present market prices are simply for present conditions and that when any latent buying disposition develops the sellers will meet the buyers half way or more than half way. With a larger operation production costs would be materially reduced. They are very high now, even without inclusion of overhead.

WAGES

A large steel interest east of Pittsburgh has reduced its rate for common labor to 30c. an hour, while no overtime for hours in excess of eight in the day is allowed. Other mills have shown no disposition to adopt a 30c. rate, though it is a common opinion that by the time the present general readjustment in industrial and economic conditions is completed the common labor rate is likely to be about 30c. The steel industry considers the cost of living very high and expects a further and substantial decline. A few mills have eliminated overtime payments, but the more common practice at mills and furnaces in the north is to pay 33c. or 37c. for common labor, with time and a half for the hours in excess of eight. In 1913 the prevailing rate was 19c., without overtime, while in 1898 the common rate was 13c.

PROSPECTS

The demand for steel having shown no tendency to revive, it is considered probable that as July, always a dull month, is approached the demand will grow lighter still, an operation averaging less than 25 per cent of capacity for the steel industry as a whole being in prospect. From such a low rate of operation a rebound seems unavoidable, and improvement is very commonly predicted for August, though from the present outlook anything like full operation is not expected before next spring. The steel industry's capacity being very large, practically unanimous consent of all fundamental conditions is requisite to full employment. All lines of steel consumption must be active, and to be active they must have sound economic conditions. In other words, the cost of consuming steel must be greatly reduced, both the labor cost of the consuming or fabricating operations and the cost of the materials other than steel that are used in conjunction with steel.

PIG IRON

Quotations remain at \$24 for bessemer, \$22 for basic and \$23.50 for foundry, f.o.b. valley furnaces, freight to Pittsburgh being \$1.96. Sales have been few and in very small lots. On competitive business for a few hundred tons the foundry iron quotation would probably be shaded.

COKE

Connellsville coke remains quotable at \$3.25@\$3.50 for furnace and at \$5@\$5.50 for foundry per net ton at ovens. Some particularly good grades for furnace coke have brought \$3.75, for purposes other than iron making, and it is reported that coke for making low-phosphorus iron has sold at \$3.75, on a contract for several months.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carats	Less Carats
Acetic anhydride.....lb.	—	\$0.40 - \$0.45
Acetone.....lb.	\$0.12 - \$0.12 1/2	1 - 1 1/2
Acid, acetic, 28 per cent.....100 lbs.	2.50 - 2.75	3.00 - 3.25
Acetic, 56 per cent.....100 lbs.	4.00 - 4.25	4.50 - 5.50
Acetic, glacial, 99 1/2 per cent, carboys.....100 lbs.	9.75 - 10.00	10.25 - 10.50
Boric, crystals.....lb.	.13 - .14	.14 - .15
Boric, powder.....lb.	.15 - .15 1/2	.16 - .16 1/2
Citric.....lb.	—	.45 - .46
Hydrochloric.....100 lb.	1.50 - 1.65	1.75 - 2.00
Hydrofluoric, 52 per cent.....lb.	.12 - .12 1/2	.12 - .13
Lactic, 44 per cent tech.....lb.	.10 - .11	.11 - .12
Lactic, 22 per cent tech.....lb.	.04 - .05 1/2	.06 - .07
Molybdic, C.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.	—	—
Nitric, 40 deg.....lb.	.06 - .06 1/2	.07 - .07 1/2
Nitric, 42 deg.....lb.	.07 - .07 1/2	.07 - .08 1/2
Oxalic, crystals.....lb.	.16 - .16 1/2	.17 - .18
Phosphoric, Ortho, 50 per cent solution lb.	.17 - .17 1/2	.18 - .19
Picric.....lb.	.20 - .25	.27 - .35
Pyrogallol, resublimed.....lb.	—	1.90 - 2.15
Sulphuric, 60 deg., tank cars.....ton	—	11.00 - 12.00
Sulphuric, 60 deg., drums.....ton	—	13.00 - 15.00
Sulphuric, 66 deg., tank cars.....ton	18.00 - 20.00	—
Sulphuric, 66 deg., drums.....ton	22.00 - 22.50	23.00 - 23.50
Sulphuric, 66 deg., carboys.....ton	—	—
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 - 24.00	—
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.	—	.90 - 1.00
Tannic (tech.).....lb.	.50 - .52	.54 - .57
Tartaric, crystals.....lb.	—	.30 - .32
Tungstic, per lb. of WO.....lb.	—	1.30 - 1.40
Alcohol, Ethyl.....gal.	—	4.75 - 4.95
Alcohol, Methyl (see methanol).....gal.	—	—
Alcohol, denatured, 188 proof.....gal.	—	.31 - .36
Alcohol, denatured, 190 proof.....gal.	—	.38 - .42
Alum, ammonia lump.....lb.	.04 - .04 1/2	.04 - .04 1/2
Alum, potash lump.....lb.	.04 - .04 1/2	.04 - .05
Alum, chrome lump.....lb.	.13 - .13 1/2	.14 - .14 1/2
Aluminium sulphate, commercial.....lb.	.01 - .02	.02 - .02 1/2
Aluminium sulphate, iron free.....lb.	.03 - .03 1/2	.03 - .04
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07 - .07 1/2	.08 - .08 1/2
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 - .32	.33 - .35
Ammonium carbonate, powder.....lb.	.08 - .08 1/2	.09 - .10
Ammonium chloride, granular (white salamoniac).....lb.	.06 1/2 - .07	.07 - .07 1/2
Ammonium chloride, granular (gray salamoniac).....lb.	.08 - .08 1/2	.08 - .09
Ammonium nitrate.....lb.	.08 - .08 1/2	.09 - .10
Ammonium sulphate.....100 lb.	2.50 - 2.75	2.80 - 2.90
Amylacetate.....gal.	—	4.00 - 4.25
Amylacetate tech.....gal.	—	2.50 - 3.00
Arsenic oxide, (white arsenic) powdered lb.	.07 - .08	.08 - .08 1/2
Arsenic, sulphide, powdered (red arsenic) lb.	.12 - .12 1/2	.13 - .14
Barium chloride.....ton	58.00 - 59.00	60.00 - 65.00
Barium dioxide (peroxide).....lb.	.19 - .20	.21 - .22
Barium nitrate.....lb.	.08 - .09	.09 - .10
Barium sulphate (precip.) (blanc fixe) lb.	.04 - .05	.05 - .06
Bleaching powder (see calc. hypochlorite).....lb.	—	—
Blue vitriol (see copper sulphate).....lb.	—	—
Borax (see sodium borate).....lb.	—	—
Bristone (see sulphur, roll).....lb.	—	—
Bromine.....lb.	.41 - .42	.43 - .45
Calcium acetate.....100 lbs.	2.00 - 2.05	—
Calcium carbide.....lb.	.05 - .05 1/2	.06 - .05 1/2
Calcium chloride, fused, lump.....ton	24.00 - 25.00	26.00 - 27.00
Calcium chloride, granulated.....lb.	.01 - .02	.02 - .02 1/2
Calcium hypochlorite (bleach'g powder) 100 lb.	2.25 - 2.40	2.50 - 2.75
Calcium peroxide.....lb.	—	1.40 - 1.50
Calcium phosphate, tribasic.....lb.	—	.15 - .16
Camphor.....lb.	—	.65 - .67
Carbon bisulphide.....lb.	.07 - .07 1/2	.07 - .08
Carbon tetrachloride, drums.....lb.	.10 - .10 1/2	.11 - .12
Carbonyl chloride (phosgene).....lb.	—	.75 - 1.00
Caustic potash (see potassium hydroxide).....lb.	—	—
Caustic soda (see sodium hydroxide).....lb.	—	—
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08 - .09	.09 - .10
Chloroform.....lb.	—	.42 - .44
Cobalt oxide.....lb.	—	3.00 - 3.10
Copperas (see iron sulphate).....lb.	—	—
Copper carbonate, green precipitate.....lb.	.20 - .21	.22 - .23
Copper cyanide.....lb.	—	.50 - .62
Copper sulphate, crystals.....lb.	.05 - .05 1/2	.06 - .06 1/2
Cream of tartar (see potassium bitartrate).....lb.	—	—
Epsom salt (see magnesium sulphate).....lb.	—	—
Ethyl Acetate Com. 85%.....gal.	—	1.00 - 1.05
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.	—	.50 - .52
Formaldehyde, 40 per cent.....lb.	.14 - .14 1/2	.15 - .15 1/2
Fusel oil, ref.....gal.	—	3.00 - 3.25
Fusel oil, crude.....gal.	—	1.75 - 2.00
Glauber's salt (see sodium sulphate).....lb.	—	.17 - .17 1/2
Glycerine, C. P. drums extra.....lb.	—	3.75 - 3.85
Iodine, resublimed.....lb.	—	.10 - .20
Iron oxide, red.....lb.	—	.50 - .75
Iron sulphate (copperas).....100 lb.	1.00 - 1.25	—
Lead acetate.....lb.	—	.11 - .13 1/2
Lead arsenate, paste.....lb.	.09 - .09 1/2	.10 - .11
Lead nitrate.....lb.	—	.15 - .20
Litharge.....lb.	.08 - .09	.09 - .10
Lithium carbonate.....lb.	—	1.30 - 1.40
Magnesium carbonate, technical.....lb.	.09 - .09 1/2	.10 - .11
Magnesium sulphate, U. S. P.....100 lb.	2.75 - 3.00	—
Magnesium sulphate, technical.....100 lb.	—	1.10 - 2.25
Methanol, 95%.....gal.	—	.75 - .77
Methanol, 97%.....gal.	—	.78 - .82
Nickel salt, double.....lb.	—	.14 - .14 1/2
Nickel salt, single.....lb.	—	.15 - .15 1/2
Phosgene (see carbonyl chloride).....lb.	—	—
Phosphorus, red.....lb.	.45 - .46	.47 - .50
Phosphorus, yellow.....lb.	—	.35 - .37
Potassium bichromate.....lb.	.11 - .11 1/2	.12 - .12 1/2

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	\$ \$	\$0.31 - \$0.32
Potassium bromide, granular	lb.		.16 - .25
Potassium carbonate, U. S. P.	lb.	.35 - .40	.45 - .50
Potassium carbonate, 80-85%	lb.	.06 - .06½	.06½ - .07½
Potassium chlorate, crystals	lb.	.08½ - .10	.10½ - .14
Potassium cyanide	lb.		.26 - .28
Potassium hydroxide (caustic potash)	lb.	.05½ - .05¾	.06 - .08
Potassium muriate	ton	50.00 - 53.00	
Potassium iodide	lb.		2.75 - 3.00
Potassium nitrate	lb.	.09½ - .09¾	.10 - .12½
Potassium permanganate	lb.	.35 - .35	.37 - .38
Potassium prussiate, red	lb.	.35 - .37	.38 - .40
Potassium prussiate, yellow	lb.	.26 - .26½	.27 - .28
Potassium sulphate (powdered)	per unit		1.50 - 1.75
Rochelle salts (see sodium potas. tartrate)			
Salammoniac (see ammonium chloride)			
Sal soda (see sodium carbonate)			
Salt cake	ton		32.00 - 33.00
Silver cyanide	oz.		1.35 - 1.38
Silver nitrate	oz.		.41 - .42
Soda ash, light	100 lb.	2.15 - 2.20	2.40 - 2.60
Soda ash, dense	100 lb.	2.40 - 2.45	2.50 - 2.75
Sodium acetate	lb.	.04½ - .04¾	.05 - .05½
Sodium bicarbonate	100 lb.	2.25 - 2.40	2.50 - 2.75
Sodium bichromate	lb.	.08 - .08½	.08½ - .09
Sodium bisulphate (nitre cake)	ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphite powdered, U. S. P.	lb.	.05½ - .05¾	.05½ - .06
Sodium borate (borax)	lb.	.06½ - .06¾	.07 - .07½
Sodium carbonate (sal soda)	100 lb.	1.50 - 2.00	2.10 - 2.40
Sodium chloride	lb.	.07½ - .07¾	.08 - .08½
Sodium cyanide	lb.	.22 - .24	.25 - .30
Sodium fluoride	lb.	.12 - .12½	.13 - .14
Sodium hydroxide (caustic soda)	100 lb.	3.85 - 3.90	4.00 - 4.50
Sodium hyposulphite	lb.		.03½ - .03¾
Sodium nitrate	100 lb.	2.90 -	3.00 -
Sodium nitrite	lb.	.07½ - .08	.08½ - .10
Sodium peroxide, powdered	lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic	lb.	.04½ - .04¾	.05 - .05½
Sodium potassium tartrate (Rochelle salts)	lb.		.27 - .28
Sodium prussiate, yellow	lb.	.12½ - .13	.13½ - .14
Sodium silicate, solution (40 deg.)	lb.	1.25 - 1.35	1.40 - 1.50
Sodium silicate, solution (60 deg.)	lb.	.02½ - .03	.03½ - .03¾
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.05½ - .05¾	.06 - .06½
Sodium sulphite, crystals	lb.	.03½ - .04	.04½ - .04¾
Strontium nitrate, powdered	lb.	.15 - .15	.16 - .17
Sulphur chloride, red	lb.	.07 - .07½	.07½ - .08
Sulphur, crude	ton	20.00 - 22.00	
Sulphur dioxide, liquid, cylinders ex. l.	lb.	.08 - .08½	.09 - .10
Sulphur (sublimed), flour	100 lb.		2.25 - 3.10
Sulphur, roll (brimstone)	100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent	lb.	.18 - .19	
Tin oxide	lb.		.40 - .42
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran.	lb.	.11 - .11½	.11½ - .12
Zinc cyanide	lb.	.45 - .49	.50 - .60
Zinc dust	lb.	.12 - .13	.13½ - .14
Zinc oxide, XX	lb.	.08½ - .09	.09½ - .10
Zinc sulphate	lb.	.03½ - .03¾	.04 - .05

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	\$1.10 - \$1.15
Alpha-naphthol, refined	lb.	1.25 - 1.30
Alpha-naphthylamine	lb.	.35 - .40
Aniline oil, drums extra	lb.	.20 - .25
Aniline salts	lb.	.26 - .29
Anthracene, 80% in drums (100 lb.)	lb.	.85 - 1.00
Benzaldehyde U. S. P.	lb.	1.50 -
Benzidine, base	lb.	.85 - 1.00
Benzidine sulphate	lb.	.75 - .85
Benzoic acid, U. S. P.	lb.	.65 - .70
Benzoate of soda, U. S. P.	lb.	.65 - .70
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27 - .32
Benzene, 90% in drums (100 gal.)	gal.	.25 - .28
Benzyl chloride, 95-97%, refined	lb.	.28 - .30
Benzyl chloride, tech.	lb.	.20 - .25
Beta-naphthol benzoate	lb.	3.50 - 4.00
Beta-naphthol, sublimed	lb.	.70 - .75
Beta-naphthol, tech.	lb.	.34 - .45
Beta-naphthylamine, sublimed	lb.	2.00 - 2.25
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 - .18
Ortho-cresol, in drums (100 lb.)	lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums	gal.	.70 - .80
Cresylic acid, 75-97%, dark, in drums	gal.	.65 - .70
Cresylic acid, 50%, first quality, drums	gal.	.45 - .50
Dichlorobenzene	lb.	.06 - .09
Diethylaniline	lb.	1.20 - 1.25
Dimethylaniline	lb.	.41 - .50
Dinitrobenzene	lb.	.32 - .35
Dinitrochlorobenzene	lb.	.20 - .30
Dinitronaphthalene	lb.	.30 - .40
Dinitrophenol	lb.	.35 - .40
Dinitrotoluene	lb.	.27 - .30
Dip oil, 25%, car lots, in drums	gal.	.40 - .45
Diphenylamine	lb.	.60 - .65
H-acid	lb.	1.30 - 1.50
Meta-phenylenediamine	lb.	1.15 - 1.20
Monochlorobenzene	lb.	.12 - .14
Monothylaniline	lb.	1.75 - 1.85
Naphthalene crushed, in bbls.	lb.	.07½ - .08½
Naphthalene, flake	lb.	.07½ - .08½
Naphthalene, balls	lb.	.08½ - .09½
Naphthionic acid, crude	lb.	.70 - .75
Nitrobenzene	lb.	.12 - .15
Nitronaphthalene	lb.	.30 - .35
Nitro-toluene	lb.	.16 - .18
Ortho-amidophenol	lb.	3.10 - 3.20
Ortho-dichlorobenzene	lb.	.15 - .20
Ortho-nitro-phenol	lb.	.80 - .85
Ortho-nitro-toluene	lb.	.15 - .20
Ortho-toluidine	lb.	.20 - .25
Para-amidophenol, base	lb.	1.50 - 1.60
Para-amidophenol, HCl	lb.	1.75 - 1.80

Para-dichlorobenzene	lb.	.15 - .20
Paranitroaniline	lb.	.85 - 1.00
Para-nitrotoluene	lb.	.90 - 1.00
Para-phenylenediamine	lb.	1.25 - 2.00
Para-toluidine	lb.	1.25 - 1.40
Phthalic anhydride	lb.	.50 - .60
Phenol, U. S. P., drums	lb.	.10 - .14
Pyridine	gal.	2.00 - 3.50
Resorcinol, technical	lb.	1.75 - 1.85
Resorcinol, pure	lb.	2.25 - 2.30
Salicylic acid, tech., in bbls.	lb.	.22 - .24
Salicylic acid, U. S. P.	lb.	.26 - .28
Salol	lb.	.85 - .95
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14 - .16
Sulphanilic acid, crude	lb.	.30 - .35
Tolidine	lb.	1.25 - 1.35
Toluidine, mixed	lb.	.40 - .45
Toluene, in tank cars	gal.	.25 - .28
Toluene, in drums	gal.	.28 - .31
Xylidine, drums, 100 gal.	lb.	.40 - .45
Xylene, pure, in drums	gal.	.40 - .45
Xylene, pure, in tank cars	gal.	.45 -
Xylene, commercial, in drums, 100 gal.	gal.	.33 - .35
Xylene, commer. l., in tank cars	gal.	.30 -

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	\$0.24 - \$0.25
Beeswax, refined, light	lb.	.28 - .30
Beeswax, white pure	lb.	.45 - .47
Carnauba, Fla.	lb.	.60 - .61
Carnauba, No. 2, North Country	lb.	.28 - .30
Carnauba, No. 3, North Country	lb.	.16 - .17
Japan	lb.	.18 - .18½
Montan, crude	lb.	.07 - .07½
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.03½ - .03¾
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02½ - .03
Paraffine waxes, refined, 118-120 m.p.	lb.	.03½ - .03¾
Paraffine waxes, refined, 125 m.p.	lb.	.04½ - .04¾
Paraffine waxes, refined, 128-130 m.p.	lb.	.04½ - .05
Paraffine waxes, refined, 133-135 m.p.	lb.	.05 - .05½
Paraffine waxes, refined, 135-137 m.p.	lb.	.05½ - .06
Stearic acid, single pressed	lb.	.09 -
Stearic acid, double pressed	lb.	.10 -
Stearic acid, triple pressed	lb.	.11 - .11½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	\$5.10 -
Rosin E-I	280 lb.	5.80 - 6.60
Rosin K-N	280 lb.	6.50 - 6.70
Rosin W. G.-W. W.	280 lb.	6.80 -
Wood rosin, bbl.	280 lb.	6.25 -
Spirits of turpentine	gal.	.69 -
Wood turpentine steam dist.	gal.	.67 -
Wood turpentine, dest. dist.	gal.	.65 -
Pine tar pitch, bbl.	200 lb.	 - 6.75
Tar, kiln burned, bbl. (500 lb.)	bbl.	 - 12.00
Retort tar, bbl.	500 lb.	 - 12.00
Rosin oil, first run	gal.	.36 -
Rosin oil, second run	gal.	.38 -
Rosin oil, third run	gal.	.43 -
Pine oil, steam dist., sp.gr. 0.930-0.940	gal.	1.80 -
Pine oil, pure, dest. dist.	gal.	1.50 -
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.46 -
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35 -
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75 -
Pine tar, ref., thin, sp.gr. 1.080-1.960	gal.	.35 -
Turpentine, crude, sp.gr. 0.900-0.970	gal.	1.20 -
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990	gal.	.35 -
Pinewood creosote, ref.	gal.	.52 -

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	\$0.41 -
70-72 deg., steel bbls. (85 lb.)	gal.	.39 -
68-70 deg., steel bbls. (85 lb.)	gal.	.38 -
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30 -

Crude Rubber

Para-Upriver fine	lb.	\$0.16 - .17
Upriver coarse	lb.	.09 - .09½
Upriver caucho ball	lb.	.11½ - .12
Plantation—First latex crepe	lb.	.18 -
Ribbed smoked sheets	lb.	.16 - .16½
Brown crepe, thin, clean	lb.	.15 -
Amber crepe No. 1	lb.	.17 -

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	\$0.09½ - \$0.09¾
Castor oil, AA, in bbls.	lb.	.10 - .10½
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.11½ - .12
Cocoonut oil, Ceylon grade, in bbls.	lb.	.10½ - .10¾
Cocoonut oil, Cochín grade, in bbls.	lb.	.11½ - .11¾
Corn oil, crude, in bbls.	lb.	.07½ - .08
Cottonseed oil, crude (f. o. b. mill)	lb.	.05½ - .05¾
Cottonseed oil, summer yellow	lb.	.07½ - .08
Cottonseed oil, winter yellow	lb.	.08 -
Linseed oil, raw, car lots (domestic)	gal.	.73 - .73
Linseed oil, raw, tank cars (domestic)	gal.	.67 -
Linseed oil, in 5-bbl lots (domestic)	gal.	.76 - .76

Olive oil, Denatured.....	gal.	\$1.35	—	\$1.58
Palm, Lagos.....	lb.	.07	—	.07
Palm, Niger.....	lb.	.05	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.06	—	.06
Peanut oil, refined, in bbls.....	lb.	.10	—	.10
Rapeseed oil, refined in bbls.....	gal.	.86	—	.88
Rapeseed oil, blown, in bbls.....	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07	—	.07
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.05	—	....

FISH

Light pressed menhaden.....	gal.	\$0.40	—	\$0.41
Yellow bleached menhaden.....	gal.	.42	—	....
White bleached menhaden.....	gal.	.44	—	....
Blown menhaden.....	gal.	.80	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	1.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	....
Blanc fixe, dry.....	lb.	.05	—	.05
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.16
Chalk, domestic, extra light.....	lb.	.05	—	.05
Chalk, domestic, light.....	lb.	.04	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07	—	.08
Graphite, Ceylon chip.....	lb.	.06	—	.06
Graphite, high grade amorphous crude.....	lb.	.02	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	....	—	10.00
Quartz (acid tower) 1 1/2 @ 2 in., f.o.b. Baltimore.....	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.75	—	....
Shellac, orange superfine.....	lb.	.79	—	.82
Shellac, A. C. garnet.....	lb.	.55	—	.58
Shellac, T. N.....	lb.	.70	—	.72
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	35.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$35.00—50.00
Carborundum refractory brick, 9-in.....	1,000	1250.00
Chrome brick, f.o.b. Eastern shipping points.....	net ton	75—90
Chrome cement, 40—45% Cr ₂ O ₃	net ton	45—50
Chrome cement, 40—45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	 55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	40—50
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	40—50
Magnesite brick, 9-in. straight.....	net ton	90
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	100
Magnesite brick, soaps and splits.....	net ton	110
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	45—55
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	45—55
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	45—55

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00 — \$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.15 — .16
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.16 — .17
Ferromanganese, 76-80% Mn, domestic.....	gross ton	80.00 — 85.00
Ferromanganese, 76-80% Mn, English.....	gross ton	80.00 — 85.00
Spiegelisen, 18-22% Mn.....	gross ton	30.00 — 32.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50 —
Ferrosilicon, 10-15%.....	gross ton	50.00 — 55.00
Ferrosilicon, 50%.....	gross ton	80.00 — 85.00
Ferrosilicon, 75%.....	gross ton	145.00 — 150.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45 — .50
Ferrouuranium, 35-50% of U, per lb. of U content.....	lb.	6.00 —
Ferrovanadium, 30-40% per lb. of contained V.....	lb.	5.00 — 6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$8.00 — \$10.00
Chrome ore, Calif. concentrates, 50% Cr ₂ O ₃	unit	45 — .50
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	45 — .50
Coke, foundry, f.o.b. ovens.....	net ton	4.50 — 5.00
Coke, furnace, f.o.b. ovens.....	net ton	3.25 — 3.75
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00 — 16.00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	15.00 —
Fluorspar, standard, domestic washed gravel.....	net ton	20.00 — 22.50
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 — .01
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.25 —
Manganese ore, chemical (Mn ₂ O ₃).....	gross ton	60.00 — 65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55 — .60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00 —
Pyrites, Spanish, fine, c.i.f. Atlantic seaport.....	unit	14 — 14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.14 — .14
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12 — .13
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15 —
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75 — 3.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00 — 3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50 — 2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25 — 2.50
Vanadium pentoxide, 99%.....	lb.	12.00 — 14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50 —
Zircon, washed, iron free.....	lb.	.03 —

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	13.25—13.50
Aluminum, 98 to 99 per cent.....	28.00@28.5
Antimony, wholesale lots, Chinese and Japanese.....	5
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blcks.....	35.00
Monel metal ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	32.25
Lead, New York, spot.....	5.00
Lead, E. St. Louis, spot.....	4.75
Zinc, spot, New York.....	5.25
Zinc, spot, E. St. Louis.....	4.75

OTHER METALS

Silver (commercial).....	oz.	\$0.58
Cadmium.....	lb.	1.00—1.25
Bismuth (500 lb. lots).....	lb.	1.50@1.55
Cobalt.....	lb.	4.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	72.00—75.00
Iridium.....	oz.	250.00@300.00
Palladium.....	oz.	65.00@70.00
Mercury.....	75 lb.	46.00—47.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	20.50—20.75
Copper bottoms.....	28.00—28.25
Copper rods.....	19.25—20.00
High brass wire.....	18.25
High brass rods.....	15.25
Low brass wire.....	20.25
Low brass rods.....	20.25
Brazed brass tubing.....	29.00
Brazed bronze tubing.....	34.25
Seamless copper tubing.....	22.00
Seamless high brass tubing.....	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound.

	New York			
	Current	One Year Ago	Cleveland	Chicago
Copper, heavy and crucible.....	8.50@9.00	18.50	10.00	10.50
Copper, heavy and wire.....	8.00@8.25	16.50	9.50	10.50
Copper, light and bottoms.....	7.00@7.50	14.50	9.00	10.50
Lead, heavy.....	3.25@3.50	7.25	4.00	4.00
Lead, tea.....	2.15@2.30	5.25	3.00	3.00
Brass, heavy.....	4.25@4.50	9.50	7.00	10.00
Brass, light.....	3.00@3.25	8.00	5.00	5.50
No. 1 yellow brass turnings.....	4.00@4.25	9.50	5.50	6.00
Zinc.....	2.00@2.50	5.00	3.00	3.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.50	\$3.23	\$3.23
Soft steel bars.....	2.50	3.00	3.13
Soft steel bar shapes.....	2.50	3.13	3.13
Soft steel bands.....	2.85	3.83	3.78
Plates, 1/2 to 1 in. thick.....	2.50	3.30	3.23

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

MOBILE—The Gilman Paint & Varnish Co., Chattanooga, Tenn., is planning for the establishment of a local plant to be equipped for a capacity of about 2,000 gal. of material per day. K. Y. Benson is vice-president.

Arkansas

LITTLE ROCK—The Rose City Petroleum Co., 407 Donaghey Bldg., recently organized with a capital of \$500,000, has plans under way for the erection of a new oil-refining plant on local site, to have an initial capacity of about 1,000 bbl. per day. A. M. Delcambre is president and E. B. Fowler secretary and treasurer.

PICRON—The Arkansas Refineries Co., Little Rock, recently incorporated with a capital of \$50,000, is planning for the erection of a new oil refinery at Picron, with initial daily capacity of about 500 bbl. Brooks & Co., Little Rock, will be in charge of erection. Joseph Berger is president.

California

LOS ANGELES—The C. F. Braun Co., San Francisco, manufacturer of metal products, is planning for the removal of its foundries to a site to be selected at Los Angeles. Details of the new plant are being arranged.

PITTSBURG—S. M. Stranahan and J. F. Mora, Pittsburg, are planning for the erection of a new plant at Martinez for the manufacture of a new airless automobile tire and other rubber products. Negotiations are under way with the Board of City Trustees for a suitable site.

Delaware

CLAYMONT—The Wilmington Sugar Refining Co., Wilmington, will resume work at once on its proposed new sugar refinery at Claymont, estimated to cost about \$1,000,000 with machinery. The company has a tract of about 11 acres of land, purchased from the Pennsylvania R.R., and a number of buildings will be constructed. The company is capitalized at \$30,000,000 and is headed by Adolph Segal, 1710 North 23d St., Philadelphia, Pa.

Georgia

CEDARTOWN—The Brewer Automobile Headlight Co., recently organized, is arranging for the operation of a local plant for the manufacture of automobile headlights and fixtures. I. L. St. Clair is president and general manager.

Indiana

BRAZIL—Officials of the Kalamazoo Tank & Silo Co., operating a local plant for the manufacture of burned clay products, have organized the Kalamazoo Clay Co. The new organization has acquired the property of the Carbon Mining Co., near Brazil, and will establish a works here for the manufacture of burned clay blocks and kindred products. The company is headed by Manvel H. Coombs, James E. Anderson and John S. Rockwell.

ELKHART—The American Coating Mills, manufacturer of enameled paper products, have awarded a contract to Henry L. Vanderhouse, Kalamazoo, Mich., for the erection of the proposed addition to its plant, to be located at the foot of Division St. The new factory with machinery is estimated to cost in excess of \$500,000. C. C. Colbert is president and treasurer.

Iowa

DAVENPORT—The Western States Portland Cement Co., Independence, Kan., has construction under way on its new local cement mills, estimated to cost close to \$2,000,000 with machinery. A. D. Stancliff is purchasing agent.

Louisiana

MONROE—The Monroe Cotton Oil Co., Newtown, near Monroe, is reported to be planning for the rebuilding of its plant,

destroyed by fire May 11 with loss estimated at about \$150,000, including equipment.

Maryland

HAGERSTOWN—Fire May 15 destroyed a portion of the mixing plant of the Central Chemical Co., manufacturer of fertilizer products, with loss estimated at about \$35,000, including machinery.

Massachusetts

CHESTER—The Cortland Grinding Wheel Co., Cortland, N. Y., has combined operations with the Maxf Grinding Wheel Co., operating a local plant, and the products of both companies will be made in the future at this location. The plant of the Cortland company was destroyed by fire last November, and it is said that it will not be rebuilt at the present time. The officers of both companies will remain as heretofore.

Michigan

THREE RIVERS—The Eddy Paper Co. has arranged for a bond issue of \$1,250,000 to be used for general operations, financing, etc. The company's plant has a total capacity of about 100,000 tons of paper per year, with branch works at White Pigeon, Mich.

CHEBOYGAN—The Union Bag & Paper Co. has awarded a contract to J. Livingston & Co., 506 Sloan Bldg., Cleveland, O., for extensions and improvements in its paper mill. A portion of the works will be remodeled. G. S. Witham is general superintendent.

Missouri

PIEDMONT—The Piedmont Units Co. has acquired a tract of land totaling about 6,500 acres, and is planning for the erection of a new plant for the production of charcoal and byproducts. The initial works will comprise a battery of 7 ovens and auxiliary operating equipment. About \$100,000 will be expended in the new plant and in property development.

SPRINGFIELD—The Willis-Smiley Producing & Refining Co., Fort Scott, Kan., recently organized, has plans under way for the erection of a new oil refinery in the vicinity of Springfield, to have an initial daily output of about 500 bbl. The plant will be arranged on the unit plan, and the first unit will be added to at a later date. W. E. Willis and W. J. Smiley, both of Fort Scott, head the company.

New Jersey

NEWARK—Aaron Friedman of the New Process Metals Co., 7 Mulberry St., is planning for the erection of a new plant for the manufacture of cerium and other rare earth metallic products.

JERSEY CITY—G. H. Aspinwall, Cornelison Ave., manufacturer of paints, will take bids at once for the erection of a new 2-story plant, 50x60 ft., to cost about \$30,000, including equipment. E. M. Patterson, 76 Montgomery St., is architect.

WOODSTOWN—The South Jersey Farmers' Exchange is considering plans for the construction of a new 1-story addition to its fertilizer plant, about 80x200 ft. A. B. Lippincott is manager.

MAURER—The Barber Asphalt Paving Co., Land Title Bldg., Philadelphia, Pa., has awarded a contract for the erection of a new service building at its local plant, 32x52 ft., to J. H. Wester, 221 Brighton Ave., Perth Amboy, N. J.

New York

SYRACUSE—The Thatcher Process Co., organized about a year ago and operating with a capital of \$200,000, has commenced production at its new local electrochemical plant for the manufacture of anthraquinone under a special process. The initial output will average about 1,000 lb. per day, and this will be increased at a later date. The company is headed by Carleton A. Chase and James D. Grant.

NEW YORK—The Ruberoid Co., Woolworth Bldg., formerly the Standard Paint Co., has arranged for a bond issue of \$1,

000,000 for general operations, financing, etc. H. F. Gillespie is vice-president.

ALBANY—The Hires-Turner Glass Co., 30th and Walnut Sts., Philadelphia, Pa., manufacturer of window glass and other rolled glass products, is taking bids for the erection of a new one-story plant on Tivoli St., Albany, to be 150x300 ft., steel and concrete, and estimated to cost about \$250,000 with machinery. A. W. Fuller, 95 State St., Albany, is architect.

DUNKIRK—The Thatcher Mfg. Co., 201 West Second St., manufacturer of glass products, is taking bids for the erection of a new 1-story plant to replace a portion of its works recently destroyed by fire.

North Carolina

HENDERSON—The Vance Fertilizer Co. has commenced the erection of a new local plant, to be equipped for the manufacture of commercial fertilizers.

WILMINGTON—The Atlantic Refining Co., 3144 Passyunk Ave., Philadelphia, Pa., is reported to have purchased the Naull Shipyard, on the Cape Fear River, near Wilmington, and has plans under way for the erection of a large oil refinery on the site.

WILMINGTON—Fire recently destroyed a portion of the plant of the Shepard Chemical Co. No official estimate of loss has been made. Plans are said to be under way for rebuilding. E. C. Dickinson is head.

Ohio

CUYAHOGA FALLS—The Surgeons' Rubber Glove Co., manufacturer of rubber goods, has plans under way for the erection of a new plant. The Akron Engineering Co., Akron, O., is engineer. C. N. Shook, 410 Merline Ave., Cuyahoga Falls, is one of the heads of the company.

CORTLAND—The Quinley Magnesia Co., recently organized with a capital of \$100,000, will soon break ground for the erection of a new plant for the manufacture of magnesium and asphalt products. The initial output will aggregate about 4,000 lb. of magnesium carbonate per day. It is proposed to have the first plant unit ready for service during July.

Quebec

EAST ANGUS—The Brompton Pulp & Paper Co. is planning for the rebuilding of the portion of its local mill, destroyed by fire, May 5. The company has arranged for a bond issue of \$2,500,000, the proceeds to be used for general operations, expansion, etc. In addition to the East Angus plant, mills are being operated at Bromptonville, Que., Claremont, N. H., and Groveton, N. H., with total annual production of 123,000 tons of newsprint, kraft and fiber paper and groundwood pulp. F. N. McCrea is president.

South Carolina

ALLENDALE—Fire, May 16, destroyed a portion of the plant of the Allendale Cotton Oil & Fertilizer Co., with loss estimated at about \$75,000, including equipment and stock.

Tennessee

MEMPHIS—The Memphis Packing Corp., Falls Building, is considering the erection of a new local plant for the manufacture of compounds. The refinery will be operated in conjunction with the present works. Joseph Newburger is president.

MEMPHIS—The Oriental Chemical Co., with offices in the Odd Fellows Bldg., plans the erection of a chemical plant in Hollywood. The officers of this company are W. L. Eichberg, president; W. W. Laughlin, vice-president and W. L. Eichberg, secretary-treasurer.

CHATTANOOGA—The Mutual Enamel Ware Co. is having plans prepared by Dwight P. Robinson & Co., 125 East 46th St., New York City, for the erection of a new local plant for the manufacture of enamel sanitary ware.

Texas

DALLAS—The Southern States Chemical Co., 1831 Clarence St., has plans under way for the erection of a new plant at Houston, comprising four complete units, two of which will be erected at the present time and the others at a later date. The larger unit will be 2 story, brick and steel, totaling about 10,000 sq. ft. of space, and will be equipped for chemical manufacture. The smaller section will be used for byproduct recovery, and will be equipped with distillation apparatus, retorts, etc. The main works will manufacture inks, paints, soaps, etc., in addition to general chemicals. Louis Rosenberg is president.

TYLER—George R. Hill and associates have plans under way for the establishment of a new brick manufacturing plant, to be equipped for a daily output of about 10,000 bricks.

West Virginia

RAVENSWOOD—The Ravenswood Porcelain Co., recently organized with a capital of \$500,000, has plans under way for the erection of a new local plant for the manufacture of electrical porcelain products, to be 1-story, 120 x 160 ft. Two kinds will be constructed. The plant is estimated to cost in excess of \$30,000 with equipment. Beaty & Halloran, New Haven, W. Va., and Cincinnati, O., are architects. C. E. Mason is president, and C. W. Turnbull, general manager.

Capital Increases, Etc.

THE IMPERIAL DROP FORGE CO., Indianapolis, Ind., has filed notice of increase in capital from \$200,000 to \$500,000.

THE STAR OIL CO., INC., Port Huron, Mich., has filed notice of increase in capital from \$65,000 to \$100,000.

THE INDIANA GLASS & FIXTURE CORP., Marion, Ind., has filed notice of change of name to the Therasse Glass Corp.

THE INTER STATE LEATHER CO., 229 West Rand St., Chicago, has filed notice of dissolution under state laws.

F. F. DALLEY CO., 321 Military Rd., Buffalo, N. Y., manufacturer of polishes, has filed notice of increase in capital from \$590,000 to \$1,340,000.

THE ROGERS RUBBER CO., Westminster, Md., manufacturer of rubber products, has filed notice of reduction in capital from \$1,000,000 to \$250,000.

THE MARION TIRE & RUBBER CO., Marion, O., manufacturer of rubber products, has filed notice of increase in capital from \$750,000 to \$1,250,000.

THE MONROE BINDER BOARD CO. and the **BOEHME & RAUCH CO.**, both of Monroe, Mich., manufacturer of paper and fiber board products, have been merged under the name of the Monroe Consolidated Paper Co., with a capital of \$7,500,000. E. C. Rauch is president.

New Companies

THE HUNTINGTON SIGNAL OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$350,000 to manufacture petroleum products. The incorporators are Carlos C. Closson, 5544 Lexington St., Los Angeles; Frank W. Foster, Artesia, Cal.; and Jewel Irwin, 262 Mira Mar Ave., Long Beach, Cal.

THE FLAGG INK CO., New York City, has been incorporated with a capital of \$100,000 to manufacture inks and kindred products. The incorporators are A. B. Flagg, J. Kirschenstein and A. P. Scharps, Tribune Bldg.

THE RORK CHEMICAL CO., 3316 North Halsted St., Chicago, has been incorporated with a capital of \$25,000 to manufacture chemical and chemical byproducts. The incorporators are Fred Lackner, M. J. Clark and M. W. Rork.

THE PENNSYLVANIA CHEMICAL CO., Brooklyn, N. Y., has been incorporated with a capital of \$25,000 to manufacture chemicals and affiliated products. The incorporators are S. L. Siegler, F. C. Skinner and M. L. Lavey. J. B. Steinfeld, 215 Montague St., represents the company.

THE STANDARD METAL PRODUCTS CO., Boston, Mass., has been incorporated with a capital of \$100,000 to manufacture metal specialties. George R. Armstrong is president and Morris M. Fineberg, 34 Orange St., Chelsea, Mass., treasurer.

THE HUNTINGTON ARENA OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are J. W. LaFrange and W. A. Davidson, Los Angeles, and James E. Jeter, Glendale, Cal. H. P. Goodwin, 231 Title Insurance Bldg., Los Angeles, represents the company.

JOHN P. CARLSON, INC., Brooklyn, N. Y., has been incorporated with a capital of \$100,000 to manufacture printing and lithographic inks. The incorporators are J. P., J. R. and S. Carlson. The company is represented by Durack & Scheilke, 215 Montague St.

THE NITROLID CO., East Stroudsburg, Pa., has been incorporated with a capital of \$50,000 to manufacture pyroxylin and composition products. Julian Davis, Stroudsburg, Pa., is treasurer.

THE HERCULOID PRODUCTS CO., 7 West Madison St., Chicago, has been incorporated with a capital of \$75,000 to manufacture wood pulp products and kindred specialties. The incorporators are J. W. Young, A. S. Flett and Benjamin N. Anderson.

THE A. & T. OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$750,000 to manufacture petroleum products. The incorporators are T. S. Trebell, Irving V. Augau and Harvey A. Young, 511 Stock Exchange Bldg.

THE NORTHSIDE BRICK CO., Pittsburgh, Pa., has been incorporated with a capital of \$50,000 to manufacture brick and other burned clay products. John Schlermann, Millville, Pa., is treasurer.

THE LEBANON GREY IRON CASTINGS CO., Lebanon, Pa., has been incorporated with a capital of \$30,000 to manufacture metal castings. The incorporators are Julius H. Caplan and John Hunsicker, Jr., Lebanon.

THE TRIANGLE TANNING CO., Medford, Mass., has been incorporated with a capital of \$100,000 to manufacture leather products. Herman See is president; Theodore W. Kerr, 22 Corey St., Medford, is treasurer.

THE MURRAY OIL CO., Room 640, 29 South La Salle St., Chicago, has been incorporated with a capital of 500 shares of stock, no par value, to manufacture oil products. The incorporators are Andrew C. Wylie, Charles Reagh and I. S. Berkman.

THE IMPERIAL PULP & PAPER CORP., New York City, has been incorporated with a capital of \$100,000 to manufacture pulp and paper products. The incorporators are W. H. Wilson, J. R. Allen and J. A. Montague. F. J. Knorr, Albany, N. Y., represents the company.

THE HAMILTON TILE CO., Los Angeles, Cal., has been incorporated with a capital of \$50,000 to manufacture ceramic tile and other kindred products. The incorporators are M. M. and G. B. Hamilton, and Lawrence W. Allen. Allen, Allen & Swender, Los Angeles, attorneys, represent the company.

THE GROSVENOR PAPER CO., Buffalo, N. Y., has been incorporated with a capital of \$100,000 to manufacture paper products. The incorporators are H. A. Grosvenor, E. F. Branch and P. Swift. Swift, Gratiwick & Peter Ellicott Sq., Buffalo, represent the company.

THE ATLANTIC & PACIFIC DRUG & CHEMICAL CO., Room 1438, 10 South LaSalle St., Chicago, has been incorporated with a capital of 1,000 shares of stock, no par value, to manufacture chemicals and affiliated products. The incorporators are Hubert E. Howard, John C. Burchard and Herbert Haase.

THE CONSUMERS' BOX CO., Philadelphia, Pa., is being organized by Jesse E. Perry, Ralph L. Patterson and Charles E. White, to manufacture paper boxes and containers. Samuel W. Cooper, Lincoln Bldg., represents the company.

THE LOS ANGELES TIRE & TUBE MFG. CO., 1338 East Slauson Ave., Los Angeles, Cal., has filed notice of organization to manufacture rubber products. T. J. Barker, 1140 East Sixtieth St., heads the company.

THE WENTZELL CHEMICAL DISTRIBUTING CO., New York City, has been incorporated with a capital of \$25,000 to manufacture chemical products. The incorporators are E. R. Dick, R. Moulton and E. T. Moriarity. J. P. Nolan, 25 Broad St., represents the company.

THE AIKEN OIL CO., Pittsburgh, Pa., has been organized by F. L. and Clarence Aiken, and I. M. Miller, to manufacture refined oil products. The company is represented by A. L. Petty, Jr., 1156 Frick Annex.

THE IMPERIAL VALLEY CRUDE OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$1,000,000 to manufacture petroleum products. The incorporators are J. F. Corbett, C. M. Graham and Frank Muller. The company is represented by Carnahan & Clark, 501 Investment Bldg.

THE OILZUM DISTRIBUTING CO., INC., 4 East Mount Royal Ave., Baltimore, Md., has been incorporated with a capital of \$75,000 to manufacture soaps, oils and kindred products. The incorporators are L. Innes Correll, Harold Simester and F. G. Riggs.

THE PERFECT CHEMICAL MFG. & DRUG CORP. has been incorporated with a capital of \$50,000 to manufacture chemicals and affiliated products. The incorporators are B. Baum, I. Goldberg and C. Zarem. C. Firstone, 299 B'way, represents the company.

THE CALUMET MALLEABLE IRON CO., 9651 Torrance Ave., Chicago, has been incorporated with a capital of \$50,000 to manufacture iron products. The incorporators are Michael J. Boyle, George R. Barker and Thomas E. Duffy.

WENDELL & WARREN, INC., 1601 West North Ave., Baltimore, Md., has been incorporated with a capital of \$31,000 to manufacture chemicals, drug compounds, etc. The incorporators are H. George Wendell, Daniel A. Warren and R. E. Lee Williamson.

THE UNITED LABORATORIES, INC., 15 East Washington St., Chicago, has been incorporated with a capital of \$100,000 to manufacture chemical and scientific products. The incorporators are C. W. Armstrong, P. C. Hughes and R. M. Hughes.

THE FITZROY CHEMICAL CORP., New York City, has been incorporated with a capital of \$25,000 to manufacture chemicals and chemical byproducts. The incorporators are E. L. Mullaney, M. Fitzgerald and F. Persh. The company is represented by Geller & Kraushaar, 51 Chambers St.

THE ILLINOIS VARNISHED TILE CO., Room 1400, 38 South Dearborn St., Chicago, has been incorporated with a capital of \$100,000 to manufacture tile and other ceramic products. The incorporators are Frank P. Page, R. W. Hendershot and James E. Hauronic.

THE MASTER PHONE-DISC CORP., New York City, has been incorporated with a capital of \$51,000 to manufacture composition rubber specialties, etc. The incorporators are M. Wiener and W. H. Deuel. S. G. Nissenson, 32 Liberty St., represents the company.

THE BRACKETT-MASON-DODGE CO., INC., Peabody, Mass., has been incorporated with a capital of \$50,000 to manufacture cements, finishes and kindred materials for leather tanning. Charles P. Brackett is president and George H. Mason, Saugus, Mass., treasurer.

Industrial Notes

THE THADDEUS DAVIDS INK CO., New York, announces the election of Harold Merckle as president, M. A. Kline as vice-president and treasurer, F. E. Ashley as secretary and T. H. Pancoast as assistant secretary.

B. F. WITBECK has been elected president and treasurer of the Albany Chemical Co., New York. Dr. Michaelis, one of the founders of the company, has been elected chairman of the board of directors. The plant of this company is at Albany, N. Y.

THE QUIGLEY FURNACE SPECIALTIES CO., New York City, announces that W. H. Gaylord, Jr., formerly president of the Gaylord International Engineering Construction Co. and later sales manager of the McPhee Cement Co., has joined the company as assistant traveling sales manager in charge of the establishment of agencies for Quigley products. He will make his headquarters in New York.

THE M. J. DOUGHERTY CO., piping fabricator and contractor of Philadelphia, announces a change of address of its Atlanta, Ga., representative's office to Candler Annex. This office is in charge of Messrs. McKee and Wright. Their territory takes in the states of Florida, Georgia, Alabama, Tennessee, North Carolina and South Carolina.

THE JEFFREY MANUFACTURING CO., Columbus, O., has placed Harold B. Wood in charge of the New York office, which is now located in the Hudson Terminal Bldg., 30 Church St.

C. H. WHEELER MANUFACTURING CO., Philadelphia, announces the opening, June 1, of a branch office in Boston at 53 State St.

THE ESSENKAY PRODUCTS CO., Chicago, manufacturer of art gum, tire filler and allied products, has leased 28,000 sq.ft. of additional floor space at 2601-9 Cottage Grove Ave. Extensive improvements are to be made to transform the building into general office headquarters, salesrooms and factory.

THE AMERICAN ANILINE PRODUCTS, INC., New York City, announces that at the last meeting of the board of directors E. E. Fischer, formerly president and treasurer of the Kalle Color & Chemical Co., Inc., New York, was elected a vice-president and director.

A PERMANENT CONFECTIONERY AND ALLIED INDUSTRIES EXPOSITION will be opened in the new Wrigley Bldg., Chicago June 1. Chicago is the recognized center of this industry.

THE ABBE ENGINEERING CO., New York City, has added to its staff H. H. Wilson, an engineer formerly connected with the Westinghouse Electric & Mfg. Co. Mr. Wilson has also been chief engineer of the Colorado Electric Power Co. and superintendent of the Ontario Power Co. and its subsidiaries and has had considerable experience with machinery in chemical and electrochemical plants.

LESLIE H. ALLEN, who has recently been with Fred T. Ley & Co., contractors, of Springfield, Mass., first as an industrial housing engineer and then as sales manager for the New England territory, has joined the staff of the Portland Cement Association, Chicago, as assistant manager of the Cement Products Bureau.

GEORGE C. DEAN, CLAIR W. FAIRBANK, IRVING M. OBRIEGHT and MORRIS HIRSCH announce the removal of their office to the Park Row Bldg., New York City, where they will continue the practice of patent, trade mark and corporation law under the name of Dean, Fairbank, Obrieght and Hirsch.

THE ALBERHILL COAL & CLAY CO., 608 Pacific Electric Bldg., Los Angeles, Cal., has established a research laboratory in Los Angeles, which is open to all manufacturers of clay products for experimental work. The company is carrying on a campaign for bringing to Los Angeles new industries which will be users of clay products.

THE WHITE MOUNTAIN CHEMICAL CO. has recently been organized for the manufacture of chemical compounds. H. J. St. Yves is president, I. J. Nobert vice-president, A. E. Provost treasurer and E. H. Archambault assistant-treasurer. The company is located at 1061 Elm St., Manchester, N. H.

WILSON H. LOW and JOHN H. SHOW have purchased the plant built by the California Chemical Products Co., about nine miles south of Lone Pine, Cal., near the north end of Owens Lake. They intend to recover alkali salts from the waters of Owens Lake, and will manufacture soda ash and caustic soda. They may also recover sodium sulphate and some potassium salts. Messrs. Low and Show were formerly chief chemist and assistant chemist respectively for the Cudahy Packing Co., Omaha, Neb. Later Mr. Show was identified with the first and most successful of the companies producing potash from the lakes in western Nebraska.

THE ROSS HEATER & MFG. CO., INC., announces the opening of a branch office at 2 Rector St., New York City, which will be in charge of C. M. Hardin, who was formerly located in the home office in Buffalo, N. Y.

THE ENGINEERING BUSINESS EXCHANGE announces that John J. Swan has become associated with it. Mr. Swan was formerly with the Prest-O-Lite Co.

THE POWER SPECIALTY CO., manufacturer of Foster superheaters, economizers and oil stills, has opened the following additional offices: 512 Reliance Bldg., Kansas City, Mo., and 627 Linz Bldg., Dallas, Tex. The Kansas City office is in charge of William F. Meyer, who has been with the company for many years, and the Dallas office is in charge of M. W. Brown.

The Chicago office of the UEHLENG INSTRUMENT CO., of New York, was moved May 1 to the Great Northern Bldg., 20 West Jackson Blvd. Walter C. Lane has been appointed manager of this office.

THE INTERNATIONAL NICKEL CO. announces the removal of its offices to 67 Wall St., New York City.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES has moved its office from 480 Lexington Ave. to 342 Madison Ave., Canadian Pacific Bldg., New York City.

THE HAUCK MFG. CO., Brooklyn, N. Y., has elected as its president Henry T. Gerdes, mechanical engineer and manufacturer, of New York; first vice-president, M. C. Hauck; second vice-president, A. B. Hauck; third vice-president, H. H. Kress; treasurer, A. H. Stein, and secretary, J. Lutz. Mr. Gerdes, who succeeds the late Arthur E. Hauck, is a graduate of Stevens Institute of Technology and was for many years manager of the Treadwell Engineering Co. of Easton, Pa.

MANNING, MAXWELL & MOORE, INC., New York City, announces the election of J. M. David as president to succeed the late A. J. Babcock. Mr. David was formerly vice-president of the Baltimore & Ohio R.R. and general manager of its New York and Staten Island rail lines and terminals.

F. J. RYAN & CO., Philadelphia, Pa., announce they have just completed the installation of a large electric processing and solvent recovery equipment for the Termoid Rubber Co., Trenton, N. J., and an electrically heated belting table for the Victor Belata & Textile Belting Co., Easton, Pa. The Mires fuel-burning department, which has recently been added to the organization, announces the following installations: 1 large annealing oven, Mare Island Navy Yard, Cal.; 1 double chamber forging furnace, Naval Airship Construction, Lakehurst, N. J.; 5 pit annealing furnaces, 1 non-ferrous annealing furnace and 2 drying

ovens, Bridgeport Screw Co., Bridgeport, Conn.

THE STEEL FABRICATING CO. announces the completion of its new works and general offices at Michigan City, Ind., and the removal to that city from Harvey, Ill., of its executive headquarters.

New Publications

BOOKS

PRINCIPLES OF PHYSICAL CHEMISTRY. Second edition. By Edward W. Washburn, professor of ceramic chemistry in the University of Illinois. Pp. 516; 83 illustrations. New York: McGraw-Hill Book Co., Inc., 1921. Price, \$4.

In this new edition the general plan and arrangement of subject matter adopted in the first edition have been retained and the revision has consisted chiefly in the incorporation of new material representing the scientific advances which have been made during the past six years. Apart from minor changes, the topics included in the new material may be summarized thus:

In Chap. I on the structure of matter, the determination of the mass of an atom by the positive-ray spectograph of Aston; in Chap. III on the liquid state of aggregation, deductions from Poiseuille's law on the flow of fluids through capillary tubes and on plastic flow; in Chap. V on the crystalline state of aggregation, the Hull method for X-ray crystal analyses, illustrations of the crystal lattice of some simple substances, atomic diameters in the crystal lattice; in Chap. VI on crystal-gas systems, the kinetics of sublimation and condensation at crystal surfaces, rates of condensation and sublimation; in Chap. X on some principles relating to energy, a brief discussion of entropy, the quantum theory, the third law of thermodynamics and the Nernst heat theorem; in Chap. XIII on the thermodynamic environment of ideal solutions, the nature of the forces which determine thermodynamic environment; in Chap. XVII on conductance and the degree of dissociation, an amplified treatment of the viscosity correction; in Chap. XX on the heat capacity and internal energy of material systems, the Jeffries-Norton apparatus for the liquefaction of gases; in Chap. XXI on chemical kinetics, contact catalysis; in Chap. XXIV on the phase rule, the system SiO_2 , general temperature-composition diagram for two-component systems, three-component systems, solid models; in Chap. XXV on disperse systems, adsorption equilibrium; in Chap. XXVII on atomic structure and the periodic system, a detailed, illustrated exposition of the Lewis-Langmuir theory. To the miscellaneous problems in the appendix has been added a set of problems illustrating the application of physicochemical principles to the Lane and Lane-Bergius processes for the manufacture of hydrogen.

CONDENSED DESCRIPTION OF THE MANUFACTURE OF BEET SUGAR. By Franz Murke, Ph.D. Pp. 175. New York: John Wiley & Sons, Inc., 1921. Price, \$2.50.

In this book the steps in the process of preparing sugar from beets are treated in a concise, yet clear, form. Chemical, engineering and economic problems are all taken into consideration and the presentation is thoroughly practical. Thus in the chapter on evaporation the method of calculating the heating surfaces for any type of vapor distribution is given in detail. The chapters in order are: Harvesting; storing and receiving beets; fluming, washing and weighing beets; cutting beets; diffusion process; pulp; diffusion juice; first carbonation; filter presses; after-purification; evaporation; thick juice saturation and filtration; first fillmass and remelt sugars; further operations with the first fillmass; after-product operations; lime kiln; Steffens separation; osmose process; boiler house; miscellation; tables for calculations.

RUBBER, RESINS, PAINTS AND VARNISHES. By R. S. Morrell, M.A., Ph.D., F.I.C., and A. de Waele, A.I.C. Pp. 236; 33 Figs. New York: D. Van Nostrand Co., 1920. Price, \$4.

This volume of Dr. Rideal's series on industrial chemistry covers a number of important and interesting industries. The book is divided into five parts: part I is devoted to the rubber industry, rubber substitutes and synthetic rubber; part II to the drying oils, including the action of driers; part III to resins and pitches; part IV is divided into two sections, (1) pigments and paints, (2) linoleum, floorcloth and cork carpet; part V, on varnishes, has sections on the oil, insulating, spirit, and cellulose ester types of varnishes and on the methods of analysis. Bibliographies and an index complete the volume.

ORGANIC MEDICAL COMPOUNDS. By M. Barrowcliff, M.B.E., F.I.C., and Francis H. Carr, C.B.E., F.I.C. Pp. 331; 24 Figs. New York: D. Van Nostrand, 1920. Price, \$4.

In preparing this volume for Dr. Rideal's series on industrial chemistry, the authors have endeavored to treat the preparation of organic medicinal compounds on an industrial scale. Thus the method given for the manufacture of ether is that in use at H. M. factories Pembrey and Gretna. The compounds are grouped as follows: Narcotics and general anesthetics; naturally occurring alkaloids and their derivatives; natural and synthetic local anesthetics; antipyretics and analgesics; organic antiseptics and disinfectants; purgatives; vasoconstrictors and vaso-dilators; diuretics and uric acid solvents; organo-metallic compounds; the digitalis group; skin irritants, glucosides and neutral principles.

URANIUM IN STEEL. Pp. 32; 20 Figs. Pittsburgh, Pa.: Standard Alloys Co.

This little book, attractively bound and printed, gives a brief account of the history of uranium, its chemical determination in ores and steels, and its properties as an alloying element. Physical test charts and records of isolated tests are given to show that steels containing but a small percentage of uranium have an unusually high merit number on account of a very material ductility in hardness specimens after a low draw.

PAMPHLETS AND CLIPPINGS IN A BUSINESS LIBRARY. By Virginia Fairfax. Pp. 62. San Francisco: Journal of Electricity and Western Industry.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold a meeting at Rumford Hall, Chemists' Club, New York City, on June 10.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20. Technical sessions are scheduled as follows: Tuesday, on Preservative Coatings and Textiles; Wednesday, on Cement, Concrete and Road Materials; Thursday, on Ceramics, Lime and Gypsum, on Petroleum Products and on Testing Methods; Friday, on Metals.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-eighth annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., the week beginning June 20.

NATIONAL LIME ASSOCIATION will hold its annual convention in New York City June 15 to 17.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

STAMFORD CHEMICAL SOCIETY, Stamford, Conn., holds a meeting in the lecture room of the local high school on the fourth Monday of each month, except June, July, August and September.

CHEMICAL & METALLURGICAL ENGINEERING

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Mineral Tariffs And Raw Materials

THE tariff on minerals involves certain economic and political problems not always considered in the usual protection vs. revenue controversy. What, for example, should be our attitude toward the continual exploitation of basic materials, the deposits of which are already rapidly approaching depletion? What should be our responsibility to American capital invested in foreign mineral supplies, and should we discourage these investments by surrounding our domestic industries with insurmountable tariff walls? Is the doctrine of free trade in raw materials applicable to our mineral industries?

Elsewhere in this issue is presented an unusual discussion of these important questions and the relation they bear to the proposed mineral tariffs. The article, representing only the author's opinions on this subject, is not to be construed as an expression of the editorial policy of this journal, but we believe that it offers a viewpoint of interest to all who are concerned with our mineral developments. To be sure, the detailed classification of some of the minerals may be questioned and many of the proposed tariffs do not warrant serious consideration. It is evident, too, that most of the rates have purposely been set at comfortably high levels in anticipation of later compromise and reduction. The general principles involved, however, apply no matter what rates are to be fixed by the new tariff law, and it is to this broader phase of the subject that CHEMICAL & METALLURGICAL ENGINEERING invites the comment and criticism of its readers.

A tariff on those minerals which because of geological limitations cannot be produced in sufficient quantities to supply the domestic requirements must necessarily raise the selling price of these products. As the producer's margin of profit is broadened, he will attempt to increase his output and will thus hasten the depletion of our limited domestic resources. This must be regarded as an extremely shortsighted policy, especially in the case of minerals of essential war- or peace-time uses. It would be more advisable, perhaps, for the Government to purchase and hold in stock sufficient supplies of these ores to carry us through another emergency.

With reference to the question of American capital invested in foreign mines, it is somewhat surprising to learn that these investments amount to almost a billion dollars and are continually increasing. Many of the proposed mineral tariffs will seriously affect the future return on these investments; in such cases the capital must be withdrawn or the mines operated solely for foreign consumers.

The third question raised by the author is the relation of our mineral supplies to the general and broader

consideration of raw materials. One of the lessons taught us by the late war was the serious economic effect of artificial barriers erected in the path of the free interchange of basic materials. The unrestricted ingress and egress of such articles would place the industries of all countries on a parity with regard to fundamental supplies and leave them dependent for their success as fabricators solely on their own skill and ingenuity. The free and unhindered development of the natural resources of the world represents a goal which can be attained only through the adoption of the broadest principles of national and international service.

Season-Cracking and Intergranular Fracture

COOKS and metallurgists have little in common. The better the cook's work the quicker it vanishes, but metallurgists build to endure—when they put a piece of metal into service it is expected to stay. Spontaneous fractures, occurring under moderate or even no load, are therefore matters of much concern; one cracked condenser tube is of more moment than thousands of sound ones.

Metals widely used in structures, utensils and machines all possess ductility to a certain degree; they deform appreciably before breaking. It has been shown that such normal or healthy fractures almost exclusively pass along crystal planes rather than between the grains which make up the metal. On the other hand, spontaneous fracture of drawn or spun brass goods while in storage, like cartridge cases, cups, jars, or tubes, has in all cases been found to be essentially intergranular. Fire-cracking, the damage done during annealing stamped utensils, is another manifestation of intergranular rupture.

Mysterious failures in other alloys have been studied in the past two or three years, and in nearly every case the crystals have given way at their borders; it therefore appears that season-cracking is a special case of a more general disease. To cite several instances, boiler plates have been found badly cracked at locations of somewhat concentrated forces after long service at the temperatures of superheated steam. Mild steel under low stress can be quickly fractured by immersing in hot chloride solutions. Corrosion, without any accompanying tensile stress, seemed to be responsible for the failure of an iron stirring rod used in a fused niter bath. Ductile metals break at crystal boundaries if tested at temperatures near the melting point. Pure copper develops intercrystalline cracks in a salt bath, and lead crumbles in the same way if exposed to certain weak acids. Furthermore, as is well known, fractures apparently the same as season cracks can be developed in brass articles by immersion in mercury solutions or exposure to ammonia gas.

Now, if these are all manifestations of the same group of phenomena, it is important to discover what is common to all; then see if that common cause is also a sufficient cause. That known, it can perhaps be avoided.

Tension stresses, either internal or imposed, are conceded to be the companion of all intergranular rupture. But why should a piece withstand the load for days or even years, and then give way? Why should a fracture imposed in ten minutes be transcrystalline, another in the same metal but in ten years be intergranular? ROSENHAIN says it is due to the fact that the amorphous intercrystalline cement is a highly viscous liquid, which, like pitch, deforms slowly even at low temperatures and under low loads, if these are prolonged a sufficient time; movement is more rapid as the temperature increases. Consequently fractures under prolonged stress will always be intergranular.

Pushed to its limit this theory would call for ultimate breakdown in all metal, no matter how small the load. Such a conclusion violates common experience and history. Consequently certain counteracting factors must exist.

The one most favored by Dr. ROSENHAIN is the interlocking of crystalline grains—if this condition exists, a small yield in the amorphous cement merely throws the load on crystal projections which can endure it forever. He believes that intercrystalline failure requires polyhedral grains bounded by quite smooth surfaces, a common condition in recrystallized metal. His recommendation is, therefore, to relieve internal stresses by a gentle anneal, but see to it that interlocked crystalline microstructure is retained. By all means avoid prolonged, high-temperature anneals.

But many annealed pieces must endure imposed tension stresses. Will they eventually rupture? It is doubtful. A second factor preventing this unhappy event is the probability that highly viscous supercooled liquids such as intergranular cement act in a truly elastic manner under moderate loads. Granted that a definite yield infers ultimate rupture in unsupported amorphous material, there is evidence that the time required to cause yield becomes infinite before the related stress approaches zero. Ten thousand pounds per sq.in. tension will not produce corrosion cracking within a measurable time in recrystallized brass having smooth grain boundaries. Even though some stress is necessary to produce season-cracking, it seems reasonable to suppose that the metal will endure at lesser stresses. In other words, no metal will break at any temperature unless loaded beyond the elastic limit of the amorphous phase at that temperature, regardless of its age, its composition or lack of crystalline interlacing.

But in many cases, if not in most, corrosion or chemical action at the crystal boundaries is the determining factor. Rarely surface corrosion or a scratch will disorganize the equilibrium of forces, building up localized and unsafe stresses, but this is only in rare cases. Reagents which cause true intergranular failure have been shown by MOORE in England and RAWDON in America to have a very superficial action—not penetrating the crystalline material, confined entirely to its grain boundaries, harmless unless external or internal tension stresses open up the cracks at the affected surfaces, providing the way for further entrance. On this basis time is evidently a controlling factor. A rough crystal surface also obstructs its progress.

But, as argued previously in these columns, there must be some essential difference between intercrystal-

line amorphous material and the amorphous material formed at gliding planes in overstrained grains. That lies either in the fact that the first is a very thick layer, while the latter is only a very few atoms thick, or that the disorganized metal at slip bands is precisely like that of its bordering crystal blocks, as far as chemical composition is concerned, whereas the non-oriented material at grain boundaries is the natural location of slightly soluble impurities. Such segregation may reach high concentrations even in normal practice, but especially in second-rate or over-annealed metal, and are certainly influential in causing the selective action of corroding substances.

It appears that chemical heterogeneity at grain boundaries has not heretofore been given the consideration its importance deserves. It accounts for failures by selective corrosion, which in turn requires time and tension. It is sure to be increased by long annealing even if no new impurities are added, by burning or overheating, since the existing ones will become more concentrated. It decreases the "melting point" of the amorphous phase, and consequently lowers its viscosity at all temperatures.

It may be argued that such chemical segregation is not a determining factor in intercrystalline failure, since it is a perfectly normal attribute of all metal. The same is true of stress. Quality metal, however, must be free of one or the other in order to withstand minute amounts of reagents so common as ammonia and salt. Since the reason for metal's existence is to do work or support loads, it follows that safety can be attained only by carefully controlling the microstructure and microchemistry of the crystal boundaries.

Dryness of The Liquid Phase

THE *Ironmonger*, an English trade paper, notes with regret in its issue of April 30 the disappearance of the corkscrew from British exports to the United States. The phenomenon is declared to be a sequel of prohibition. Little does the editor know his America! Laws are said to follow customs and public opinion, but customs in language and even processes of thought sometimes follow laws. Thus in the olden days a dry liquid such as wine was held to contain a minimum of sugar. The expression did not indicate that the wine was sour, but rather the absence of sweetness. Now, under the enlightenment of prohibition dry indicates the absence of a fermentation product of sugar and not of sweetness itself. Vast quantities of sugar are employed in the manufacture of beverages without affecting the meaning of dry. Out of prohibition also has grown the rule of physical chemistry in regard to dryness of the liquid phase, viz.: The dryness of a liquor varies inversely as to its C_2H_5OH content and directly as the mass.

Now, since all potable liquors are by law between 99.5 and 100 per cent dry the quantities consumed become very great and so do the number of stoppered bottles that contain them. The demand for corkscrews would therefore become greater than before were it not for the crown stopper and another reason which the editor of the *Ironmonger* misses utterly. This is the powerful thirst which has developed among Americans. It is held that a good American of the 100 per cent variety can easily draw the cork from a bottle of high-proof spirits by merely kissing it.

Can Opportunity Be Capitalized?

IN RECENT conversation with a thoughtful scientist he drew our attention to a present tendency on the part of some labor organizations to claim the right to work as their property. In this attitude they do not claim to represent all the people, but they are unwilling to submit their contentions to all the voters. They are a minority, but in some cases they propose to force their views on an unwilling public.

The point at issue and which must not only be decided but made clear one of these days is whether opportunity is property or not. We have prided ourselves in this country that every man has his opportunity free. It is a partial truth, like the lawyer's claim for equity in a day at court. But more men have had opportunity in this country, we think, than elsewhere. It is and always has been our ambition to make opportunity as nearly free as it can be made. The point at issue is how far opportunity may be capitalized and held to the exclusion of outsiders. We have property rights in houses, in bank accounts, in business, in good will, but we have held that every man is free to work.

The rule is not universal. In China they have property rights in houses, land, etc., just as we have, but also such rights in work. The coolie, for instance, is an outsider. He has no property rights in his labor, but he buys the privilege from the man that owns it, that has the concession. This same ownership is claimed by the officials of many labor unions. The tendency under unionism is to insist that work be farmed out to the unions just as the collection of taxes used to be farmed out. The unions select their members, decide what is fair or unfair, and use the power of siege to enforce their decisions.

Now, we favor the organization of workers for their welfare and protection. The selfishness of many employers has made that necessary. But does such organization provide ownership in the privilege to work? Let's take a stupid job like carrying a hod that requires neither training nor intelligence beyond a twelve-year-old mind. Is the opportunity to do this thing restricted to men who belong to the union? Many claim that it is; that the union is sole owner of the opportunity to work at the so-called craft, and that only its members may be employed. But *does* the union *own* the access to work that its members perform? It may and does hold possession, but is it the union's property?

Without of necessity thinking so (and we admit we do not think so), let's grant for the sake of argument that it is. Then the closed shop follows as a natural conclusion. The work is done under centralized, outside control which does not own the business or the machinery. The man who has work to be done and the man who wants to work for him cannot come together without authority which rests apart from them both, in the officials of a union.

There are more things to be done in nearly every country in the world than there are persons to do them. But if the opportunity to work is not reasonably free, then the work cannot be done. If opportunity is property, invention of labor-saving machinery must be brought to a stop as soon as general unionization ensues.

But if opportunity is not property; if the outsider, no matter who he is, has access to opportunity, there would seem to be a lack of equity in the closed shop. In the open shop the union must prove itself and do well. In the closed shop it is an absentee landlord.

Common Honesty And Self-Interest

ONE of the notable features of the present economic situation is the fact that some commodity prices are very much higher than others, judged either by their pre-war standards or by the production costs involved. In his very able discussion of the business and economic situation before the recent meeting of the American Iron and Steel Institute Judge GARY intimated that some sellers who are still holding their commodities at very high prices "ignore the principles of common honesty." Many may hold that it is taking new or advanced ground to declare that it is not honest for the ordinary seller to seek the highest price he can obtain or ask any price he has a mind to ask. Judge GARY is the head of a large corporation, and it is commonly held that a corporation large in its field should not charge an unreasonable price. Why should it be right for a seller small in his field to do so, when circumstances unprecedented have made it possible? Society always decides that what is not good for itself is wrong, and the great majority of men today believe that the continuance of high prices for some commodities, when prices of other commodities have greatly declined, is retarding the resumption of business activity, which would be for the general good.

Entirely apart, however, from "the principles of common honesty" is the question of enlightened self-interest. Is it wise, from the purely selfish viewpoint, for a seller to maintain high and unreasonable prices, simply by the fortuitous circumstance that all sellers of the commodity chance to be of the same mind and competition does not reduce prices? General business activity will not be resumed before all prices are adjusted, and if the completion of the adjustment is expedited all will benefit.

The common view seems to be that business will become active when the readjustment is completed—in commodity prices, in wage rates and in charges for service. It is by no means certain that resumption on the full scale will occur at once. Two things are required—the investment of capital and the spending of a large percentage of the normal or full income of the people. When there is much idleness, as at present, that income is greatly reduced. The normal buying power of the people must be restored, and that is a process requiring time and it is the duty of everyone to do what he can to help.

It has always been recognized that for the good of society all prices should be fair and reasonable, whether for commodities, for service or for plain work. Prices too low are as bad as are prices too high. Hitherto we have depended chiefly upon competition as the regulator, as is seen, for instance, by our being very jealous of suppression or partial suppression of competition by the acts of men; and more than thirty years ago Congress enacted a law fixing penalties and establishing methods of procedure in cases of "conspiracy in restraint of trade." In essence the Sherman law did not make such conspiracies illegal, as it was recognized that they were contrary to the common law; it prescribed what should be done. Present experience indicates that reliance upon competition as a corrective has broken down and society needs something more for its protection and welfare. Hence arise references to "the principles of common honesty" and the hope that enlightened self-interest will have a controlling influence where competition fails to operate.

Readers' Views and Comments

Easy Money From Peat

To the Editor of Chemical & Metallurgical Engineering

SIR:—A few days ago I learned from a friend of mine that a friend of his and several other gentlemen were investigating and seriously considering investing in a world-revolutionizing process which is none other than the one you exposed in the article "Easy Money From Peat" in *CHEM. & MET.*, Feb. 2, 1921, page 213.

I told him of your article, which he subsequently brought to the attention of his friend, with the result that the prospective investors will save their money for other purposes. I would have been glad to see a demonstration of the process, but when the investors asked for a demonstration they were told that none could be made now, as the amount of stock at present offered for sale had already been subscribed. The promoter evidently surmised that the would-be investors had discovered his game and he found it expedient to look elsewhere for lambs to be shorn. I thought it would interest you to know that the process is still very much alive.

Newark, N. J.

CHEMIST.

A Suggestion for the National Research Council

To the Editor of Chemical & Metallurgical Engineering

SIR:—The National Research Council, like every other organization at the time of its creation, to become a functioning body has to grope around and possibly crowd itself into some niche partly or wholly occupied by some other organization already in existence. Without doubt in the effort to find some one duty the National Research Council can perform better than any other existing organization a number of experiments will be tried which will wholly or partly fail.

At the present time the council is vaguely offering aid to American scientists—and I am writing this from the organic chemist's standpoint—in their research problems. I believe that this endeavor will have little success for several reasons. First, no scientist will disclose his plans sufficiently for the council to get an adequate idea what he is trying to do and its advice can be very general only. Directions in research work should be more specific than the directors of the Research Council will be able to give. Second, the organic chemist in the smaller schools doesn't usually suffer from lack of material and apparatus, but from lack of access to literature; therefore he will not take advantage of the offer to lend apparatus. Books to be useful must be readily accessible. If one is to consult a reference it is important that it can be done promptly. One can anticipate very few of his needs in literature references. For this reason I do not believe the experimenter in the smaller school can make use of the offer of aid in research.

One who has taught in a small school, which is often located in a small town, knows that the greatest need of the teachers is the stimulus obtained from meeting and hearing our able chemists. Sending them around the country makes them accessible to a few of us, but we aren't asking for charity so much as we are asking for

an opportunity. Would it not be feasible and worth while to conduct a series of meetings resembling the present teachers' institutes, to be held in a number of centers where we could spend a week or ten days during vacation periods and hear and meet a number of our prominent chemists? In addition to hearing these men we would have the chance to exchange ideas with men who are interested in the same work and the result would be an increased interest and efficiency and an increased amount of research work.

These institutes could be conducted in a business-like way with a charge which would cover or at least partly cover the cost of the undertaking. I am interested in learning what others think of such a plan.

Miami University,
Oxford, Ohio.

HARVEY C. BRILL.

Cost of Fixed Nitrogen

To the Editor of Chemical & Metallurgical Engineering

SIR:—In your issue of April 20 K. W. Jensen makes some comment on my article concerning cost of nitrogen fixation in the issue of March 23. Mr. Jensen states that his knowledge of the question is derived from a visit to Rjukan, Norway, and from theoretical studies. As I have been connected for twelve years with the Norsk Hydro-Elektrisk Kvælstofaktieselskab, which operates the factories at Rjukan and Notodden, and during this time have conducted the work of projecting and fitting up the firm's most modern plant, Rjukan Fabrik anlæg II (100,000 kw.), Mr. Jensen's experience does not impress me very much.

In explaining the Birkeland-Eyde furnace Mr. Jensen has the ill luck to make an erroneous statement. The disk of flame is *not* due to the action of *two* magnets, alternately charged and discharged, but to the action of *one* magnet, charged with *continuous* current, one pole at each side of the furnace. The extension of the disk at both sides of the electrodes is due to the fact that the *electrodes* are charged with alternating current. It ought not to be necessary for Mr. Jensen to travel to Norway to gain this knowledge, as he might have learned it from the technical literature. (Cf. Geoffrey Martin, "Industrial Nitrogen Compounds and Explosives," 1917, page 23; Jean Escard, "Production Industrielle Synthétique des Composés Nitrés," 1920, page 40; H. Ost, "Lehrbuch der Chemischen Technologie," 1920, page 168.)

Mr. Jensen writes that I ought to have made a lengthy explanation of the Birkeland-Eyde furnaces. In giving a short statement of the steps in the process the intention was to give information to readers who knew little of the subject, or, like Mr. Jensen, had formed mistaken notions. Is Mr. Jensen aware of the fact that at Rjukan Schönherr furnaces are used besides the Birkeland-Eyde furnaces?

I must maintain that in all types of electrical furnaces for the fixation of atmospheric nitrogen the electrical arc is given an increased area in order to heat the air by forming an enlarged heating surface. I presume that after all Mr. Jensen and I are of one mind about this point.

Christiania, Norway.

T. C. HAGEMANN.

British Chemical Industries

FROM OUR LONDON CORRESPONDENT

LONDON, May 17, 1921.

BUSINESS in the chemical markets is still mainly of the hand-to-mouth variety and the increasing number of works that have closed down on account of the coal shortage has naturally had a cumulative effect in reducing the volume of business transacted. The undertone both prior to the stoppage and even now is, however, favorable, surplus stocks are dwindling, and it is expected that, taking into account the practical cessation of German imports, there should be a healthy revival two or three months hence. The financial resolutions for the protection of industries bill have been duly passed by Parliament, but it is too early to predict the effect of the actual measure when it comes up for consideration after the holidays. The reparations bill, under which 50 per cent of the value of German goods imported is to be recovered, has so far produced only \$25,000, a figure which is a true measure of its failure to date. It is understood that the amount payable will now be reduced to 26 per cent on account of Germany's acceptance of the Allied ultimatum.

MANY PLANTS CONVERTING TO OIL FUEL ON ACCOUNT OF COAL SHORTAGE

The big oil-producing companies have been quick to seize the opportunity afforded them by the cutting off of supplies of coal and so far labor has not attempted to place an embargo upon the importation of fuel oil as in the case of foreign coal. By a suitable reduction in the price, oil fuel has for the time being become a serious competitor of coal, particularly in power plants and works situated some distance away from the main colliery centers. The ease and cheapness with which conversion can be effected has induced others to install oil-burning appliances as a stand-by for existing coal-fired installations and the natural result has been a boom in oil burners new and old, good, bad and indifferent. It is a little difficult for a great oil-burning nation like the United States to realize that the use of fuel oil in this country is practically in its infancy, but provided the present reduced price can be maintained, there can be no doubt of a steady increase in demand, which in its turn would react upon the price and also upon the supplies available in the future for American consumption.

"CHALKOAL"—A JOKE OR AN ATTEMPT TO GULL THE PUBLIC?

A further sign of the difficult industrial and domestic position occasioned by the coal stoppage is the crop of coal substitutes such as peat, logs, sawdust and briquets of all kinds which are being advertised for sale. A good illustration of the potential gullibility of the public and perhaps also of the promoters of the enterprise is the amusing advertisement and propaganda of the Chalk Fuel, Power Gas and By-Products Corporation, Ltd. This company proposes to supply blocks or ovoids of "Chalkoal," a mysterious "patented" substance manufactured under a secret process and stated to contain 70 per cent of chalk mixed with "10 per cent of a rich carbon substance subjected to special treatment" and the basis of which is coal tar. The preliminary announcement states that it is "a scientific fact that chalk by itself is not a satisfactory fuel [*sic*], but in

conjunction with other substances it has more fuel properties." A user is quoted as follows: "I find that in burning the briquet the gas which the chalk contains readily combines with the carbonaceous matter, and therefore gives you a combustible gas, giving off great heat, and double that of the ordinary household coal at from one-half to three-quarters less cost." The tragedy of it all is, of course, that the residue amounting to between 10 per cent and 33 per cent is a valuable byproduct threatening the cement and lime industries with extinction. Why the promoters should have kept the matter secret since 1914, when it was first "tested," is not disclosed.

CHEMICAL STONEWARE FIRMS RETURN TO PRE-WAR APATHY

During the war several manufacturers of stoneware undertook, at the request of the government, the production of chemical stoneware, and while the need remained urgent, valuable work was done and chemical stoneware almost equal to the pre-war German material was obtainable. The enormous demand shortly after the armistice for stoneware other than chemical stoneware caused most of these firms to abandon the less profitable manufacture of chemical ware, and as a result it is almost impossible to obtain reasonable deliveries, or any deliveries, at the present time, while with one or two exceptions manufacturers are asking exorbitant prices, probably with a view of discouraging the continuance of this class of business as being too much trouble. Supplies of German stoneware came into the market only to stop on account of the reparations act. The position has therefore become an interesting one and French, Belgian and even American stoneware is likely to be in demand in the near future. Curiously enough, an American firm, Bush, Beach & Gent, is acting as the British agent for the Deutsche Steinzeugwaarenfabrik, of Friedrichsfeld, but judging by its advertisements in the press, the technical knowledge of its staff leaves much to be desired. It is generally thought that a progressive American firm able and willing to purchase an existing works in this country would soon find a ready field of activity in the chemical stoneware market, particularly if standardization were carried out as far as possible.

SIR WILLIAM POPE DEFENDS CHEMICAL WARFARE

In a closely reasoned contribution to *Chemical Age* (London), the president of the Society of Chemical Industry has once again displayed a fearlessness and independence of thought which has left some of his more staid and more conservative colleagues somewhat aghast. Not only is it claimed that the use of gas is less inhuman than other accepted forms of warfare—and this is effectively and humorously demonstrated by historical and practical evidence—but in effect it is shown that the most fatal weapon in the war was that of preventive medicine. By enabling millions to wage war and by depriving the non-combatants of the world of their meed of medical protection the responsibility for another and very large class of casualties is laid at the door of the medical profession. Sir William Pope, by his candor and innovations in other directions—for instance, by welcoming criticism as indicating a healthy tone in any society, by promoting joint local meetings of the Chemical Society and of the Society of Chemical Industry—has done more good than is realized by the "Old Guard."

The Tariff on Minerals

A Novel View in Opposition to the Policy of Tariff Protection for Minerals, Based on the Present Status of Our Mineral Industries and on the Effect of a Tariff on Their Development

By MARC PAWL

THE Ways and Means Committee of the House of Representatives has an exceedingly difficult job in trying to fix just rates in the new tariff bill that is to be introduced during the present session of Congress, for no man can know the conditions surrounding all the multifarious industries of this country, and no man can visualize the ramifying effects of a tariff. The difficulties are increased by the testimony and the briefs brought before the committee, for they are almost invariably highly colored by the desires of financially interested pleaders. In some of the briefs not a single fact is given without distortion, though a very few give fair and even scholarly presentations of their cases from the pleaders' standpoints.

In most pleas, especially by monopolistic concerns, costs, which ought to be the very foundation on which a tariff is erected, are carefully concealed, or excessively high costs covering the less defensible part of the industry are given, and the public is asked to grant a tariff to bolster prices, the justice of which is not shown.

In going over the reports of hearings before the Ways and Means Committee of the House, the unanimity of the emphasis placed on certain points is striking. Nearly all bills declare that they are "to provide revenue for the Government and for other purposes." One is to provide for the national security and defense, but I have seen one only that frankly states that it is merely to fix a duty on a mineral. One fears the Greeks who come bearing gifts.

Many of the pleas are for a tariff of 100 per cent or more of the price of the mineral or metal before the war, though some are less, and many have not yet reached the form of bills. Most of them ask for duties that will hold prices at or near the level reached during the Great War, but all show that the industry will not be overly enriched, and that the ultimate consumer will never know that his pocketbook has been touched.

Congress, in order that it might have less biased information than that introduced by special pleaders, provided for a Tariff Commission to investigate conditions governing the various industries, one of the most forward steps taken in tariff legislation in this country. This commission has done serious, hard work, but being composed of mortals, even as you and I, will require years to cover the huge and ever changing industrial world before it.

EFFECTS OF A MINERAL TARIFF

Perhaps no industry offers simpler conditions for weighing the application of a tariff than the mineral industry, and no industry except farming is more vital to our well-being.

General Hancock was, of course, wrong when he said that the tariff was a local issue. None but the immediate beneficiary has a local habitation. The payor is

every purchaser from Cape Prince of Wales to Key West, and the effect of a mineral tariff may be much more serious than the immediate effect it has in increasing the industry or raising prices.

Ore deposits are diminishing assets. They are like cisterns—they hold a fixed quantity, but unlike cisterns they cannot be filled again. The first production—that from the outcrop—is the cheapest, and as the deposits are worked to greater depth, or the richer ores are worked out, the costs become greater. The first deposits worked are usually the richest and nearest to transportation routes, and there is only one crop of ore.

On these truths, so axiomatic that they are almost trite, is built the mining industry, yet every appeal for a tariff is based on the assumption that these factors do not apply to the particular item under consideration. The plea is almost invariably made that if proper "protection" and "encouragement" are given, the industry will prosper, though the lack of prosperity may be due to lean deposits, inefficient operation and poor location, for ore deposits are where you find them and may be in very inconvenient places.

Never before has there been so good an opportunity for a proper estimation of the country's mineral resources as the present. During the Great War, the prices for minerals and metals reached heights unheard of. Prospecting took on new life, and men went over the country with a fine-toothed comb. Every possible outcrop was carefully examined and known deposits were worked to the limit. At the same time, governmental agencies gathered together all possible data thus made available.

OUR MINERAL RESOURCES AND PROPOSED TARIFFS

Although the United States is the richest mining country in the world, there are certain metals and minerals in which it is very poor, of which the principal are nitrates, the platinum metals, tin, nickel, soluble potash salts and diamonds. We have some of all of them, but by no possibility can we get enough for our needs from known deposits. If we think of our mineral resources as represented by a pyramid, these mineral products may be taken as forming the apex, thus approaching zero. If we imagine the lower part of the pyramid as curving so that at the bottom the sides become nearly horizontal, the base may be taken to represent our illimitable supplies of such minerals as salt.

Using such an idea, the minerals and metals on which duties are now being asked have been grouped in the accompanying table. The list is divided into two main groups: I. Minerals of limited quantity; II. Minerals in large quantity. Under the first group three divisions may be made: A. Minerals insufficient for domestic needs; B. Minerals insufficient for domestic needs ex-

MINERALS ON WHICH DUTIES ARE ASKED

	Proposed Tariff	Price in 1913
I. Minerals of limited known quantity:		
A. Minerals insufficient for domestic needs:		
1. Antimony ores.....	10c. per lb. contained Sb in ores, matte and antimonial lead.....	Best grade, 8.53c. per lb.
2. Cobalt oxide.....	75c. per lb.....	50c. or more per lb.
3. Tin ore.....	10c. per lb. Sn and 4c. on Sn in ore.	44.2c. per lb.
4. Graphite (lump and amorphous).....	Lump 3-6c., amorphous 2c. per lb..	Ceylon lump 6.5-11c. per lb.; amorphous 1-1½c. per lb.
5. Diamonds.....	10% (incl. borts).....	.....
6. Iodine (resublimed)...	33½% ad val.....	.....
7. Nickel.....	10c. per lb.....	38c. per lb.
B. Minerals insufficient for domestic needs, except at artificial prices:		
1. Aluminum (bauxite)...	Al 7c. per lb., bauxite, not determined	.....
2. Chromite.....	60c. per unit.....	50% Cr ₂ O ₃ , \$10.12 per long ton.
3. Manganese ores.....	40c. per unit.....	\$7-\$12 per ton.
4. Monazite.....	15c. per lb.....	None produced.
5. Tungsten ores.....	\$10 per unit (20 lb.) WO ₃	\$7.50 per unit WO ₃ .
6. Pyrite.....	10c. per unit S.....	8.4c. per unit S (Virginia).
7. Mercury.....	50c. per lb.....	52.7c. per lb.
8. Graphite (flake).....	6c. per lb.....	6-8c. per lb.
9. Mica.....	Unrefd. 25c. per lb. and 20% ad val.....	37c. per lb.
10. Potash.....	50c. per unit K ₂ O.....	66c. per unit.
11. Vanadium.....	\$1 per lb. (in ore?).....	.....
12. Magnesite.....	Crude \$15 per short ton. Calcined \$25 per short ton.....	Crude \$7. Austrian calcined \$16.20 per short ton.
C. Minerals sufficient for the immediate future:		
1. Arsenic (white).....	5c. per lb.....	4.4c. per lb.
2. Barite.....	\$15 per short ton.....	\$1.71 per short ton.
3. Bromine.....	7c. per lb. plus 30% ad val.....	20.1c. per lb.
4. Fluorspar.....	\$5 per long ton.....	\$6.37 per ton.
5. Fullers earth.....	75c. and \$1.50 per short ton.....	\$9.58 per short ton.
6. Lead ores.....	½c. per lb. Pb cont.....	4.4c. per lb.
7. Molybdenum ores.....	50c. per lb. on MoS ₂ and concentrates.	80% conc. 42½c. per lb. MoS ₂ cont.
8. Zinc ores.....	2c. per lb. Zn in ore.	5.6c. per lb.
9. Feldspar.....	Not determined.....	\$3.31 per ton.
10. Sulphur.....	0.75c. per lb.....	0.8c. per lb.
II. Minerals in large quantity:		
1. Lime.....	\$1 per bbl.....	75.3c. per bbl.
2. Building and monumental stone.....	\$1 per cu.ft.....	.....
3. China clay.....	\$6 per ton.....	\$6.76 per ton.
4. Gypsum.....	50c. per ton.....	\$1.51 per ton.
5. Magnesium chloride.....	\$15 per ton.....	Fused, \$8 per ton.
6. Magnesium.....	10c. per lb. plus 15% ad val.....	\$1.65 per lb.
7. Flint (quartzite is used as a substitute).....	Not determined.....	.....
8. Pumice.....	\$20 per ton.....	\$2.26 per ton.
9. Talc.....	\$10 per ton.....	\$11.90 per ton.
10. Salt.....	\$5 per ton and duty on container.....	\$2.72 per ton.
11. Coal.....	75c. per ton.....	\$1.33 per ton at mine.
12. Phosphorus.....	17c. per lb.....	.....

cept at artificial prices; C. Minerals sufficient for the immediate future. It is probable that few if any of the producers will agree with the grouping, but the divisions are as indicated by the statistics of the United States Geological Survey.

A. MINERALS INSUFFICIENT FOR DOMESTIC NEEDS

All of the minerals of the first group are necessary in our commercial economy and will be imported no matter what tariff is placed on them. Tin ore, diamonds, and graphite in lump form are three mineral products that the United States lacks almost entirely.

We do have some amorphous graphite, to which reference will be made again. Flake graphite is put in the second group.

ANTIMONY ORES

Our experience during the war showed that sufficient antimony to supply the needs of the United States cannot be produced from our known deposits at five times the price of 1913, the last normal year, or seven times the present price of 5.5c. per lb. Even at a price of 14 to 16c. which the proposed tariff would probably put on the metal, it is likely that not over 500 of the 7,500 tons normally used in this country could be produced. Ten cents per lb. above the normal market price for

7,500 tons would be \$1,500,000, that someone would have to pay as a tax, although the revenue that the Government would receive would be \$100,000 less. Besides the deposits in our own country, Americans own considerable antimony deposits in Mexico.

COBALT OXIDE

Cobalt oxide is produced in only one mine, that at Fredericktown, Mo. Queerly it is controlled by Canadian capital, and Americans produce much more cobalt ore in Canada.

TIN

We produce not more than 200 tons of tin concentrate per year, say 135 tons of tin, and we can not enlarge this notably. The war put a price of 75c. to \$1 a pound on tin for a considerable period, but production did not increase. Great Britain, through her assiduous and long-continued collection of unprotected territories, has acquired about 50 per cent of the world's tin deposits, not including Siam's, which she also virtually controls, but the United States, a non-producer, uses about 80,000 short tons (1918 figures) out of a world's production of 131,000 tons, or more than 60 per cent, and it seems possible to control commercially only a part of the ore necessary. The largest independent miner of tin ore is Bolivia, which produces 28,000 tons of tin in ore that is shipped to other countries for smelting, equivalent to more than one-third of our requirements, and it is possible that more ore may be mined under the initiative of outside capital.

Years ago the spectacle of American tankers carrying kerosene to Asia and coming back empty moved some American capitalists to build a tin smelter at Bayonne, N. J., with the idea of smelting tin concentrate to be brought back by the tankers from the Malay Peninsula, but a British company had a smelter at Singapore and the government promptly placed a 33½ per cent export tax on the ores and the smelter at Singapore continued a strict monopoly. The Bayonne smelter was put out of business, but five others have grown up, and all the Bolivian ore can now be handled here, though much of it goes to Europe and Singapore. Excellent electrolytic tin, apparently fit for all purposes, is now made here. A tariff on ores will give revenue, but cannot build a tin mining industry.

It must be remembered, however, that the United States cannot buy ore sufficient for her needs, for she uses 60 per cent of the world's output, and, including Siam's output, Great Britain controls nearly 60 per cent.

A duty of 10c. per lb. on tin would make an extra cost of \$3 a ton on tin plate, and unless a rebate were allowed on export material, this might readily kill the export trade. Americans, however, would have to pay the increased cost.

Americans have several million dollars invested in tin mines in Bolivia and other millions invested in tin mines in the Federated Malay States and China.

GRAPHITE

This country has no deposits of lump graphite, from which the best crucibles are made, but imports its supplies from Ceylon, the one great producer, and Americans are interested financially in Singalese deposits. Our American deposits of amorphous graphite are not to be compared with the deposits in Sonora owned and operated by Americans. These deposits formerly fur-

nished and probably yet furnish the graphite for the best lead pencils of both domestic and foreign make. The heavy duty proposed, about 100 per cent on flake graphite, is probably aimed at the Madagascar flake, which really competes with the American product, but the tariff on amorphous graphite is from 167 to 200 per cent of the 1913 prices.

DIAMONDS

The problem of the diamond is only a phase of the "woman question." The diamond millionaires of Great Britain, forming one of the most rapacious and complete monopolies known, were created and are kept growing by the American bride-to-be. Her solitaire is usually far more expensive than the young man can properly afford, and the price is maintained and kept up to all the traffic will bear. The mass of diamonds are indefensible luxuries for which prices beyond all reason are charged and paid to satisfy mere whims, so that no objection can be made to a tariff of any sum. A smaller part of the diamonds imported are for serious use. (It is not, however, intended to suggest that being a bride-to-be is not a serious matter!) They are the borts or imperfect stones and the carbons or amorphous diamonds, and are used in diamond drilling, glass cutting, etc., and a duty on them is a tax on necessities and especially on mining. The prices for these stones reflect the prices on gem stones and are out of all reason, even without a duty.

IODINE

Iodine has so far been produced only experimentally in this country. It comes from Chile, where it is obtained as a byproduct from the nitrate deposits in which American firms have millions of dollars invested, and can be produced in quantities far beyond the world's needs.

NICKEL

The suggestion that a tariff be placed on nickel is probably not to be taken very seriously. The richest nickel deposits in the world, those of Sudbury, Canada, are largely held by the International Nickel Co., an American company, and this company also supplies the larger part of the world's manufactured nickel. The investments of the company in Canada are valued at many millions. Under no imaginable circumstances could the United States supply its needs of the metal.

On none of the minerals of the first group except diamonds for gems does a tariff seem justifiable.

B. MINERALS INSUFFICIENT FOR DOMESTIC NEEDS EXCEPT AT ARTIFICIAL PRICES

In the group of minerals insufficient for domestic needs except at artificial prices are several minerals of which it is conceivable that if the price were high enough the entire needs of the United States might for a short time be supplied from domestic mines. During ordinary times, however, it has been found expedient to import a considerable part of our supplies, the proportion varying from almost the total quantity of potash to a comparatively small part of our flake graphite and mercury.

With the exception of monazite, this group of minerals was of enormous use in carrying on the Great War. Except for aluminum, graphite, mica and pyrite, these minerals were almost or quite irreplaceable by substitutes. We have not yet joined the League of Nations

and there is as yet no insurance against war. Few thought the Great War possible, another may be nearer than we think.

Using for our nation the same sort of thoughtful care that we do for our families, what must be our attitude toward these deposits, the depletion of which, comparative or total, is apparently only a handful of years away?

BAUXITE

An important item that must be stressed when considering the cost of minerals is the matter of purity. Thus American bauxite ordinarily carries from 8 to 9 per cent SiO_2 , against 2 to 3 per cent SiO_2 in good foreign material, and only 55 per cent Al_2O_3 , against 62 per cent Al_2O_3 in the foreign ore. These differences are equivalent to an added cost of several cents a pound to the manufacturer if he must use the lower grade mineral. The same reasoning applies to chromite and manganese ores, to monazite and pyrite. The mass of domestic ores are of lower grade than the imported ores, and if the American metallurgist is compelled to use them either he must bear the added expense of reduction, or he must pass the cost along with the duty to the ultimate consumer—to you and to me, and to William Jones and John Brown, who are so lost in the crowd that, like the grains of sand on the beach, we blend in blurred obscurity unless someone stoops to look at us.

CHROMITE

Under the desperate needs of the Great War we produced 82,350 long tons of chromite averaging 50 per cent or less Cr_2O_3 at \$48 per ton, but at the same time we imported more than 100,000 long tons averaging 50 per cent or more Cr_2O_3 at \$28.88 per ton. That is, we produced four-ninths of our needs at a cost one-third higher than that of the five-ninths imported. Not only were the actual costs higher during the war, but an indirect cost was added of which little account was taken. That was the excess of cost in working lean concentrates, of which I have just spoken. At a time when every pound of coal and every bit of electrical energy was so greatly needed, we had to waste a great deal of it in slagging off useless rock. This was a tax as burdensome as the higher prices, but invisible to any but the metallurgist.

MANGANESE ORES

Almost the same conditions applied to manganese ores. Our own deposits were mostly small and mostly poor. Some high-grade deposits were developed and some are now known, but they are very much smaller than our needs, and must have high prices to work successfully. The manganese deposits associated with the copper ores at Butte (rhodochrosite) and Phillipsburg, Mont., are large, and water power is conveniently developed, but mining is expensive and the ore is not the cheapest to reduce. But even under war conditions, we cannot produce the ores we need, and under peace-time conditions higher grade ores at much lower prices can be readily obtained from India, Brazil and Russia.

Americans own large manganese deposits in Brazil, and other deposits are owned in Mexico and India, involving investments of probably \$5,000,000.

MONAZITE

The proposed tariff on monazite is another case of a proposal to compel the use of American material of lower grade and higher price. The marketable mona-

zite from the Carolinas carries only 4.5 to 5.5 per cent ThO_2 , against about 6.5 per cent in the Brazilian monazite, and 8 to 9 per cent in that from Travancore. If the bill passes, either the waste of chemicals and the extra freight and labor costs required to use the American material or trebled cost for foreign "sand" must be faced. It is worth mentioning that John Gordon, an American, is the principal Brazilian monazite producer.

TUNGSTEN ORES

Tungsten ore is another particularly bad subject for a tariff. In 1917, under prices at least three times the normal and which had existed for two years, we were able to produce a little more than one-half of our needs. In 1918, under similar prices, we produced one-third of our needs. Under a price of \$17 per unit, two and one-half times the normal price before the war and the price which it is hoped will be reached under the proposed tariff of \$10 per unit, it does not seem probable that the United States can produce more than 3,000 tons per year for three years from the deposits now known. Indeed this seems a rather optimistic estimate. Remembering the intensive prospecting of the war period, we have no reason to expect the discovery of deposits that will greatly alter the situation.

Americans own tungsten deposits in Bolivia, Mexico, Portugal, Argentina, Korea and Siam, worth probably a million dollars. The imposition of a tariff will, of course, prevent their shipping their ores to this country.

PYRITES

Before the Great War most of our sulphuric acid plants were fitted to use pyrite only, and great cargoes were brought from Rio Tinto, Spain, to supplement domestic supplies. Huge quantities of acid are made from waste gases from smelters, and sulphur is now being burned in large quantities for acid making. The usefulness of sulphuric acid depends largely on its cheapness, and a high degree of civilization demands cheap sulphuric acid, but tariffs on pyrite and sulphur mean dearer acid. In their need for pyrite, Americans were forced to buy pyrite mines in Canada and have considerable money invested in them. Their output will be affected by the tariff like any foreigner's product.

MERCURY

Of mercury the United States mines about half of the world's supply, but according to testimony before the Ways and Means Committee our ores carry only about 8 lb. to the ton and our cost is 93c. to \$1 a lb. According to the same testimony, Spanish quicksilver is produced at a cost of 50c. per lb. During the Great War, the price of mercury reached \$125.89 per flask of 75 lb. If the figures for costs of production are accurate, American mercury cannot compete with foreign mercury even under the proposed tariff, for it certainly cannot be put on the market at less than 20 per cent gross profit. This added to the cost of \$70 to \$75 per flask will make a price of \$84 to \$90 per flask. The Spanish producers, if their costs are given correctly, should at the same rate of profit be able to lay their mercury down in this country at slightly less. Either the figures are wrong or the tariff proposed by the miners will be futile. For years American mercury has been sold for export at \$5 per flask under the domestic price.

FLAKE GRAPHITE AND MICA

Of flake graphite the deposits of the United States are comparatively large, and Americans are known to be interested in flake graphite deposits in Canada. The Madagascar flake is better than the American, and will probably be imported in spite of a tariff, the duty merely adding to the user's troubles.

Mica is mined from pegmatite dikes and like all pegmatitic minerals is proverbially in uncertain quantity. The mining of mica in this country has always been so precarious that large users have invested in Canadian deposits in order that they might be sure of their supply. No one can foresee or foretell what the future supply will be. It is peculiarly an industry adapted to countries like India, where labor is cheap. Prices for mica have always been very high, and with the advent of the great electrical industry they have become higher. It is at present a small industry employing very few persons.

POTASH

So far very few deposits of soluble potash salts have been found in the United States. They are confined to the small brine lakes of northwestern Nebraska, the salt fields in Great Salt Lake Desert, and Borax Lake in the Mohave Desert, California. There is no likelihood of our being able to supply our needs from these sources. More laboriously, potash is being obtained from kelp along the Pacific Coast, from the dusts of cement mills, from wood ashes, from alunite and from green sand marls of the Coastal Plain. Experiments without number have been made on the production of potash from the feldspars and other silicates, but to date these have not met with commercial success, though the use of glauconite is promising. We are still, and probably will be for a good while, dependent on the German and French deposits for a large part of our potash. The proposed tariff will add 75 per cent to the cost of potash, and may encourage continued experiments on the extraction of potash from the silicates. Potash is used mostly in fertilizers that are used in farming, the most poorly paid of the basic industries, and by the farmer must the cost of the experiments be paid. The passing along of the tax is in his case a grim pleasantry, for he does not and cannot fix the price of his products.

VANADIUM

The proposed vanadium tariff is probably not to be taken too seriously. More than half of the world's vanadium comes from the unique deposits at Minaragra, Peru. The deposits are American owned and operated, and recently changed hands at a price of \$3,000,000.

Our own vanadium deposits are mostly in southwestern Colorado and southeastern Utah. A large part of the output is made as a byproduct from radium ores.

It is likely that at recent prices we can supply most of our needs for five years or more from the known deposits.

MAGNESITE

Under normal open market conditions, magnesite has been a comparatively cheap mineral, but it is heavy and bulky. The American mines are located in California and Washington, but the principal users, the steel mills, are located from Chicago eastward to Buffalo. The California deposits are comparatively small, and for many years were worked with the tacit acknowledgment that without an unreasonable tariff they could not well

compete with the Austrian magnesite on account of the much greater size of the Austrian deposits and the high freight rates from California to the Eastern steel mills. Before the Great War it was not always easy to get supplies of magnesite as they were needed and one of the large American magnesite brick manufacturers bought an Austrian deposit and invested altogether \$1,000,000 in the project. Other Americans bought and operated magnesite deposits in Venezuela, Lower California and Canada.

In 1915, the year following the outbreak of the war, when all imports were cut off, Austrian calcined magnesite was selling for from \$25 to \$26 a ton in New York, and brought as high as \$60. The deposits near Chewelah, Wash., were rediscovered, and the high prices and shortage of magnesite offered an excellent opportunity for their exploitation. One company made an investment of nearly a million dollars and another company made an investment of half a million. At the prevailing prices and shortage of the material even the California deposits were enabled to ship to the East, and large developments were made. But the war came to a close and left the large Washington investments unamortized. With the cessation of hostilities in Europe, the usual sources of magnesite again became more or less available, and railroad freight rates had meanwhile increased largely so that neither the Washington nor the California operators would have been able to ship magnesite in competition with the European producers, even had the demand not collapsed with the steel business. It is now proposed that a duty of \$25 per short ton of calcined magnesite, equivalent to more than 150 per cent ad valorem, be levied, making the price to the Eastern consumer at least \$41 per short ton of calcined magnesite, and probably nearly as high to the Western buyer.

On the crude magnesite a duty of \$15, or more than 200 per cent, is proposed, making the cost at least \$22 per ton. Should the consumption be equal to that of 1913, it would be equivalent to 172,591 tons of calcined and 161,967 tons of crude, on which would be levied a total tax of \$6,740,000. It is explained that the cost is distributed over so many tons of steel that it will be unnoticeable. It will, however, put out of business the Americans who have invested in mines in foreign countries.

The proposed tariffs are so high that, if put into effect, they may defeat their objects, for at these prices it seems possible to make profitably an artificial magnesite and thus leave the Western mines without their market.

BAUXITE AND ALUMINUM INDUSTRY

It is impracticable to consider the tariff in relation to all the minerals as such and without regard to the manufactures from them; thus bauxite must be considered with aluminum. In the United States the aluminum industry is centered in a single company. It owns most of the American bauxite deposits and controls most of those in the Guianas—the best and largest known. This company, the Aluminum Company of America, has a monopoly of aluminum production both in the United States and Canada, and in 1919 its capacity in the United States was 90,000 short tons of the world's plant capacity (exclusive of Canada) of 270,000 tons, and including its Canadian plant, possibly 210,000 tons, or about 70 per cent of a total of 310,000 tons. It has kept free from competition probably as closely as any other American company.

It has net assets of more than \$110,000,000, apparently mostly derived from earnings.¹ Inquiry along this line at the tariff hearings was not allowed to proceed. The representative of the company admitted that it had had, through its Canadian branch, a selling agreement in Canada and Europe which on account of the law did not apply to the United States. The cost of manufacture is supposed to be from 12c. to 13c. a lb. The selling price is from 28c. to 30c. a lb. In the committee hearings no data were brought out or asked for on this point. In its brief the company speaks of using only Arkansas bauxite of low grade, although in British Guiana the company owns the finest known bauxite deposits, and has brought in large quantities of the ore.

A tariff on bauxite means a burden on any company that might have the temerity to try to compete with the Aluminum Company of America, and further profit to the present monopoly. Aside from raising revenue, it can do no good. The company manufactures aluminum products and a tariff on the metal means more profit to the company, added cost to competitors in the manufacture of aluminum articles, and added cost to the consumer.

IMPORTANCE OF SOME ORES IN MODERN WARFARE

Manganese, chromite, quicksilver and tungsten are indispensable in modern warfare. Without manganese the making of steel is immensely more difficult; without chromite armor plate is useless and tool steels sink to a level little higher than carbon steels; mercury makes our best percussion caps, and without tungsten high-speed steels we would have been unable to equip enough factories to turn out our munitions in the Great War.

It is possible that very high artificial prices may cut part of the metals off from some of their most useful though as yet unproved applications. This may be shown by chromium. Stainless steel, an alloy of 13 to 17 per cent chromium with iron, is remarkably resistant to rust and seems to offer great possibilities of usefulness. As an example, concrete sea walls now destroyed by the rusting of the steel reinforcement would probably stand indefinitely were stainless steel bars used for reinforcement. The extra cost for such material would be much less than the cost of replacing the walls.

In many oil wells the pipes are destroyed by corrosion long before the well is exhausted. In certain favored wells it seems possible that a stainless steel casing could be used. The present cost of the chromium in a ton of such steel would be from \$40 to \$50 per ton, and must be near if not above the limit of cost. The heavy duties asked may well be the deciding factor for such possible uses.

In proposing heavy duties on these minerals, the plea has been that there is great need of home development so that the Government might have the necessary quantity of the minerals in case of another war, and that the mines should be kept in a state of development so that the ores could be quickly obtained and that if the mines were allowed to close they would be flooded and ruined.

This is merely plausible sophistry, for no man will develop ore bodies to let them stand for the Government's convenience. Development means depletion, and a tariff on the ores means a premium on early depletion. Flooded and caved mines are bad, but exhausted

¹Hearings on general tariff revision before the Committee on Ways and Means, House of Representatives, Pt. 2, pp. 894-921.

mines are useless. If the Government held in stock supplies of these ores large enough to carry us through a considerable period of another great war, such a situation could be faced with more equanimity.

MINERALS SUFFICIENT FOR THE IMMEDIATE FUTURE

In the group of minerals the deposits of which seem to be sufficiently large to furnish our needs for an indefinite time are two of the principal industrial metals—lead and zinc; two elements usually recovered only as byproducts—white arsenic and bromine; molybdenum, a metal apparently just finding its use; and a number of non-metallic minerals, particularly sulphur. Of lead and zinc the United States is the largest producer. The only difference between the minerals of Group C and Group B is that our supply is larger, but the end is just as definite and as certain to be reached.

If I understand the pleas for a tariff on zinc aright, however, it is not that we cannot produce in competition with the world, but that many of our poorer mines cannot compete. So far as I know, no figures of costs are given for the Franklin Furnace mines nor for the best of the northeastern Oklahoma mines. For many poor mines undoubtedly the costs are higher than the market price, but that would be true if the price were a dollar a pound. The principle advocated seems to be that when once a camp is started the tariff should follow rising costs in order that the operators may continue to make money until the zinc ore is all mined. If for poor zinc mines, why not for every non-paying industry?

Much the same arguments apply to lead. It is, however, a remarkable and disconcerting fact that if we except the continuance of the Joplin field into Oklahoma, the Bawdwin deposit in Burma is the only really large new deposit of lead that is known to have been found anywhere in the world in the past ten years. This shows how much nearer the end of the mines may be than we have thought.

Bromine is saved as a byproduct from salt wells and will be saved only if the price and demand justify. Arsenic is caught in the fumes at the great copper and precious metal smelters and practically must be saved to prevent its being a nuisance. Though some is now being made from arsenopyrite, no direct production is needed if the fumes are saved. Before the great increase in freight rates it could be marketed very cheaply. The duty asked, 5c., is probably more than a 100 per cent tariff on cost f.o.b. New York.

Our supplies of sulphur are comparatively large and cheaply produced from the domes of Louisiana and Texas. It is difficult to see how anyone can compete with them more than temporarily. If prices on both pyrite and sulphur are revised upward by high tariffs, the price of sulphuric acid, fertilizers and other materials must rise accordingly, or be kept from approaching pre-war levels.

MINERALS IN LARGE QUANTITY

The minerals in large quantity are mostly those generally referred to as non-metallic, by which we mean that the compounds are more useful than the contained metals are after isolation. They are mostly bulky materials and the supply approaches infinity so far as human industry is concerned. Thus the ocean is a huge salt bed in solution and an inexhaustible supply of magnesium ore.

In these bulky products, position, freight and labor, rather than foreign competition, may cut the largest figures, and unless carefully drawn laws are made one locality may be placed at the mercy of a particular company.

This may be illustrated by a story told some years ago by a gentleman connected with a cement company. The company owned cement plants near the boundary in both this country and Canada. When a former tariff law was being framed in this country, he went before the Ways and Means Committee and asked for a specific duty of \$1 a bbl. on cement to keep out the "pauper-made" cement of Canada and other countries, explaining that an earlier tariff of 20 per cent was equal to about \$1 a bbl. He did not explain that, at the earlier date, the price of cement was \$5 a bbl., but that at the time of his plea cement was being made profitably as low as 70c. a bbl. Then he went to Canada and petitioned for a tariff of 20 per cent against the American cement, as he wished to put up a mill in western Canada, where an extensive region was being supplied by a recently erected American plant. After both tariffs were granted, a new plant was built to supply the field in western Canada, and both an American and a Canadian community were compelled to pay tribute to the company.

Before the war anhydrous magnesium chloride used as a source of magnesium and as a component of oxy-chloride cements came from Germany, where it was made as by a byproduct of potash refining. Probably it has not been very successfully made anywhere in this country, though the hydrous chloride is easily made.

Phosphorus is made in the electric furnace from lime phosphates. The other items are so familiar that little explanation is needed except as to coal.

M. R. Campbell estimates that at the present rate of use we have coal enough for 4,000 years, but the best steaming coal is being used rapidly and may not last more than fifty years, so that this might well be separated and put under Class C. Of the lignites and other poor coals the supply is huge, but on the other hand our uses are increasing at a rapid rate. As the United States is the largest exporter of coal, a tariff could have the effect only of raising the already high price in some poorly supplied locality like the Pacific Coast.

The fixing of a tariff on this group of minerals may well follow the same considerations as are applied to the fixing of tariffs on manufactured articles or farm products.

GENERAL CONSIDERATIONS

Some repetition in an effort to emphasize some of the points raised in this paper may be pardonable.

Of certain necessary minerals and metals we have practically none. Of certain other minerals, the bulky and common class, our supplies are very large, and of a few like salt, magnesium and lime, the supplies are, so far as human industry is concerned, unlimited. Between these two groups of minerals are two other groups. Of one we have a known quantity sufficient for our needs for a short time only and at highly artificial prices. Of the other we have a supply that is sufficient for our needs for some time to come. To all of the deposits of these two groups there is a definite end. Using them is precisely like drawing the water from a cistern, except that an ore deposit is filled only once, and when once mined, it is gone. There is no second crop. They are wasting assets.

Of the first group, that which we lack entirely, diamonds for gems are luxuries sold at absurdly extravagant prices, and no valid objection can be made to a duty of an amount comparable to the price. On the other substances, except borts and carbons, tariffs may be levied according to the theories of the party in power without directly affecting the mining industry of this country. To the last group tariffs may be applied much as to manufactures.

The minerals of the two middle groups, except bromine and arsenic, deserve entirely different consideration. Bromine and arsenic may also fairly be treated as manufactured products, for bromine will be saved from brines only if it pays, and arsenic can be supplied to fill all our needs as a byproduct from the smelters. We have the others in limited quantity. To place a tariff on them is to place a premium on depletion and to hasten the day when they too will be among the minerals of which we cannot supply our own needs. To bring that day more quickly than necessary is economic crime.

The civilization that we enjoy and that we are attempting to intensify is making more and more use of mineral products. To our grandfathers nickel was a curiosity; to our fathers aluminum was an unseen metal; tungsten, vanadium and chromium were heard of only among the abstruse things of chemistry. To us they are all necessities, and perhaps the Great War was won so soon because Germany lacked tungsten.

The mineral products are becoming more and more indispensable to us and depletion of deposits more and more of a menace. A hundred years ago iron furnaces were operated on chunks of iron ore picked up between Washington and Baltimore; now a single blast furnace will turn out as much pig iron in a day as one of those furnaces would in months, and it must have a large and assured ore supply to guarantee operation. When our great Lake Superior iron deposits were discovered they were heralded as inexhaustible—but our iron and steel industry has grown so that already we have had to commence beneficiation of the lean Lake Superior ores, and American firms are exploiting iron deposits in Cuba and Chile. It is probable that in 100 years the owners of the Brazilian iron fields will control the world's steel trade.

We have been the world's greatest copper producers, but our energetic mining firms have found it expedient to take over the great copper deposits of South America.

Besides these great investments by the most powerful of our mining interests, many smaller investments have been made in foreign mines—made at a time when our every endeavor has seemed to be to obtain foreign trade. These men have retained their American citizenship, and their ties with the United States are very real. Uncle Sam never forgets them when their income tax is due and they pay precisely the same rates as those of us who live at home where we have some advantage from the tax. These men have been, and are, the advance guard of American exports. They buy American machinery, foods and clothing; and in very many places they import American timbers for their mines and American lumber with which to build their mills. They are probably our best field agents for American exports. Do we believe in American exports, or is it mere cant?

Some of the American owned foreign mines are so close that the minerals are brought into the United States by aerial tramways; others are in the snowy heights of the Andes and in torrid India.

Probably the total American investment in foreign mines amounts to between \$600,000,000 and \$1,000,000,000, and if our metallurgical industry grows with our population it will mean greater and greater foreign investments. Are these then to be forgotten when we are passing tariff legislation?

Not only our own Americans but other miners in foreign countries are willing to sell us their cheap and rich ores. If we insist on making our own ores expensive by placing a protective tariff on foreign ores, then we place in the hands of our competitors the cheap ores of the world, and our manufactures must be increased in cost. The proposition that ores intended for incorporation in goods to be exported will be relieved of duty only half answers the question. Our own machinery and the manufactures of our own country must yet be made of the expensive ore, and the cost is passed on to the consumer, with the argument for each duty that it affects him little. Straws broke the camel's back.

But above all, the tariff puts a premium on the early depletion of our deposits. It will leave posterity only the caved mines that might have been an asset to them. Posterity will have to buy from the foreigner his deep mined ores and the United States will always work on expensive metallic products. The cynical question, "What has posterity done for us?" so glibly asked in reply to such an objection, may be answered by another and more honest question:

"Shall we rob our children?"

Imports of Carbonate of Potash Into the U. S.

There was 33,380,205 lb. of carbonate of potash, valued at \$1,218,851, imported into the United States during the calendar year 1920. The countries of origin were as follows, according to data compiled by the Statistical Division of the Bureau of Foreign and Domestic Commerce:

Countries	Lb.	Value	Countries	Lb.	Value
Austria.....	11,023	\$3,914	Switzerland.....	5,089,720	\$214,274
Belgium.....	227,736	3,702	England.....	346,735	35,716
Czechoslovakia..	170,854	26,695	Scotland.....	10,000	452
Denmark.....	22,386	5,148	Canada.....	61,529	4,414
France.....	15,139,936	136,410	China.....	26,000	4,109
Germany.....	7,891,821	445,095	Dutch East In-		
Netherlands.....	2,367,806	62,290	dies.....	34,442	9,493
Russia in Europe..	1,185,028	106,653	Hongkong.....	8,628	1,323
Spain.....	256,346	7,440	Japan.....	495,740	141,608
Sweden.....	34,481	10,115			
			Total.....	33,380,205	\$1,218,851

Largest Electrified Sugar Mill in Central America

It has been decided to electrify the new sugar mill of the Sula Sugar Co. at La Lima, Honduras, and plans have been drafted which will make it the largest electrified sugar mill in Central America. Power will be developed by a 1,000-kw. turbo-generator set with an auxiliary set of 200 kw. for lighting and general purposes. All the electrical equipment will be furnished by an American company and installation will be made by the same American company that is constructing the mill. The fuel to be used for running this system will be cane fodder and scraps, the supply of which is expected to be sufficient. Construction of the new mill is going forward rapidly. The boilers have been set in place and smokestacks and water towers erected. Most of the heavier machinery is also installed and the machine shop is nearly completed. Consul Albert H. Gerberich, Puerto Cortes, Honduras, reports that the first cane will be crushed in October.

Preventing Corrosion in Iron and Steel Under Water*

The Intensity of Corrosion Under Water Is Almost Proportional to the Amount of Oxygen in Solution—Mechanical and Chemical Means of De-aërating the Water, Thus Retarding the Rate of Corrosion

By F. N. SPELLER

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THE electrolytic theory of corrosion as formulated in 1903 by Dr. Whitney has led to the development of certain protective systems which are based on the removal of dissolved oxygen from water. Careful experiments in the research laboratories of the Massachusetts Institute of Technology and the National Tube Co. have demonstrated that the amount of corrosion found is almost directly proportional to the amount of oxygen in solution and varies directly as the temperature. The predominating influence of free oxygen in water was suspected before this as a result of the early study of pipe corrosion, for the most striking fact in practical pipe experience is that hot-water-heating systems invariably showed no corrosion to speak of after 35 or 40 years' use, whereas frequently hot-water-supply systems operating at the same average temperature with the same water lasted only six or eight years. That this was independent of whether the material was iron or steel was fully demonstrated by many service tests which were conducted for a period of over ten years, in which representative pipes of each class were installed alternately in hot water lines. A few of the more recent tests by independent observers are given in Table I for reference. It is believed to be unnecessary in view of this evidence to refer to any of our older investigations recorded elsewhere several years ago.¹ Suffice it to say that all the reliable data on this subject which we have seen up to the present indicate that the composition of the iron—i.e., the varying amount of carbon, phosphorus, manganese, sulphur, silicon, oxides, slag and copper usually found in wrought iron and soft steel—makes very little difference on the amount or character of corrosion under water. This refers particularly to the depth of corrosion commonly known as pitting.

INFLUENCE OF MILL SCALE ON PITTING

The location and depth of pitting seem to be mainly determined by variations of potential on the surface of the metal, principally due to the mill scale in irregular patches usually found on the surface of rolled iron or steel. Welded pipe and tubes having a particularly heavy and tightly adhering scale are on this account susceptible to pitting. It has been found by experimenting that the useful life of the tube as measured by the time to perforate is materially increased by removal of all mill scale and rust. Several years ago, after considerable study of the influence of mill scale on corrosion of iron in service, the National Tube Co. gave me the opportunity to make an attempt to remove this scale from pipe. A butt-weld pipe mill was provided with

special machinery for this purpose. The pipe was made about 10 per cent larger than standard. After welding it was cooled to about 1,700 deg. F. and passed at this temperature through a train of circular reducing rolls by which the section was reduced to standard size, and the pipe elongated, thus breaking loose all scale. The usual straightening operations followed during which a light loosely adhering scale formed which has little influence on corrosion and is easily removed if desired by pickling.

In the absence of oxygen such electro-negative materials as mill scale, oxides of iron, copper or brass have much less influence in accelerating corrosion.

It is necessary to establish these points before entering on a practical consideration of the subject of protection of steel, which in the case of closed systems can evidently be accomplished in most cases by elimination of dissolved oxygen from the water.

In practice oxygen removal has been accomplished economically in two ways, namely: By de-aërating the water mechanically and by fixing the free oxygen by chemical combination.

MECHANICAL DE-AËRATING OF WATER

The mechanical de-aërating of water is accomplished by passing the water over baffles or spraying into a high vacuum chamber at normal temperature or by increasing the temperature and controlling the pressure and temperature so that more or less complete removal of all the gases is obtained.

One system which has been proposed involves heating the water above the boiling point corresponding to

TABLE I. WEIGHED TEST PIECES IN HOT WATER LINES

Comparative corrosive action of de-aërated and of untreated water at Irene Kaufmann Settlement, Pittsburgh, Pa., on (1) zinc plates, (2) brass plates, (3) steel and brass plates coupled together, and (4) steel and copper plates coupled together. Test finished Jan. 14, 1919.

Test	Piece No.	Original Weight, Grams	Final Weight, Grams	Loss in Weight, Grams	Loss, Grams per Sq. In.
(1) Zinc plates 2x6x $\frac{1}{8}$ in.	DD-4	348.15	314.70	33.45	1.194*
Area—28 sq. in.	DD-5	351.62	320.90	30.72	1.097*
Time—12 mos., 52 days	DD-6	350.82	316.35	34.47	1.231*
Avg. temp. about 160° F.	DD-1	Lost			
	DD-2	352.20	345.10	7.10	0.146†
	DD-3	351.00	346.50	4.50	0.161†
(2) Brass plates 2x6x $\frac{1}{8}$ in.	BB-1	108.87	108.50	0.37	0.011*
Area—25 sq. in.	BB-2	105.50	103.65	1.85	0.074*
Time—12 mos., 52 days	BB-3	107.00	105.95	1.05	0.042*
Avg. temp. about 160° F.	BB-4	107.08	107.00	0.08	0.0032†
	BB-5	103.97	103.90	0.07	0.0028†
	BB-6	108.15	108.09	0.06	0.0024†
(3) Steel and brass plates (1 $\frac{1}{2}$ x4x $\frac{1}{8}$ in.) coupled together with brass rivets at one edge. Area—14 sq. in.	Brass-C-3	28.893	28.391	0.502	0.036*
Time—12 mos., 10 days	Steel-C-3†	16.008	0.00	16.008 total loss*	
Avg. temp. about 160° F.	Brass-C-4	29.474	29.463	0.011	0.0008†
	Steel-C-4	15.809	13.268	2.541	0.1815†
(4) Steel and copper plates (1 $\frac{1}{2}$ x4x $\frac{1}{8}$ in.) coupled together with copper rivets at one edge. Area 14 sq. in.	Copper-B-3	16.535	16.368	0.167	0.0119*
Time—12 mos., 10 days	Steel-B-3‡	16.128	0.00	16.128 total loss*	
Avg. temp. about 160° F.	Copper-B-4	16.444	16.416	0.028	0.002†
	Steel-B-4	16.623	13.255	3.368	0.2405†

* In untreated water line. † In de-aërated water line. ‡ Steel pieces C-3 and B-3 were entirely corroded away.

*Paper presented at the spring meeting of the American Electrochemical Society at Atlantic City, N. J., April 21, 1921.

¹Comparative service obtained with wrought iron and soft steel pipes as water lines in the United States. International Association for Testing Materials, New York, 1912.

the pressure and spraying into a chamber at lower pressure. The air and aqueous vapor are drawn through a condenser where the vapor is condensed with a simultaneous transfer of heat to the incoming cold water. Almost perfect removal of gases is said to be accomplished in this way and there is no reason why nearly perfect removal cannot be thus obtained with a properly designed plant, but the condenser and other apparatus required makes such a plant quite costly and subject to severe deterioration.

For practical protection of water pipe from internal corrosion at 180 deg. F. (80 deg. C.) it is not necessary to have the oxygen lower than 0.4 c.c. per liter (cold water carries from 5 to 10 c.c. per liter, depending on the season of the year and temperature). For the protection of steam boilers, superheaters and economizers operating at a much higher temperature, the oxygen should be below 0.2 c.c. per liter or an appreciable amount of corrosion will occur. This may be accomplished by means of de-aerators now on the market, which are simple in construction and operate without heating the water to the boiling point. (Fig. 1.) The design of the apparatus used should be adapted to the particular conditions in each case. Several of these are in use doing good work in the protection of iron and steel hot-water piping systems and boilers. A large system has recently been installed to de-aerate 5,000,000

to 20 per cent of that previously experienced, this being a very corrosive water.

FIXING FREE OXYGEN BY CHEMICAL COMBINATION

The fixing of the free oxygen in the water by chemical combination has been carried out in practice in the case of hot-water systems by passing the heated water through a storage tank carrying a mass of expanded sheet iron giving about 60 to 70 sq.ft. of surface per cu.ft. of space (200 to 230 sq.m. of surface per cu.m. of space). In half an hour or so at 170 deg. F. (77 deg. C.) the oxygen may be reduced in this way to 0.3 c.c. per liter. If the water carries free CO_2 and bicarbonates, as is usually the case, the free CO_2 contents are often a little higher after this treatment, notwithstanding which practically no corrosion is found. My first experiments with the use of scrap iron in 1907 were made with steel turnings, which after a time clogged up tightly into an impermeable mass. This difficulty was overcome by the use of expanded steel sheets suitably formed so that they would not pack tight. The first plant of considerable size based on this principle was designed and built by the author in Pittsburgh in 1915, and has now been in successful operation for over five years; the essential features involved are indicated in Fig. 2. For domestic use the water after this treatment should usually be filtered.

COMBINATION OF MECHANICAL AND CHEMICAL DE-AERATION

This method of "de-activation" (the term suggested to designate this process) may be used to supplement mechanical de-aeration as described above, which combination seems to be the most economical means for oxygen removal from hot water on a large scale under average conditions. For example, take a power plant equipped with open-feed water heaters operating at 180 deg. F. (80 deg. C.); it will be found possible by means of the heaters alone to reduce the free oxygen in the feed water from 8 c.c. to 2 c.c. per liter. If the water space of the heater is filled with thin steel lathing or the water, preferably in some cases under reduced pressure, be made to flow through another tank containing steel scrap in this form, the residual oxygen will be fixed in a few minutes. Water so treated is practically inactive toward iron, and may be used in boilers or steel economizers without fear of corrosion so far as the water is concerned.

Other metals in scrap form may be used for oxygen removal, such as zinc, but iron is the most economical, not only because of its low first cost but for the reason that the ferrous hydrate formed removes an equivalent of oxygen in addition to oxygen taken up by the hydrogen. Furthermore it has been proved to be true, as would be inferred from the above, that the corrosion of zinc, brass and other metals is greatly retarded if not entirely stopped by the removal of oxygen from the water which comes into contact with these metals.

Brass and copper piping are seriously attacked by heated water under pressure. For example, we find that the water which is heated for our laboratory in a copper coil heater of the usual type loses nearly one-half of its free oxygen in passing through this heater, and brass pipes after ten or twelve years are frequently found to have lost nearly all their zinc contents. The same has been observed with alloy condenser tubes, so that there is apparently an important field for the application of these principles of protection to brass and copper piping systems.

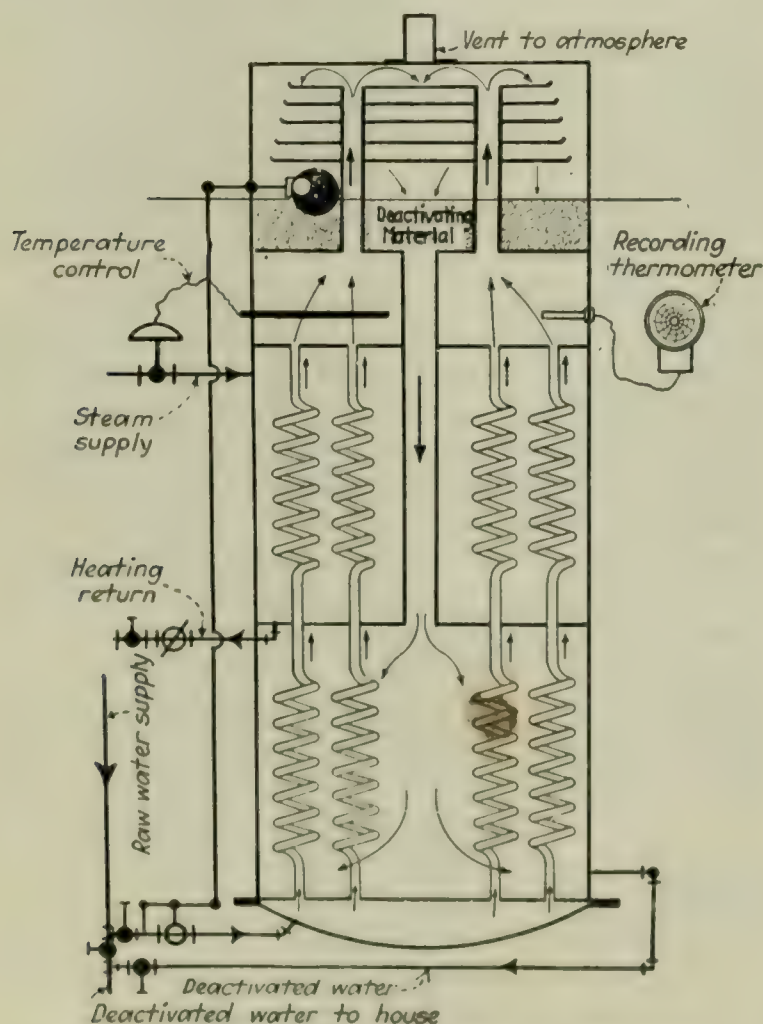


FIG. 1. MECHANICAL WATER DE-AERATOR

In operation the cold water enters the aerator at the bottom and flows upward through the coils, taking up some heat from the down-flowing water. The temperature of the water is raised to about 205 deg. F. (96 deg. C.) as it passes through the middle steam-heated compartment. From this the water rises and flows over baffles, where the air is nearly all separated, the residual oxygen being removed by some suitable de-activating material before the water passes downward to the outlet, its temperature being reduced to about 150 deg. F. (66 deg. C.) in passing through the lower heat exchanger.

gal. (20,000 cu.m.) of cold water per day for the protection of the 30-in. (75-cm.) steel main from the Darling ranges to Coolgardie mining district, Western Australia, which is reported to have reduced the corrosion

TABLE II. SUMMARY OF RESULTS OF INVESTIGATIONS OF THE CORROSION OF WROUGHT IRON AND STEEL PIPE IN HOT WATER SUPPLY SERVICE

Date	Where Test Was Made	Length of Time Pipe Lines Were Installed	Authority and References	Number of Cases on Record	Average of Deepest Pits, Inches		Conclusions
					Wrought Iron	Steel	
1919	Irene Kaufmann Settlement, Pittsburgh, Pa.	2 yrs., 7 days.	Jas. O. Handy, Technical Director, Pittsburgh Testing Laboratory. Report made to Resident Director Teller, Jan. 22, 1920; p. 97, Jan., 1920, A. S. H. & V. Engrs.; p. 276, Mar., 1920, A. S. H. & V. Engrs.	Fifteen lengths of steel, 15 lengths of wrought iron arranged alternately.	0.1144	0.1095	"These figures show that no marked distinction is possible between the rate of corrosion of the steel and the iron pipe."
1919	Harvard University, Cambridge, Mass.	3 yrs.	Melville C. Whipple Inst. in San Chem., Harvard University. Jrn'l New England Water Wks. Asso., p. 42, Mar., 1920.	Two sections each of scale-free (steel); galvanized steel, copper steel and wrought iron pipe.	0.073	Scale Free 0.045 Copper Steel 0.068 Galvanized 0.078	"Judging from the depths of pitting and the general appearance of the inside of the pipe, it was evident that, so far as the conditions of this particular experiment with the Cambridge hot water service were concerned, scale-free pipe had suffered less real damage than any of the others after three years' exposure."
1919	Irene Kaufmann Settlement (2d Test), Pittsburgh, Pa.	1 yr., 2 mos.	Jas. O. Handy, Technical Director, Pittsburgh Testing Laboratory. Report by Pittsburgh Testing Laboratory, April, 10, 1918, p. 217, 1918 Trans. A. S. H. & V. Engrs.	Six sections each of steel and wrought iron pipe.	0.131	0.122	"This test and other similar tests have shown beyond question that in the Pittsburgh district wrought iron and steel pipes in hot water lines are rapidly corroded by pitting and that the laminated or fibrous structure of wrought iron produced by the included layers of slag, does not give any added durability to wrought iron, as compared with steel pipe."
1918	Brown University, Providence, R. I.	11 mos.	Wm. F. Kenerson, Professor of Mechanical Engineering, Brown University. Report made June 7, 1918. Bulletin 2—"Corrosion of Hot Water Piping." National Tube Co.	Two sections each of black and copper steel and wrought iron; one section each of galvanized and copper steel, galvanized.	0.0674	Black Steel 0.0544 Copper Steel 0.0639 Galvanized 0.0547 Copper Steel Gal. 0.0938	"There is evidently no marked superiority of either the wrought iron or steel for the test conditions described. The wrought iron failed first by developing the deepest pits. The steel developed a greater number of shallower ones."
1917	This test was conducted in four different places as follows: (A) West 41st St. Bath, New York. (B) East 76th St. Bath, New York. (C) East 109th St. Bath, New York. (D) Cherry and Oliver Sts. Bath, New York.	2 yrs., 9½ mos. 2 yrs., 5 mos. 2 yrs., 6 mos. 2 yrs., 6 mos.	James S. Macgregor, Instructor in Civil Engineering, Columbia University. Report made Jan.-March, 1917. Bulletin 2—"Corrosion of Hot Water Piping." National Tube Co.	(A) 3 sections each of wrought iron and steel pipe. (B) 4 sections of steel and two of wrought iron pipe. (C) Same as test B. (D) One section each of steel and copper steel.	(A) 0.057 (B) 0.075 (C) 0.035	0.052 0.070 0.035 (D) Steel 0.021 Copper Steel 0.022	Taking the total averages of steel (which includes scale-free and copper steel, as well as ordinary black), pipe as against those for iron in the four tests we find the latter to have pitted deeper by 0.025 in., which indicates in favor of steel pipe in these particular tests.
1916	Irene Kaufmann Settlement, Pittsburgh, Pa.	11 mos.	Jas. O. Handy, Technical Director, Pittsburgh Testing Laboratory. Report made December 6, 1916. P. 125, 1917 Trans. of A. S. H. & V. Engrs.	Two sections of steel, one of galvanized steel and one of wrought iron pipe protected by deoxidizer; 2 sections each of steel and wrought iron pipe not so protected.	Protected by Deoxidizer (Galvanized) 0.045 (Black) 0.016 Unprotected by Deoxidizer 0.121	0.040 0.016 0.125	This test had as its chief aim a study of the protection of pipe by use of a deoxidizer, and the author does not draw direct conclusions on the comparative corrosion of the iron and the steel pipe. The figures on depth of pitting, however, stand in favor of steel pipe.
1916	Irene Kaufmann Settlement, Pittsburgh, Pa.	10 mos.	Jas. O. Handy, Technical Director, Pittsburgh Testing Laboratory. Report made October 31, 1916. P. 125, 1917 Trans. of A. S. H. & V. Engrs.	Seven sections of steel and 4 of wrought iron pipe.	0.116	0.110	The author states that a certain sample of wrought iron showed the most general corrosion, while a steel section showed the greatest number of separate pits. No direct reference to comparative corrosion is made.

In connection with our tests in Pittsburgh we placed some zinc, brass, and steel-brass and steel-copper plates in contact in raw and de-activated hot-water service for one year with the losses in weight shown in Table I.

The accelerating effect of copper and brass in contact with steel under these conditions has been greatly reduced by the lack of a depolarizer, as would be expected, and it will be noted that the loss in weight of the steel when in riveted contact with copper and brass is very little more than that suffered by the insulated zinc plates in de-activated water under the same conditions. In this experiment the test pieces were placed in two horizontal steel water lines, one carrying raw water

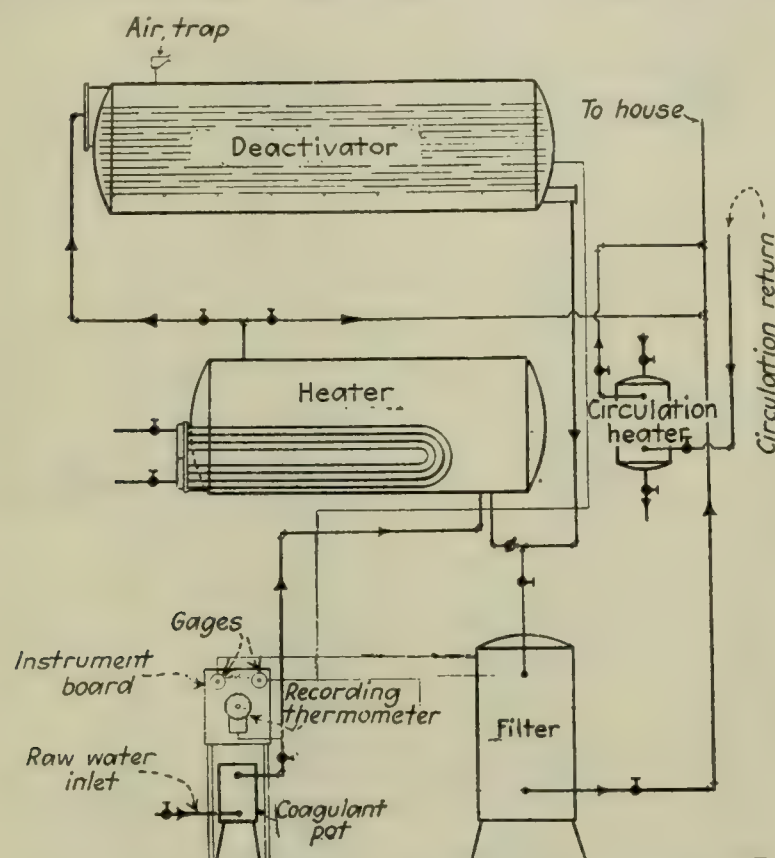


FIG. 2. CHEMICAL WATER DE-AERATOR

In this system the oxygen is removed by combination with scrap steel sheets in the upper tank (the de-activator). The heater circulating pipes and filter are shown.

with about 6 c.c. per liter of oxygen and the other water with an average free oxygen content of about 0.3 c.c. per liter.

RETARDING THE RATE OF CORROSION

The rate of corrosion may be retarded by increasing the proportion of hydroxyl ions with relation to the hydrogen ions present in the water. In practice in the case of boiler water this can be carried out by the use of 5 to 10 grains per gallon of hydroxide alkalinity, but with domestic water it is possible to use only a comparatively small amount of alkali and the protection afforded is proportionately lessened. Great Lakes water with about 8 grains per gallon of calcium carbonate is very much less corrosive than New York city water with 1 or 2 grains per gallon of carbonates, although each have about the same amount of oxygen.

There are cases where natural waters used for cooling purposes in condensers or transformers may have their corrosive activity reduced with economy 50 per cent or more by passing the water through a bed of crushed limestone, but this treatment is not nearly so effective as partial de-aeration and may cause an insulating scale to form if this treatment is carried too far.

The more important research on the subject of relative corrosion of piping in hot water feed service that has been accomplished within the last five years is summarized very briefly in Table II.

Alsatian Potash Production in 1920

Commercial Attaché Huntington, at Paris, has transmitted comparative statistics on the Alsatian potash situation.

The total production of the Alsatian mines in 1913 was 350,341 tons, corresponding to 56,000 tons of pure potash; in 1919 the production was 464,607 tons, corresponding to 92,006 tons of pure potash; and in 1920 the total reached 1,061,191 tons, corresponding to 199,230 tons of pure potash.

The following shows the amount of the 1919 production of the grades named compared with the production of 1920:

Grades	1919 Tons	1920 Tons
Sylvanite, 12 to 16 per cent.....	262,779	664,019
Rich sylvanite, 20 to 22 per cent.....	163,714	335,820
Chloride of potassium, 50 to 60 per cent.....	38,114	61,352
Total.....	464,607	1,061,191

Shipments during 1919 and 1920, expressed in terms of pure potash, were in amount as follows:

Grades	To France		To United States		To Other Countries	
	1919 Tons	1920 Tons	1919 Tons	1920 Tons	1919 Tons	1920 Tons
Sylvanite, 12 to 16 per cent.....	20,820	43,994	11,022	27,355	6,303	25,557
Rich sylvanite, 20 to 22 per cent....	16,260	31,420	8,276	19,720	9,096	17,679
Chloride of potassium, 50 to 60 per cent.....	9,973	11,164	3,849	8,892	6,407	13,394
Total.....	47,053	86,578	23,147	55,967	21,806	56,630

Since March, 1921, the concentration plants of the Alsatian potash mines have been manufacturing rich sylvanite of 30 per cent K_2O content and sylvanite of 40 per cent K_2O content.

Niagara Hydro-Electric Canal Nearing Completion

The hydro-electric canal is and has been making rapid progress toward completion. This great public work has been especially favored by the weather, which made it possible for the work to go on unimpeded during the past winter.

Of 13,500,000 cu.yd. of earth excavation, 12,500,000 cu.yd. has already been removed; while of the 4,000,000 cu.yd. of stone excavation, 2,500,000 has been taken out. This speed in the removal of earth and stone has been accomplished by shovels which excavate 8,500 cu.yd. of earth or 3,000 cu.yd. of stone in twenty hours with two shifts of men. These shovels handle 8 cu.yd. of earth or 6 cu.yd. of stone at a time. The deepest cut in the canal is 135 ft.

At the present rate of progress the earth excavation will be finished by July next and the stone excavation by August. The excavation of earth and stone are now ahead of schedule.

There is 280,000 cu.yd. of concrete work in the walls of the canal, while in the power house, screen house, intake and control works there is 145,000 cu.yd., making a total of 425,000 cu.yd. of concrete work. Three turbines of 52,500 hp. have already been installed; generator 1 is well on the way to completion, and generator 2 is set in place, but not yet wound. By Jan. 1, 1922, there will be in operation 100,000 hp.

There are now, and have been during the past winter, 7,200 men working on this job. To house the workmen it has been necessary for the Hydro-Electric Canal Commission to construct many buildings, as it is has been impossible to get adequate housing accommodations in the City of Niagara Falls, Ont.

A New Type of Benzene Still in European Operation

Descriptive Details of the Tubular Type Bamag Benzene Still—Tee Head Joints—Vapor and Condensate Countercurrent Flow Positive—Central Control
—Notes on Corrosion

By A. THAU

Superintendent of the Oxelösund's Iron Works, Sweden

DURING the war a new type of benzene still was brought out by the Bamag Co. of Cologne which was the result of many forerunners and while not free of faults, it can at least claim perfection in its line. The still consists of a number of horizontally arranged cylinder sections joined by flanged branches. A short description will be given and in order to make the somewhat complicated looking design readily comprehensible the rectifying sections in which no heating arrangements are provided will be described first.

RECTIFYING SECTIONS

Fig. 1 shows such a still section in vertical section, Fig. 2 the left head in line *AB* of Fig. 1 with its connections through which the vapors enter from below, while the condensed oil runs down from above through the upper branch. Fig. 3 shows a vertical section of the apparatus in line *CD* of Fig. 1, and Fig. 4 a section through the opposite head of the still section in line *EF* of Fig. 1 with the vapor outlet through the upper branch, while the condensate leaves through the lower branch.

The section consists mainly of a cylindrical, horizontally suspended tubular body *a* of 200 mm. internal diameter with flanges *b* on both ends. The tee heads enable a number of sections to be assembled into one still. The tubular body *a* in Fig. 1 is partly closed by

a cast-in partition *c*. This partition is grooved inside, projects into the head *d* and holds the wrought iron distributing pipe *f*, which is expanded into the socket *e* and passes through the entire length of the section, projecting a little into the opposite head *g*. The closed end distributing pipe *f* is bored with two rows of holes *h*. The construction of the head *d* can be seen upon inspection of Figs. 1 and 2. The condensate flows through the branch from above and is diverted upon reaching the cast partition *i* to both sides and conducted into the passage *k* under the socket *e*. In the lower half of the partition *c* a radial opening *l* is left as shown in Fig. 1 and conducts the condensate from below, thereby filling the whole section and sealing the openings of the vapor distributing pipe *f*. On the open end of the body *a*, opposite to the liquor entrance side, a vertical support *m* is fixed which holds the distributing pipe *f* rigidly and positively level. In the lower half of the head *g* the dam *n* is cast and cut to the height of the upper edges of the holes *h* in the vapor distributor *f*. In the opposite head *d* the dam *o* is higher than *h*. In the head *d* the partition *i* forms a closed annular space (Fig. 2) which is in direct connection with the distributor *f*, being open on this end, while the annular channel continues downward into the connecting branch *p*.

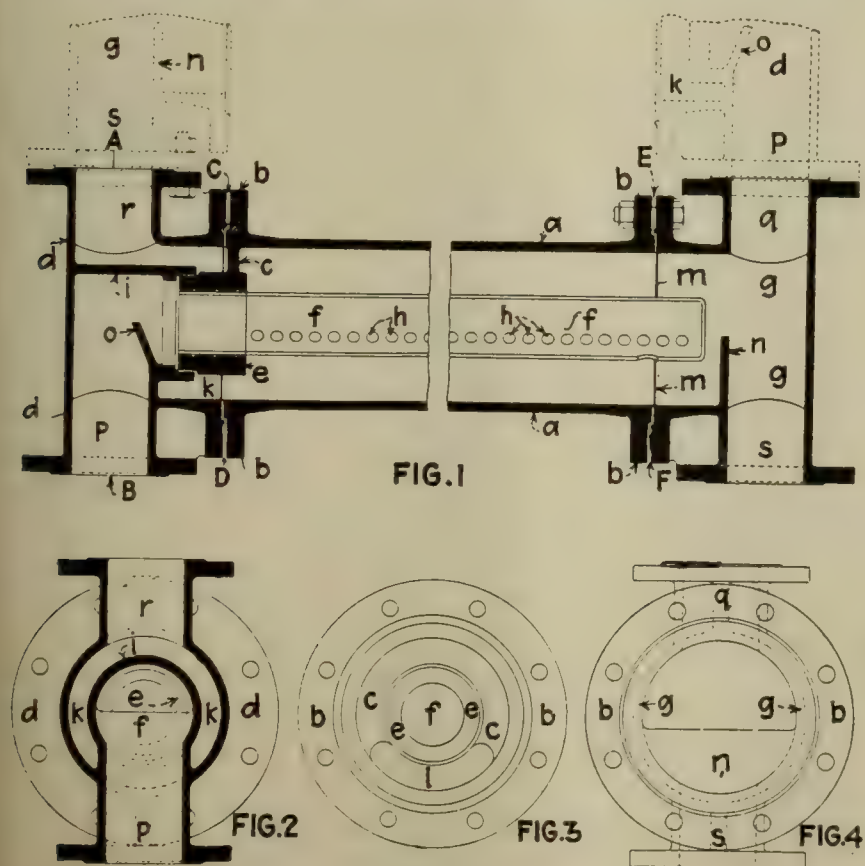
ROUTE OF VAPOR AND CONDENSATE

The vapors entering from the still section through the branch *p* are conducted through the channel formed by the partition *i* inside the end piece *d* and reach the distributor *f*. Equally distributed by the holes *h*, the vapor is forced through the liquid seal and enters the end piece *g*, from which it escapes through the connecting branch *q* and enters the next higher section, in which it repeats the operation. As indicated by the dotted lines in Fig. 1, representing joining sections, they are put together in the returning direction, so that piece *g* always goes on head *d*.

The condensed benzene entering the head *d* from above through the branch *r* circulates through the section as described before and increasing in volume by the addition of condensate, runs over the upper edge of the partition *n* and leaves the end piece *g* through the lower connecting branch *s*. The liquid enters the next section below through a head *d*.

By such means a positive and segregated countercurrent flow of liquid and vapor is obtained through the whole still. They pass separately through the connecting heads and are in contact only when inside the sections. The cylindrical bodies of these sections between the flanges *b* are thickly insulated to prevent too rapid condensation.

The distilling sections in which heat is introduced

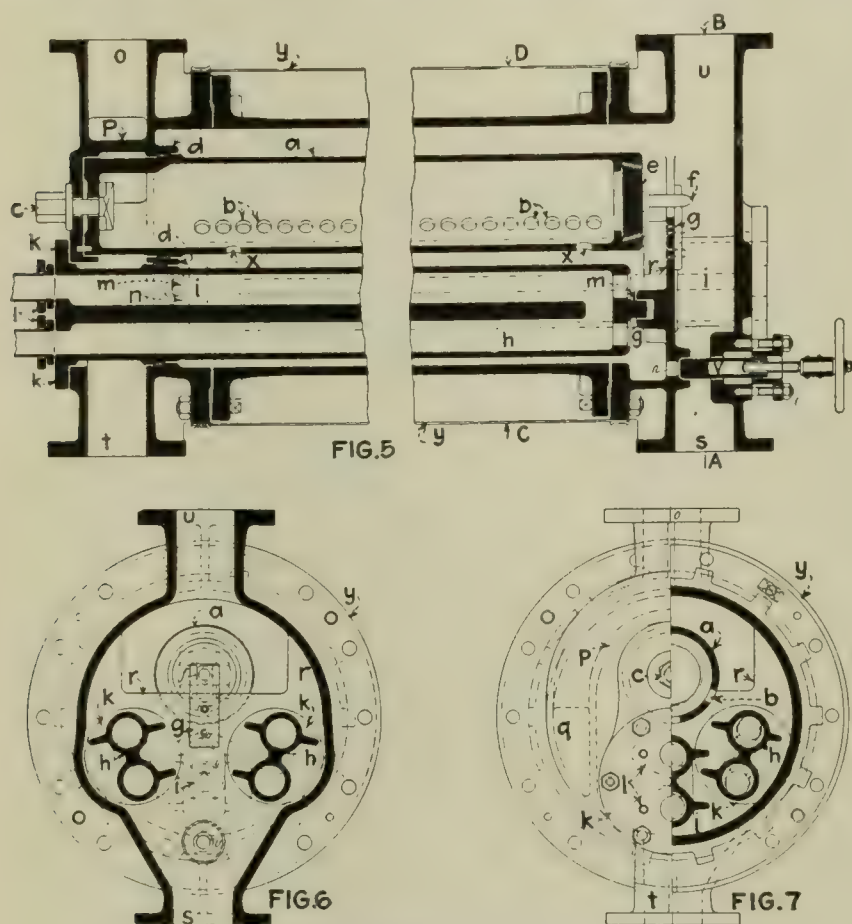


FIGS. 1 TO 4

Fig. 1—Longitudinal section of rectification section. Fig. 2—Vertical section through Fig. 1 at *AB*. Fig. 3—Vertical section through Fig. 1 at *CD*. Fig. 4—Vertical section through Fig. 1 at *EF*.

by indirect steam resemble those just described very much and the action set up in them is decidedly the same. The difference is in the use of three heating elements in each section, which results in a greater internal diameter of the cylindrical bodies. Fig. 5 shows a longitudinal section through a still section, Fig. 6 a cross-section through the right head of Fig. 5 in line *AB* and Fig. 7 shows in the left half an outside view of the left head of Fig. 5 and to the right a cross-section through this head in line *CD* of Fig. 5.

In these sections the vapor-distributing pipe *a* is of cast iron and has two rows of equally spaced 1-in. holes.



FIGS. 5 TO 7

Fig. 5—Longitudinal section of distilling section. Fig. 6.—Vertical section through Fig. 5 at *AB*. Fig. 7—Vertical section through Fig. 5 at *CD*.

The distributing pipe *a* is fastened at the entrance end of the vapors by the bolt *c* and supported in the socket *d* by means of asbestos packing. At the opposite end the distributor *a* is closed by a cast-iron plug *e* calked in with lead packing. The plug *e* holds a bolt *f* projecting through the hole *g* giving support to the distributor *a* and holding it level. Below the distributor *a* three heating elements are arranged in the distilling sections. The two heating elements *h* introduced from the left-hand side in Fig. 5 occupy the space below the pipe *a*, while the third, *i*, being introduced from the other end, is located immediately under the distributor *a* in the section between the other heating elements. These elements consist of tubular castings strengthened by side ribs and the steam passage through the elements is shaped like a U-tube. As will be seen from Figs. 6 and 7, the elements *h* on both sides are provided with three ribs, and *i* with four. The heating elements have a circular flange *k* which is drawn tight by bolts. The flanges are machined on both sides. The connections are so arranged that the upper openings of each element are connected to the high-pressure steam supply, the lower ones to a common pipe leading to a steam trap. The ends of the heating elements opposite the flange lids *k* are provided with a flat nose piece *m* reaching into a fork *n* cast into the branch lids of the sections. The heating elements are supported by these on both

ends. The nose piece *m* is somewhat shorter than the fork *n*, allowing for expansion of the elements.

OIL CIRCUIT

The oil entering from above passes through the branch *o* exactly as shown in the rectifying sections without heaters (Figs. 1 and 2) and is diverted by the partition *p* to both sides and enters the section through the two openings *q*, one of which is indicated on the left side of Fig. 7. The oil passes through the section, which is filled so that the holes *b* of the vapor distributor *a* are completely immersed in accordance with the level of the dam *r*. The surplus oil runs over the top edge of the dam on the heating element *i* (as far as this crosses the passage in the branch lid) and leaves the section through the passage in the head *s* to the next section. The vapors enter from below through *t*, pass through the annular space formed under the partition *p*, which is in direct connection with the open end of the vapor distributor *a*. They are then bubbled through the hot oil covering the ports *b*. The vapors pass upward through *u* to the next section, through which they are conducted in the same fashion. To obtain the zigzag passage of oil and vapor through the assembled units, it is necessary to connect the adjoining sections in opposite directions to Fig. 5—that is to say, if the letters marking the four connecting branches in Fig. 5 are applied to all the sections of which a still is composed, then the following combinations are observed: *ut*, *os*, *tu*, and *so*.

To drain these sections in case of repairs the head through which the heating element *i* is introduced is provided with the drain valve *v*. A hole *w* is drilled immediately above the bottom of the dam, which is closed by the valve. By opening it the section is drained completely, and the oil runs out through the opening *w*. The holes *x* are drilled through to drain the distributor dry when emptying the section. The cylindrical part of the sections is insulated and covered by sheet iron, giving the still a pleasing appearance.

THE ASSEMBLED STILL

The arrangement of a benzene plant in which continuous distillation of the crude products is effected in three such stills is shown in Fig. 8 in front view, while in Figs. 9 and 10 the stills are shown in side view, Fig. 9 in line *AB* and Fig. 10 in line *CD* of Fig. 8.

A strong concrete foundation supports two vertical frames *a* of steel construction. They are provided with cross beams *b* by which the weight of the stills is partly taken up by means of suspension bolts. The diagonally strengthened frames *a*, which are somewhat higher than the stills, hold the preheaters, dephlegmators and a platform with stairs.

A light-oil still *c* of normal capacity consists of seven cylinder sections each of about 2,700 mm. length and 600 mm. outer diameter. The sections are flanged together at the heads. The three heating elements of each section are supplied with high-pressure steam from the two common pipes *e*, while the two common pipes *f*, being connected to a steam trap *g*, drain the condensed water. The third steam pipe *h* running parallel to *e* and *f* conducts the steam to the heating elements of the oil preheater *i* on top of the platform. The enriched wash oil, which arrives somewhat preheated, having passed through heat exchangers in which it has taken up part of the heat of the light-oil vapors and of the spent oil

leaving the still, enters the preheater *i* through the pipe *j* and leaves it through the pipe *k* to enter the still *c*. It is admitted in the top section on the front, circulates through it toward the back, runs into the next lower section, through which it passes in the opposite direction, and so forth through the whole still, leaving the bottom section through a branch under the back side provided with a siphon.

DESCRIPTION OF OPERATION

The light-oil vapors leave the section through the head on the back side and enter the next section, which they leave through the head on the front side, and so forth through the whole still. From the head on the back side of the top section the vapors are conducted through the pipe *l* into the dephlegmator *m* and leaving the latter on the top are brought to a condenser. The pipe *l* is connected with the top of the preheater *i* by means of a pipe bent to so high a pitch that no oil can pass that way and only the vapors which are given off in the preheater are conducted direct into the dephlegmator.

The light oil produced in the still *c* is collected in a receiver and pumped to a tank sufficiently high to supply the preheater *n* by gravity. The preheated light oil is conducted through the pipe *o* into the top section

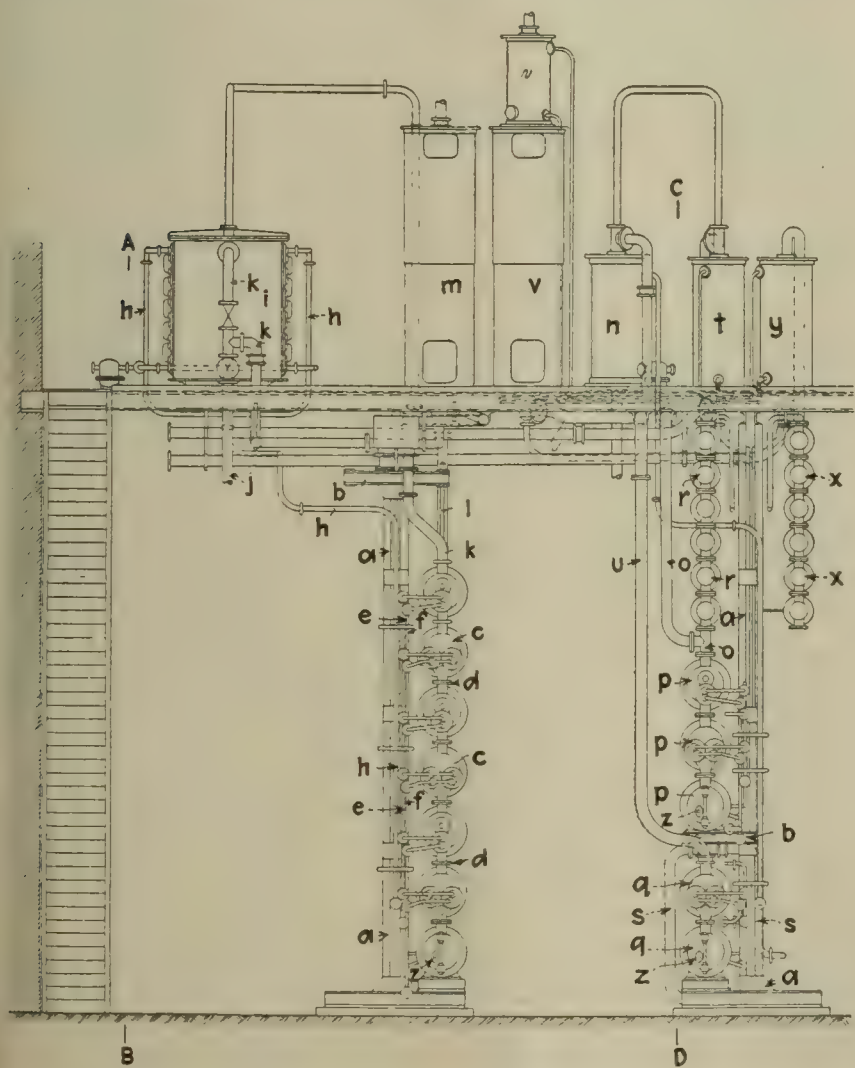
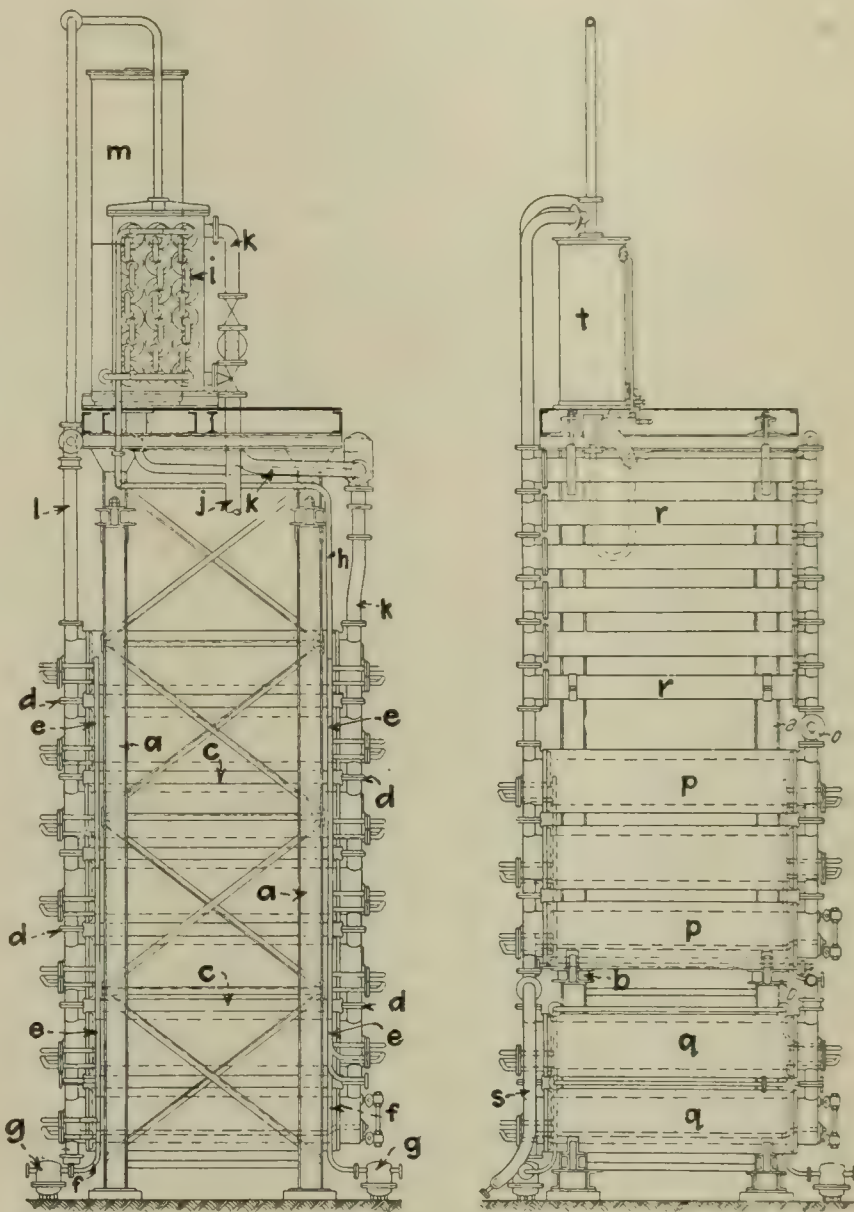


FIG. 8. FRONT VIEW OF ASSEMBLED STILL

of the still *p*, which, consisting of three distilling and six rectifying sections *r*, drives off the crude 90 per cent benzene. The still *q* is immediately under the still *p* and consists of two sections in which the products with a higher boiling point than benzene are driven off in one single fraction called crude naphtha.

The individual sections in the three stills *c*, *p* and *q* are of identical design. The preheated light oil fed into the still *p* through the pipe *o* circulates through the upper distilling section from front to back, through

the second from back to front and through the third and last again from front to back, where the rest arrives free from benzene. It passes now through a siphon pipe *s* and enters the upper of the two sections of the naphtha still *q*. The residue leaving the lower section of the still *q* consists of wash oil holding naphthalene in solution and is conducted through a steam-



FIGS. 9 AND 10.

Fig. 9. (left)—Side view showing preheater. Fig. 10 (right)—Side view showing naphtha still and dephlegmator.

heated pipe siphon to crystallizing pans, where the naphthalene solidifies, while the wash oil can be decanted off and brought back into the wash oil circuit.

The benzene vapors leaving the upper distilling section of the still *p* enter the rectifying sections *r* on top, which are in immediate connection with the still *p*. The surplus benzene condensed in the section *r* flows from the lowest section into a T-piece built into the light-oil feed pipe *o*, so that light oil and condensed benzene enter the still *p* together. The vapors leaving the upper section *r* are conducted through the water dephlegmator *t* of usual design with vertical water-cooled tubes. The vapors enter the dephlegmator from above and a pipe bent to a U is connected between the vapor pipe and the light-oil preheater *n* to conduct the vapors developed in the preheater direct into the dephlegmator *t*. Under the bottom of the dephlegmator a catch box is provided which conducts the condensed benzene from the dephlegmator through a siphon pipe back into the upper section of the rectifying still *r*. The vapors leaving the dephlegmator *t* are brought to a condenser of usual design.

The vapors driven off in the naphtha still *q* are conducted through the pipe *u* into the dephlegmator *v*, into

which they are admitted through a branch connection in the bottom. Leaving at the top, the vapors enter the small water dephlegmator *w* arranged immediately above the former. The vapors leaving the latter through a branch in the lid are conducted to a condenser of usual design. The naphtha condensed in the dephlegmators *w* and *v* runs to the bottom of the latter and collects in a catch box which is connected by means of a pipe to the siphon pipe *s* and thus enters again the section *q* of the naphtha still.

It will be quite clear now that the stills *q* and *p*, although arranged in one vertical line, are two independent units, the still *q* receiving the residue from the still *p* by means of an interconnected siphon *s*. Continuous benzene distilling is obtained in one process up to the point where the products must be washed. Two fractions are continuously produced—viz., 90 per cent crude benzene and crude naphtha, of which the latter must be separated in the desired fractions during the final distillation after washing.

NAPHTHA STILL

The lowest section of the stills *c*, *p*, and *q* differs from those described in Figs. 5 and 6 in that no vapor-distributing pipe is provided. This is not required, as no vapors enter the bottom sections in which the last traces of benzene are driven out. There are also only two heating elements in these sections and in place of the middle one a perforated steam pipe is introduced into the section resting on its bottom over the whole length. Through this a small amount of direct steam is admitted to the still—just enough to start and accelerate distillation. The three bottom sections *c*, *p* and *q* are also provided with glass gages to observe the liquor level inside, as indicated in the side views, Figs. 9 and 10.

The rectifying still *x* suspended from the platform and the water dephlegmator *y* on top shown to the extreme right in Fig. 8 form a quite independent unit from the apparatus so far described. They are of identical dimensions and construction as the unit *r* and *t* and are connected to the intermittently working finishing still for the treatment of the washed products. This still is of the usual design and thus not included in the figures.

The large dephlegmator *m* of the light-oil still *c* and the one *v* of the naphtha still *q* are hollow cylinders filled with wrought-iron cylindrical rings.

CENTRAL CONTROL BOARD

To control these stills the bottom section is provided with a gage glass to show the liquid level. The steam valves and pressure gages for each still are united on a control board, of which the one serving the crude benzene and the naphtha still at the same time is shown in front and side views in Fig. 4. The gage board is placed and fixed in front of the still and consists of lacquered sheet iron mounted on an iron frame and bent over to a right angle on both sides. Behind this plate the steam pipe entering with a main valve *a* is divided into several branches. By means of a separate branch with valve *b* steam is admitted to the heating elements of the benzene still. The pressure thereby applied to the elements is indicated by the high-pressure steam gage *c*. Through the valve *d* direct steam is introduced into the bottom section of the benzene still, the pressure thereby created in the section being indicated on the low-pressure gage *e*. The steam to the heating elements

of the naphtha still is admitted through the valve *f*, the pressure indicated by the high-pressure gage *g*. Direct steam is introduced into the lowest section of the naphtha still by means of the valve *h* and the pressure created therein is indicated by the low-pressure gage *i*. The valve *k* admits the steam to the light-oil preheater and its steam pressure is shown on the high-pressure gage *l*.

As indicated in Fig. 11, near every valve and gage an enameled plate is fixed labeling its purpose. The writer suggests in order to enlarge these very useful control boards that the thermometer dials belonging to the particular apparatus be installed on the same

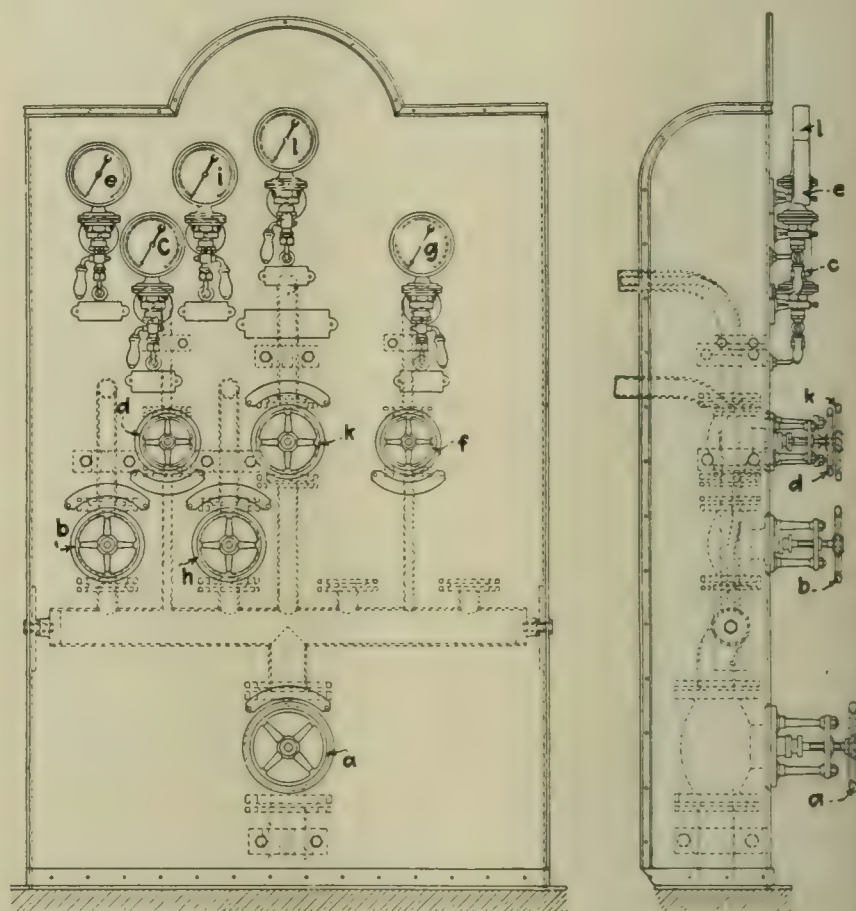


FIG. 11. CONTROL BOARD

board, which by using mercury steel tube thermometers with flexible connections between dial and mercury bulb does not present any difficulties. The control board should be provided with a thermometer showing the temperature of the steam, which, in connection with light-oil stills, is of great importance to keep the spent oil free of water on leaving the still.

The advantage of these latest designs of benzene stills is in the high efficiency reached. They have been working over a year, have not given cause for complaints and their steam consumption is relatively low. The distilling effect is mainly obtained by large indirectly heated surfaces over which the liquid is forced to travel almost continuously on its way through the stills. The amount of direct steam used is comparatively very small and in the case of light-oil stills the spent oil is kept free from water without the least difficulty.

CAST-IRON CONSTRUCTION

Before concluding, a few words should be included on the material employed in benzene stills. For the stills themselves, cast iron must invariably be used and although with steam coils bent from seamless steel tubing a much better heating effect is obtained than with cast-iron elements or cells, the latter are to be given preference, or frequent stoppages and renewals are encountered. Wrought iron is strongly attacked and

blank flange of 2.5 mm. thickness which the writer applied on the outside of a still was eaten through completely within ten days when the oil leaked out. For the same reason oil preheaters with steel tubes lead to continuous repairs. Two attacking agents are ammonia and cyanides, though of the former only traces should be found in the gas after it has passed the saturators. Ammonia and cyanogen are not easily absorbed by the wash oil, but the latter contains a sufficient quantity of water to saturate them and cause trouble. Ammonia and cyanogen are completely volatilized if the temperature is maintained sufficiently high and the corroding effect of the oil in the still, into which no ammonia or cyanides should be carried over, has for a long time remained a mystery.

CORROSION DUE TO ORGANIC SULPHUR

Quite recently, however, the results of the research of Dr. Weissgerber¹ show that the corroding effect of tar oils on wrought-iron tanks, etc., must be attributed to organic sulphur compounds in the oil, and especially in naphthalene oil. These observations are confirmed by the experience of the writer, who found the corroding effect of the wash oil in the still more pronounced the higher the contents of naphthalene were. It would mean a deviation from the present subject to dwell further upon these interesting investigations, and the conclusion must be drawn that a departure from cast iron in the construction of preheaters and distilling sections in preference to other metals is to be avoided, or heavy and frequent repairs must be reckoned with after a time.

Preliminary Reports of 1919 Census of Manufactures—Sugar and Glass

Preliminary statements of the general results of the 1919 census of manufactures with reference to beet sugar, cane sugar and glass have been issued by the Bureau of the Census. The statistics for 1919 and 1914 are summarized in the following tables, prepared under the direction of Eugene F. Hartley, chief statistician for manufactures. These figures are subject to such change and correction as may be necessary from further examination of the original reports.

BEET SUGAR INDUSTRY

Reports were received from 85 establishments engaged in the manufacture of beet sugar in 1919 and

BEET SUGAR STATISTICS, 1919 AND 1914		
	1919	1914
Number of establishments.....	85	60
Total value of products.....	\$149,155,892	\$62,605,210
Sugar:		
Pounds.....	1,426,891,315	1,486,947,817
Value.....	\$138,099,693	\$58,590,466
Granulated—		
Pounds.....	1,421,914,425	1,478,466,899
Value.....	\$137,852,387	\$58,351,324
Raw:		
Pounds.....	4,976,890	8,480,918
Value.....	\$247,306	\$239,142
Molasses:		
Gallons.....	18,841,429	26,461,291
Value.....	\$2,364,563	\$1,536,192
Pulp:		
Tons.....	2,082,531	*
Value.....	\$5,798,412	\$2,094,863
Dried:		
Tons.....	976,501	*
Value.....	\$4,829,568	\$1,510,759
Moist:		
Tons.....	1,106,030	*
Value.....	\$968,844	\$584,104
All other products, value.....	\$2,893,224	\$383,689

* Not reported in 1914.

their products for the year were valued at \$149,155,892. At the census of 1914 there were 60 establishments with products valued at \$62,605,210. The value of products therefore has been increased \$86,550,682, or 138.2 per cent.

In 1919 there were 16 establishments each in Michigan and Utah, 14 in Colorado, 10 in California, 8 in Idaho, 5 in Ohio, 4 each in Nebraska and Wisconsin, and 1 each in Illinois, Indiana, Iowa, Kansas, Minnesota, Montana, Washington and Wyoming.

CANE SUGAR INDUSTRY

Reports were received from 202 establishments in 1919 engaged principally in the manufacture of cane sugar. The products for the year were valued at \$57,741,320. At the census of 1914 reports were received from 181 establishments with products valued

CANE SUGAR STATISTICS, 1919 AND 1914		
	1919	1914
Number of establishments.....	202	181
Total value of products.....	\$57,741,320	\$21,635,373
Sugar:		
Pounds.....	450,955,838	529,601,993
Value.....	\$46,659,085	\$18,947,683
Refined:		
Pounds.....	71,627,346	107,187,416
Value.....	\$9,547,378	\$4,228,860
Clarified:		
Pounds.....	258,293,878	182,149,649
Value.....	\$26,563,156	\$6,742,266
Raw:		
Pounds.....	113,154,404	229,646,354
Value.....	\$9,898,958	\$7,615,147
Brown:		
Pounds.....	7,880,210	10,618,574
Value.....	\$649,593	\$361,410
Molasses:		
Gallons.....	20,058,248	20,675,260
Value.....	\$4,868,740	\$2,021,517
Sirup:		
Gallons.....	6,739,978	2,420,633
Value.....	\$4,189,199	\$609,696
All other products, value.....	\$2,024,296	\$56,477

at \$21,635,373. The value of annual production has therefore increased \$36,105,947, or 166.8 per cent.

In 1919 189 establishments were located in Louisiana, 6 in South Carolina, 3 in Florida, 2 in Georgia, and 1 each in Mississippi and Texas.

GLASS INDUSTRY

In 1919 102 glass manufacturing establishments were located in Pennsylvania, 77 in West Virginia, 43 in Ohio, 35 in Indiana, 21 in New Jersey, 19 in New York, 16 in Oklahoma, 12 in Illinois, 8 in Maryland, 7 in

GLASS STATISTICS, 1919 AND 1914			
	No. of Establishments		Production
	1919	1914	1919 1914
Total for the industry.....	367	348	\$254,709,000 \$123,085,000
Building glass.....	125	102	\$83,718,000 \$36,824,000
Window glass:			
Quantity, sq.ft.....			368,912,209 400,998,893
Value.....			\$41,106,000 \$17,496,000
Obscured glass, including cathedral and skylight			
Quantity, sq.ft.....			33,822,302 43,040,079
Value.....			\$4,300,000 \$2,417,000
Plate glass (made for sale):			
Quantity, sq.ft.....			57,612,491 60,515,008
Value.....			\$33,519,000 \$14,800,000
Wire glass:			
Quantity, sq.ft.....			15,691,486 15,688,844
Value.....			\$2,907,000 \$1,591,000
All other building glass:			
Value.....			\$1,886,000 \$520,000
Pressed and blown glass.....	130	107	\$70,708,000 \$30,279,000
Bottles, jars, etc.....	139	150	\$87,762,000 \$51,959,000
All other products.....			\$12,521,000 \$4,023,000

California, 5 in Kansas, 4 in Missouri, 3 each in Arkansas and Virginia, 2 each in Louisiana, Texas and Wisconsin, and 1 each in Massachusetts, Michigan, Rhode Island, South Carolina, Tennessee and Washington.

¹Brennstoff-Chemie, vol. 2, p. 1.

Legal Notes

BY WELLINGTON GUSTIN

Grosvenor Process for Hardening Siccative Coatings Held Invention

The United States District Court upholds the validity of the William M. Grosvenor patent, No. 1,186,477, claims 2 and 4, for a process for drying and hardening siccative coatings, in a suit by the Wenborne-Karpen Dryer Co. against the Rockford Bookcase Co.

Siccative coatings are said to be such as varnish, oil paints and oil-containing fillers which harden by oxidization. It was pointed out that hardening of paint was oxidization—a chemical action—while drying or evaporation of water is a physical process. Grosvenor's process was intended to harden the coatings rapidly and to produce them superior to those treated by other processes. It was not claimed to be new in the arts. In its simplest form it consists of simultaneously adding heat and moisture to the air surrounding the siccative coatings. Such a process has been used for years in drying lumber. It was learned early that if lumber were subjected to artificial heat it would dry rapidly, but the outside would become case-hardened. Steam vapor was therefore introduced into the drying chamber simultaneously with the heat circulation procured by fans, etc., and in that way the outside drying was retarded until the inside drying caught up, and the whole dried thoroughly and evenly.

A QUESTION OF PATENTABILITY

The only question, said the court, was whether the old lumber dry-kiln methods, when applied to harden siccative coatings, was patentable. (269 Fed., 144).

It was shown that prior to the Grosvenor process it required from eighteen to forty-eight hours to harden thick varnish, whereas under the new process the same result was reached in from six to eight hours. The so-called drying of paints and varnishes is not the same as evaporating moisture from wood or other products, nor does the use of the earlier lumber dry-kiln process even suggest that it might be used to dry paints, said the court. For years it was thought the introduction of moisture would delay hardening and water was generally kept away from fresh paints. The court held that the old and well-known process referred to was not only applied in a different art, but with a new and different result.

It required genius to discover, thought the court, by experimentation or otherwise, that the old process was suitable for the new use, and would produce a beneficial result therefrom unforeseen. It is apparent that the suitable hardening by oxidization of substances like a siccative film was not suggested by the drying of substances like a porous block of wood; because before the Grosvenor process it was the consensus that moisture was one of the greatest obstacles to the rapid drying of varnish, observed the court.

NO ANTICIPATION, DECIDES COURT

The second defense to the suit was anticipation by patents in the prior art, along with a published article, entitled "Pigments, Paints and Painting," written by

George Terry in 1893, where the author says: "The drying of paint being a process of oxidization and not evaporation, it is essential that a good supply of fresh air should be provided," adding that the presence of moisture in the air was beneficial and tends to counteract the tendency of the paint to crack or shrink. But Terry not only failed to indicate that moisture increased the rate of drying; he made no suggestion of any advantage to be secured by the rapid circulation of currents of air or other oxidizing agents across the surface of the material. Terry at best only anticipated the drying of paint under the action of heat, fresh air and whatever moisture nature happens to give in the air.

Grosvenor took a decided and important step in advance, said the court. His process cuts down the time of drying one-half, and in that way saved huge sums tied up in time and space in the manufacture of articles requiring such coatings. No prior reference or patent points out that the use of moisture in excess of natural humidity would be of any value, if indeed it was not said to be a disadvantage.

The patent was held valid and the usual reference was made for an accounting on the part of defendant.

Crop Surplus Awarded Fertilizer Works Where Surplus Was Due to Fertilizer Used

In a lien creditor's suit by the Armour Fertilizer Works against John W. Taylor and others, the Supreme Court of Appeals of Virginia reversed the lower court and directed that the fund in controversy be paid over to the fertilizer works. Taylor owned valuable farm lands which were heavily encumbered by many deeds of trust and judgments. To enforce these liens a lien creditors' suit was instituted. Later the several tenants who had leased the lands from Taylor purchased fertilizers from the Armour Fertilizer Works for use in making crops, giving their notes for the fertilizers purchased, securing the notes by crop liens duly executed under the Virginia statute.

A sale was had of the lands under direction of the court, under a decree in the lien creditors' suit. After payment of the old liens there was a balance left, applicable to either the crop lien claim or to payment to the trustee in bankruptcy for distribution among general creditors of Taylor who had become bankrupt. On Armour's crop lien claim it was found that the proceeds of the sale of the lands were augmented by the value of the crops, and that such crop value was due to the known and recognized effects of the fertilizer, which had been obtained upon by the security afforded by the crop liens. In other words, the court said the crop liens must be regarded as having produced the surplus.

DECISION SETS A PRECEDENT

The law is that where crops are planted after a mortgage is given on lands the crops pass with the lands for the benefit of the mortgagee, whether planted by the mortgagor or his tenant. No authority was found on the point involved, and the court was forced to proceed on equitable principles. It said the fund in controversy and claimed by the fertilizer works under its crop lien was in existence as a direct result of the sale of fertilizers to the tenants of the landlord, who had agreed or should have agreed in equity and good conscience for that fund to go to the seller of the fertilizer. The trial court's holding that the surplus belonged to Taylor's creditors was therefore reversed and the amount awarded to the fertilizer works.

Gases in Aluminum Furnaces and Their Analysis

**A Number of Common Gases Are Mixed in the Atmosphere of Various Furnaces Melting Aluminum—
The Problem Is to Develop a Portable Gas-Sampling Apparatus Which Will Extract
a Portion From a Desired Spot and Store It for Analysis**

BY ROBERT J. ANDERSON AND J. H. CAPPS

NO SYSTEMATIC studies of the actual constitution of the gas atmospheres prevailing in the interior of industrial metallurgical melting furnaces have been made. The constitution of flue gases in boiler-room practice and in coal-fired furnaces has been examined exhaustively by Kreisinger¹ and others, and is of interest and importance in connection with coal-fired metallurgical furnaces, since many gas analyses are given of the atmospheres obtaining in the fuel bed and in the combustion space.

LITTLE KNOWN ABOUT FURNACE ATMOSPHERES

As to the constitution of the gas atmospheres in the interior of metal-melting furnaces, the available data are very meager. In the publication of the Bureau of Mines on brass-furnace practice,² some analyses of the waste gases from a gas-fired, pit-crucible furnace are reported. The results of these analyses indicated the presence of a slight trace of carbon monoxide, never exceeding 0.40 per cent, and the proper proportions of nitrogen and carbon dioxide, indicating good combustion. Just recently, Bamford and Ballard³ have reported the sampling of gases from points near the top of a coke-fired pit-crucible furnace. In all cases the gases over the crucible contained an excess of oxygen and also small quantities of carbon monoxide ranging from 0.50 to 0.90 per cent. In one case, where the fire had burned down badly, 1.30 per cent hydrogen was found. In no case was there more than a trace of sulphur dioxide, but this is stated to be a condition dependent upon the character of the coke used, since when the coke contains any sulphur the combustion products must show the presence of sulphur dioxide.

It will be plainly evident that the constitution of the gas atmospheres in most industrial melting furnaces will be dependent upon a number of governing factors. The most important of these are the following: (1) Kind and quality of the fuel used; (2) type and design of the furnace; and (3) operating conditions.

KINDS OF FURNACES USED IN ALUMINUM MELTING

In large foundries, the stationary and tilting iron-pot furnaces appear to be favored considerably, but the tilting open-flame furnaces are also used a good deal. In small foundries, pit furnaces, using a plumbago crucible for both melting and pouring, are still employed

quite largely. Electric furnaces for melting aluminum and its light alloys are just now receiving considerable attention, and a few installations have been made. In the case of melting and smelting furnaces for aluminum and light aluminum-alloy borings, scrap and drosses, the domestic practice is not standardized. For smelting borings and other light scrap for the production of so-called "casting aluminum," stationary iron-pot furnaces, reverberatory furnaces, pit furnaces and tilting, open-flame furnaces are employed commercially. Experiments have also been made on the electric smelting of these materials.⁴ More recently a number of companies have made preliminary studies of the electric smelting of light aluminum-alloy borings, but no electric furnace is operating commercially on such material at the present time.

CONSTITUENTS OF MELTING-FURNACE ATMOSPHERES

It will be shown in a later contribution by detailed lists of analyses that the constituents which may be present in various furnace atmospheres vary widely as to kind and amount.

Carbon dioxide is a frequent constituent in the atmospheres of practically all types of furnaces used in the commercial melting of aluminum and its light alloys. The complete combustion of fuel results in the conversion of all the carbon, in whatever form, to carbon dioxide.

Carbon monoxide is a frequent constituent of melting-furnace atmospheres. In certain types of furnaces, it is normally present in small percentages under ordinary operating conditions, but the amount contained in the atmosphere can be varied within wide limits by varying the method of firing. A high carbon-monoxide atmosphere is normal in most electric furnaces.

Free cyanogen is of comparatively rare occurrence in furnace atmospheres used for melting aluminum and its light alloys. Cyanogen is formed in small amount when a discharge of electricity takes place between carbon electrodes in the presence of nitrogen. Thus, cyanogen is normally present in small amount in arc-type electric furnaces.

Hydrogen is normally regarded as a reducing gas; it is a frequent constituent in fuel-fired furnace atmospheres in small but variable amounts, and it has also been found in the atmospheres of electric furnaces. The presence of hydrogen in a fuel-fired furnace atmosphere normally indicates incomplete combustion, since the combined or free hydrogen in a fuel should burn to water.

Methane, in small but appreciable amounts, occurs in the atmospheres of furnaces fired by methane-containing fuel, due to incomplete combustion. It can scarcely

¹Published by permission of the Director, Bureau of Mines.

²Kreisinger, H., and Ovitz, F. K., Sampling and Analyzing Flue Gases, Bureau of Mines Bull. 97, August, 1915. Kreisinger, H., Ovitz, F. K., and Augustine, C. E., Combustion in the Fuel Bed of Hand-Fired Furnaces, Bureau of Mines Tech. Paper 137, September, 1916. Kreisinger, H., Augustine, C. E., and Katz, S. H., Low-Rate Combustion in Fuel Beds of Hand-Fired Furnaces, Bureau of Mines Tech. Paper 139, June, 1918. Also see related papers of the Bureau of Mines quoted in the above publications.

³Gillett, H. W., Brass-Furnace Practice in the United States, Bureau of Mines Bull. 73, second ed., June, 1916, p. 99.

⁴Bamford, T. G., and Ballard, W. E., The Influence of Gases on High-Grade Brass, paper read before the Institute of Metals, Sept. 15, 1920, Barrow-in-Furness meeting.

⁵Gillett, H. W., and James, G. M., Melting Aluminum Chips, Bureau of Mines Bull. 108, August, 1916.

be doubted that no methane is formed by the direct union of carbon and hydrogen. The occurrence of free methane in a furnace atmosphere indicates incomplete combustion, since methane burns to carbon dioxide and water in air.

Nitrogen is a normal constituent of all furnace atmospheres, being derived from the air. It is, of course, evident that nitrogen will always constitute a large percentage of the atmosphere in any fuel-fired furnace, since air is required for combustion.

Free, uncombined oxygen may be present in varying amounts in the atmospheres of industrial melting furnaces operating on aluminum and its light alloys. Ordinarily, free oxygen is the result of a large excess air supply, but it is possible that considerable carbon monoxide may be present in furnace gases together with some oxygen. This condition is stated by Gillett⁵ to be common in industrial melting furnaces when the attempt is made to avoid an oxidizing flame. At the same time, free oxygen is normally present in open-flame furnaces when run with an excess air supply; here, both oxygen and carbon dioxide may be present in large percentages, together with nitrogen and other gases. As in the case of other constituents of furnace atmospheres, the oxygen percentage depends upon the type of furnace, upon the fuel used and upon the operating conditions.

Sulphur dioxide may be present in furnace atmospheres in appreciable amounts when high-sulphur fuel is used. It results from the combustion of the sulphur in fuels, and at least small amounts occur normally in furnace atmospheres.

Unsaturated hydrocarbons in a furnace atmosphere normally come from the fuel used and are the result of incomplete combustion. The percentages present in various furnace atmospheres are usually quite low. No examination of the effects of unsaturated hydrocarbons upon the properties of aluminum and its light alloys has been made so far as is known.

Water vapor is a constituent of many furnace atmospheres, and it results from the combustion of free or combined hydrogen. The amount of water vapor in an atmosphere at high temperature is not readily determinable quantitatively, since the water vapor condenses on exposure to temperatures below 100 deg. C. From the chemical analysis of the fuel used, it is possible, however, to gain an idea of the amount of water vapor produced on combustion.

PORTABLE SAMPLING APPARATUS

In view of the influence which correct atmosphere control undoubtedly has upon melting losses, the Bureau of Mines resolved to make an effort to supplement the meager data now available on the composition of furnace atmospheres.

Most of the furnaces from which the gas samples were taken were located in plants several hundred miles from the Pittsburgh station of the Bureau of Mines. Hence it was necessary to devise a portable sampling apparatus for taking the gas samples. The apparatus described below has proved to be entirely satisfactory for the authors' purpose, and it is believed that the method of drawing off the gases by means of the mercury "pump" will be found preferable to any aspirating device. The apparatus as devised can be readily packed in a small box for shipment, and it can be carried about

in the plant for set up at a given furnace. The gas samples collected from furnaces at different plants throughout the country were contained in heavy glass bottles fitted with a spring cork and a rubber gasket. They were packed in excelsior at the plant where the samples were taken and shipped to the gas laboratory at the Pittsburgh station for analysis.

The portable sampling apparatus used for the removal of samples from furnace atmospheres is shown in Fig. 1. Tube *a* is attached to a fused silica tube, 4 ft. long, $\frac{1}{4}$ in. internal diameter and $\frac{3}{8}$ in. external diameter which is placed in the furnace so that gases may be drawn through it. Part *b* is a rubber tube, of the heavy-walled pressure type. A 20-ft. length is sufficient for most conditions met with in furnace installation. Part *c* is a glass bulb of about 100 c.c. capacity mounted upon a support.

SAMPLING PROCEDURE

In collecting the gas samples from the atmospheres of the various furnaces, the method for drawing off and holding the gas was the same throughout. The detailed method for obtaining a gas sample is as follows: The

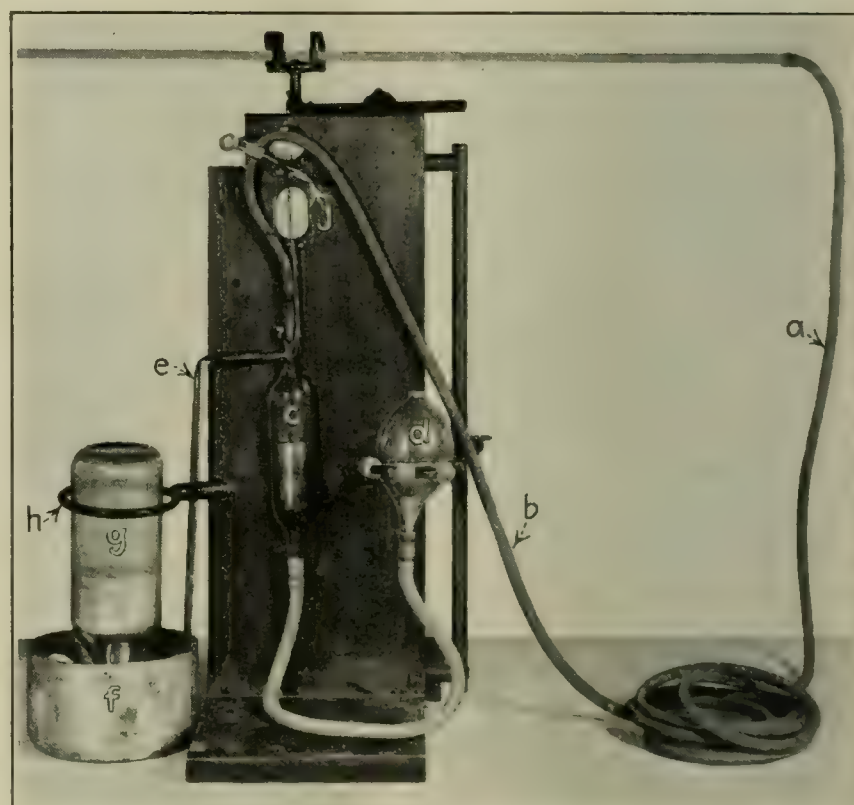


FIG. 1. PORTABLE DEVICE FOR SAMPLING FURNACE ATMOSPHERES

sample bottle *g* is filled with mercury and sealed with the rubber spring stopper; it is then inverted in the ring stand *h* into the dish *f*, which contains sufficient mercury to seal the mouth of the bottle when the stopper is opened. Bulbs *c* and *d* contain mercury in the amounts indicated in Fig. 1—i.e., when the mercury in both bulbs is at the same level the bulbs are each about half full. The actual amount of mercury required for manipulation depends upon the size of the bulbs and the connecting tube. With the sampling tube placed in position in the furnace atmosphere to be sampled, pinch cock *j* is opened and the delivery tube *e* is placed in such a position that it may exhaust gas into the mercury in the dish *f* but not into the bottle *g*, which is not opened until the apparatus is thoroughly "washed."

Bulb *d* is now lowered, the falling mercury in *c* causing gas to be drawn from the furnace through *a* and *b* and into *c*. The tube *b* is then closed by the pinch cock *j*, thus preventing the egress of gas through that line on raising *d*. When *d* is now raised, the mercury rising in *c* expels the gas, drawn into *c*, through *e*, through the

⁵Gillett, H. W., *Brass-Furnace Practice in the United States*, Bureau of Mines Bull. 73, second ed., June, 1916, p. 214.

mercury, and into the air. The apparatus is washed through with furnace gas from six to fifteen times before admitting gas to the sample bottle. When ready to deliver gas to the sample bottle, assuming that a quantity of gas is inclosed in *c*, the sample bottle is uncorked under the mercury in dish *f*; the end of the delivery tube *e* is inserted into the neck of *g*, and by raising the bulb *d* (*j* being closed), gas is delivered to the bottle. Then *b* is opened at *j*, and the operation is repeated until the sample bottle is full of gas, the mercury having been displaced and discharged into the dish *f*. The mercury in *f* acts also as a seal for *e*, thereby preventing ingress of air when *j* is opened and *d* is lowered.

As indicated, the "pump" is operated until the sample bottle is full, after which the bottle is sealed with the stopper, still under the mercury, removed, labeled, and its whole neck with stopper dipped in liquid paraffine to insure an air-tight seal. With this apparatus, samples can be taken at the rate of one every four or five minutes. Changes in the composition of a furnace atmosphere and variations in furnace operation can thus be detected during the course of a complete melting period.

In general, the open end of the sampling tube was placed in a position at about the center of the interior of the furnace and very near the surface of the liquid melt, say $\frac{1}{2}$ to 1 in. from the surface. In all cases the aim was to secure samples of the gas in contact with the alloy. For open-flame tilting furnaces, and in some closed furnaces, the sampling tube was admitted into the interior of the furnace through a hole in the door or through the pouring spout and luted firmly with clay. The intention for all furnaces was to bring the intake end of the tube to a position in about the center of the furnace and very near to the surface of the liquid alloy. This was not possible in the rocking-type indirect-arc electric furnace, nor in other furnaces under some conditions—such as in the early stages of a melt when the interior was filled with bulky scrap. In such cases the sampling tube reached well into the furnace, although not to the center. For open iron-pot furnaces and crucible furnaces, the sampling tube was simply supported by a stand in such a way that the intake end reached to within about one inch of the bath near the center.

GAS ANALYTICAL METHODS

In the analysis of the various gas samples a Bureau of Mines modified Orsat apparatus was used. Detailed description of the apparatus or of the methods employed for the determination of the constituents of the samples is not necessary here, since these subjects have been treated fully in other publications⁶ of the Bureau of Mines. Briefly, the different constituents in the gas samples are determined as follows: Carbon dioxide is determined by absorption in potassium hydroxide, oxygen by potassium pyrogallate solution, and unsaturated hydrocarbons by fuming sulphuric acid. Hydrogen and carbon monoxide are determined by the copper-oxide combustion method and saturated hydrocarbons by slow combustion. Cyanogen is determined by absorption in 2.0 per cent sodium bicarbonate solution and titration with standard iodine.

Pittsburgh, Pa.

⁶Burrell, G. A., and Seibert, F. M., The Sampling and Examination of Mine Gases and Natural Gas, Bureau of Mines Bull. 42, 1913. Burrell, G. A., and Oberfell, G. G., The Use of Copper Oxide for Fractionation Combustion of Hydrogen and Carbon Monoxide in Gas Mixtures, *J. Ind. Eng. Chem.*, vol. 8, 1916, pp. 228-231. Jones, G. W., and Neumeister, F. R., An Improved Orsat Apparatus, *CHEM. & MET. ENG.*, vol. 21, 1919, pp. 734-736.

Growth of the American Sulphur Industry

During the year 1910 crude sulphur imports into the United States totaled 28,648 long tons, valued at \$495,988, or an average of \$17 per ton. These figures were closely related to the domestic exports of brimstone and other refined forms, amounting to 30,742 tons, invoiced at \$552,941, an average export price of \$18 per ton.

For the calendar year 1920 imports were only 44 tons, valued at \$1,722. The domestic exports of sulphur amounted to 477,450 tons, worth \$8,994,350. From 1880 to 1903, the average annual importation was approximately 100,000 tons. Since 1907, annual imports have never gone above 30,000 tons. The average was about 20,000 tons. Receipts have been considerably lower since 1917.

Domestic sulphur was originally exported in 1904. In 1907, for the first time exports exceeded imports. From 1906 to 1911, about 30,000 tons was exported annually, increasing more than fifteen times, to 477,450 tons, in 1920.

The decline of imports followed the development of the Louisiana deposit, the first to be discovered in the United States. According to the United States Geological Survey, early attempts to mine the Louisiana deposits were unsuccessful, until the double problem of reaching the deposit and extracting the sulphur was solved by Dr. Herman Frasch. The original Frasch patents having expired, the same general process is now in use, both at the original locality and at Freeport, Tex., the next most important center. The United States Geological Survey has more recently investigated additional sulphur deposits in New Mexico and Alaska.

Exports in 1916 exceeded imports by 107,000 tons and were valued at over \$2,500,000. They showed increased valuation for each year thereafter. The annual growth in the export trade and the corresponding decline in imports during the past eleven years is shown in the following table, compiled from statistics from the Bureau of Foreign and Domestic Commerce:

EXPORTS AND IMPORTS OF SULPHUR 1910-1920

	Exports		Imports	
	Tons	Value	Tons	Value
1910.....	30,742	\$552,941	28,647	\$495,988
1911.....	28,103	545,420	24,250	436,725
1912.....	57,736	1,076,414	26,885	494,778
1913.....	89,221	1,599,761	14,636	278,56
1914.....	98,163	1,807,324	22,810	409,537
1915.....	37,271	724,679	24,647	405,990
1916.....	128,755	2,505,857	21,510	364,787
1917.....	152,736	3,500,819	973	20,176
1918.....	131,092	3,626,638	55	1,692
1919.....	224,712	6,325,552	77	1,997
1920.....	477,450	8,994,350	44	1,272

French Steel Companies Combine

Through the office of the commercial attaché at Paris it is learned that three of the largest steel corporations in France have recently combined. The principal company of the new combine is the Société Anonyme des Forges et Aciéries du Nord et de l'Est, the capital of which is to be increased from 46,000,000 to 86,000,000f. It will absorb the holdings of the Société des Forges et Aciéries du Nord et de Lorraine and of the Usines Métallurgique de la Basse-Loire. It is stated that the new company will control an ore domain with equipment for an annual production of 4,000,000 tons, and also six large French coal companies and important coal deposits in England as well as coke, cement and building material companies, rolling mills, foundries and casting plants.

Some Chemical Considerations of Petroleum Refining*

Factors Influencing a Change in Attitude of Petroleum Refiners Toward Chemical Research and Development of Non-Benzenoid Hydrocarbon Chemistry—Unsaturated Hydrocarbons Misunderstood—Polymerization Phenomenon Should Be Studied

By BENJAMIN T. BROOKS

PROF. IRVING FISHER in outlining his analysis of reconstruction problems has made use of the headings, "1. What is it? 2. Why is it? 3. What of it? 4. What are you going to do about it?" and it seems to me these questions may well be asked in discussing the chemical aspects of petroleum refining.

One might seriously debate the question whether or not there is such a thing as the chemical technology of petroleum. As to whether or not there *may* be a chemical technology of petroleum is another question, and I believe that this possibility is one of the best reasons for the formation of a petroleum section of the American Chemical Society. It is not the purpose of this discussion to quibble over definitions, but I believe that most of us will agree that while we have a more or less specialized technology of petroleum, chemistry has thus far played a relatively unimportant part in this industry. Many of us believe that chemistry should have played a much more important part in the technology of petroleum and the utilization of its products than it has done in the past, and that it is destined to do so. Let us attempt to analyze this situation and find out the reasons why.

Petroleum has been plentiful and it has until quite recently yielded handsome profits when simply burned as fuel. Greases and lubricants at least as good as anything to which the public was accustomed were easily made; not much chemistry required here. Petroleum has been so plentiful that refiners have often been hard pressed to take care of it; "throughput" has been the first consideration and only the simplest refining operations were permitted.

Research has been regarded as a kind of "wildcatting" in which the chances of success were not very good, the objectives often hazy and indefinite and not well understood; the gulf between scientific men and "practical oil men" has been very wide indeed. Burton's cracking process is the one important exception of a process having been originated and developed entirely by the works. This process and its demonstrated success is the best sign that the character of works management is changing. The Gulf Refining Co. has maintained a small research organization in the Mellon Institute for several years.

Work that has been done by chemists in the employ of oil companies has usually been buried, owing to the supposed value of secrecy and to the inertia of conservative oil producers of the old school. No one knows how much valuable work has been done and practically lost or buried in this way. Under these conditions initiative and the incentive to investigation are killed.

There exists no journal or publication which is recognized as serving the interests of petroleum technology, with the result that such few matters as are published

are scattered in a number of publications of indefinite or heterogeneous character. Petroleum investigations published in this way get lost in the shuffle and their message does not "get across." At present chemists interested in petroleum research are inarticulate.

There is a broad gap between petroleum technology and theoretical organic chemistry, and in this connection it should be emphasized that comparatively little systematic work in the chemistry of the non-benzenoid hydrocarbons which should serve as the fundamental groundwork of petroleum investigations has been done. Easily 80 per cent of the work which has been done must be credited to Russian chemists.

Poor training and narrowness of chemists; a chemist must be vastly more than an analyst to be of great service in this or in fact any industry.

FACTORS INFLUENCING A CHANGE

Let us see if there are any factors now operating which may change this state of affairs. I believe the following are likely to prove important.

Compared with demand, petroleum is much less plentiful than in former years. Its use as fuel has already ceased in many localities, and the cost of gas oil, for the manufacture of carburetted water gas, has become almost prohibitive.

Greater flexibility in refining operations is demanded so as to increase the production of the more valuable products.

The quantity of high-grade crudes, such as that of Pennsylvania, is relatively much less than ever before and it is far more difficult to manufacture products of satisfactory quality from oils such as Mexican or Californian oil.

The large refining losses resulting from treatment of highly unsaturated oils, together with the general economic situation, alluded to above, makes a study of refining, with the object of eliminating or minimizing these losses, almost imperative. Pyrolysis of oils as in the Burton process is now an indispensable process; shale oils and oils from the low-temperature carbonization of coal are on the way and the losses resulting on refining such oils by ordinary methods are very large indeed. In spite of the many years of oil-shale practice in Scotland, the losses on refining are enormous, and it may be said that no satisfactory method of treating these oils exists today.

The reaction of the automobile industry on the petroleum industry has been to emphasize the need of getting down to bed rock fundamentals, particularly as regards motor fuels, lubrication and the study of lubricating oils, their refining, carbonization, air oxidation, etc.

Following the lead of the Russians in the application of scientific research to petroleum, the Anglo Persian Oil Co. has established a large research laboratory in

*Read before the Petroleum Section of the American Chemical Society, Rochester, N. Y., April 27, 1921.

England under the direction of an able theoretical chemist, Dr. Dunstan. American petroleum interests probably will follow these leads. The American Petroleum Institute will undoubtedly be strongly influential in bringing this about.

NON-BENZENOID HYDROCARBON RESEARCH

A larger number of men, well trained in chemistry, are available than ever before. University laboratories are more handsomely equipped and the number of post-graduate students in chemistry is greater than ever before. If interest in the chemistry of the non-benzenoid hydrocarbons is stimulated, we may yet acquire the necessary fundamental information which petroleum research needs so badly. Such research should be systematic and broad in scope and will require the labor of many for a long period of years. Work of this kind in Russia has practically ceased, and American organic chemists may well give this field of work its due share of attention.

The formation of this petroleum section may promote chemical research on petroleum products and assist in placing chemistry in a more important relation to this industry. Dr. R. B. Sosman, president of the Philosophical Society in Washington, has recently called attention to the difficulties in the way of utilizing scientific information which arises from the great volume and heterogeneity of published scientific research and the wide gap which exists between isolated producers of scientific information and others who can apply or make use of it. It is worth while to recall that American investigations of interest to petroleum technologists have been published in a number of different journals, so that this literature is scattered and inaccessible to many. These considerations were partly responsible for the formation of the Institute of Petroleum Technologists in England, which now publishes an admirable journal. American investigations relating to petroleum have been published chiefly in the *Bulletin of the American Institute of Mining Engineers*, *Engineering and Mining Journal*, *CHEMICAL & METALLURGICAL ENGINEERING*, *Journal of Industrial and Engineering Chemistry*, *Journal of the American Chemical Society*, *American Chemical Journal*, *Proceedings of the Philosophical Society of Washington*, *American Journal of Science*, *Journal of the Franklin Institute*, and also many trade journals, which are filled with personalia, pictures of gasoline-filling stations and like matter, which very few libraries consider valuable enough to bind and preserve. In addition to this, there are a large number of Government bulletins and, as Dr. Sosman has so well pointed out, matters of real value may become submerged in the enormous flood of wood pulp which is thus fed through our printing presses. In view of this scattering of petroleum literature in this country, works such as Bacon and Hamor's recent volumes should be particularly welcome, and one of the most valuable results which this section might possibly bring about is the centralization of material published in America relating to petroleum.

Most large industries have passed through a stage in which secrecy was much prized. Each manufacturer imagined that he possessed keys to mysteries which others did not possess. As instances of this I need only mention the steel industry, the metallurgy and refining of copper, zinc, lead, aluminum, nickel and other metals, the paint and varnish industry, the electrochemical industry, the refining of sugar—and many

others might be added to this list. It may be conceded that in matters of industrial importance, and particularly in the case of patentable matter, a delay in publication sufficient for patent protection is reasonable, but beyond this there is no excuse for the burying of scientific information in private office records. I do not believe that well-informed and progressive business men would consider this question to be a subject of debate, and yet certain petroleum refiners adhere to the old policy, and it may be noted that such refiners are usually the kind who refer to the person whose duties are to make flash point and viscosity determinations as their "chief chemist." The latter remarks are not made in any spirit of criticism merely—in fact such testing work has to be done—but if chemical investigation of petroleum and refinery problems is ever seriously undertaken, the so-called "chief chemist" will not be one whose duties are almost solely taken up with routine tests on the refiners' products.

WHAT CONSTITUTES REFINERY PRACTICE

As regards the refining of petroleum products, we may well use Prof. Fisher's expression, "What is it?" and ask "What does refining really consist in?" Opinions may differ, and usually do, as to what constitutes refining and whether or not a given oil is "refined," "well refined," "poorly refined," "properly refined" or "suitably refined" for a given purpose and what not, but I believe the only answer or definition of refining which can at present be given is substantially this: *Doctoring it, so it will sell.* Petroleum products are "refined" according to the dictates of the salesmen and the standards to which the public has become accustomed. People outside of petroleum refineries object to offensive odors, and therefore one of the first requirements of a refined oil is that its odor shall not be unduly offensive. People generally like pretty colors and the public has become accustomed to insist upon water-white oils in certain cases, light yellow or amber oils in others, pretty red ones in other cases, or oils with a pretty green, bronze or blue fluorescence, as the case may be. The public has become accustomed to and expects these properties in certain oils, but does not expect petroleum oils to be perfumed or colored pink. These physical properties, odor and color, are mentioned in the first place as they are most conspicuous and have considerable to do with the salability of these products, but have little or nothing to do with their suitability or relative excellence in their usual applications.

UNSATURATED HYDROCARBONS MISUNDERSTOOD

One class of hydrocarbons which has been considerably discussed, particularly since the development of the now well-established processes of pyrolytic decomposition, as for example, the Burton process, is the class known as olefines or unsaturated hydrocarbons. Previously the general notion has been that refining consists essentially in removing these unsaturated hydrocarbons, and practically everything in the calendar which could be considered objectionable in an oil, including odor, was attributed to the presence of unsaturated hydrocarbons. But in the case of gasoline or motor fuel it has been shown by Hall and others that ordinary simple olefines behave just as well in internal combustion engines as saturated hydrocarbons; perhaps a little better. In fact, several years ago at the Mellon Institute Dr. Harry Essex made very satisfactory block tests on an automobile engine running entirely on unsatur-

ated hydrocarbons, even turpentine doing very well considering its boiling point and volatility, once the engine had become warm. Offensive odors in motor fuels are due to relatively very small proportions of derivatives containing sulphur, nitrogen and naphthenic acids, and these malodorous constituents can be completely removed independently of the unsaturated hydrocarbons and the resulting motor fuel may be quite superior in odor, and keeping qualities as regards color, to most of the gasoline marketed today.

The economic importance of an adequate supply of motor fuel is such that the unsaturated hydrocarbons present, which in the aggregate represent many millions of gallons, particularly in the case of cracked oils, should not be removed unless it can be conclusively shown that there is good reason to do so. In fact, I have shown in a previous paper on the subject,¹ that refining by ordinary sulphuric acid does not remove all of these olefines, but polymerizes a considerable proportion of them to higher boiling hydrocarbons, which are themselves unsaturated. The presence of these polymers in refined motor fuel may be objected to on the ground of their high boiling point, but not on account of their chemical unsaturation. It would undoubtedly be better to leave the original volatile unsaturated hydrocarbons in the motor fuel than to partly remove and partly polymerize them, as is done in ordinary refining, resulting in loss and in introducing heavy oily residues into the refined product.

In this connection it is worth while to point out that there is no analytical method which gives at all accurately the per cent by volume of unsaturated hydrocarbons in mixtures such as commercial motor fuel or other petroleum products, and in my opinion it is not worth while to seek such an analytical method. These unsaturated hydrocarbons have in the past merely served the purpose of something on which to blame all sorts of troubles and have often been used merely as a cloak for our ignorance. Founded upon some of these notions is the idea that they should be hydrogenated to saturated hydrocarbons and that this would constitute an excellent refining method. At least as regards odor it would do nothing of the sort, and in the case of lubricants the writer agrees with Dunstan that it would be preferable to have larger proportions of them in such oils.

RESINOUS DEPOSITS

It is well known that highly cracked oils leave a thick resinous deposit on slow evaporation in air, and this might conceivably lead to carburetor troubles if such oils were used, but Hall has shown that these resin-forming constituents, present in exceedingly small proportions, can be removed by fullers earth. These resin-forming constituents are probably conjugated unsaturated hydrocarbons, illustrated by isoprene, dimethylhexadiene, cyclohexadiene and the like, which, as is well known, tend to resinify in contact with air. These conjugated diolefines also react very energetically with concentrated sulphuric acid, and this behavior is particularly pronounced in crude benzene from water-gas tar, the light condensate from Pintsch gas and the like. That ordinary unsaturated hydrocarbons, containing one double bond, do not exhibit this behavior has been definitely established—in fact, even pure olefines, with no saturated hydrocarbons present, do not yield

tars with ordinary concentrated sulphuric acid at ordinary atmospheric temperatures, but, on the contrary, the most reactive ones, amylenes and hexylenes, give amber-colored solutions in sulphuric acid. On standing these solutions give steadily increasing proportions of light, amber colored, oily polymers, which form an upper supernatant, oily layer. In the case of the usual hydrocarbon mixtures these polymers are found in the so-called refined oil.

When we consider the refining of lubricating oils we encounter another set of trade customs and prejudices, together with a series of unsolved scientific problems, the most important of which is naturally the subject of viscosity and lubrication. Every one knows that when an unrefined lubricating oil distillate is allowed to stand it darkens rapidly in color, and this proceeds from the exposed surface gradually downward until the whole oil has become very dark in color. This phenomenon is evidently one of air oxidation. As usual, following the old formula, the blame is put upon olefines. However, viscous oily polymers consisting entirely of unsaturated hydrocarbons do not show this behavior. This has been shown in the case of polymers of a wide variety of olefines including amylenes, hexylenes, octenes, decenes, including unsaturated cyclic hydrocarbons of the terpene type, and other unsaturated hydrocarbons of 12 to 18 carbon atoms, either pure, made synthetically or derived from the decomposition of natural waxes and fatty acids. The substances which cause this development of color may easily be minor constituents constituting less than 1 per cent of the crude lubricating distillate, but just what they are we do not know.

TAR-FORMING CONSTITUENTS

It may also be pointed out that unsaturated hydrocarbons, so far as these are actually known, are increasingly stable to sulphuric acid as the molecular weight increases, and do not form tars. As to what the constituents of crude lubricating distillates are which do form the tars observed in refinery practice we do not know, but it does not get us anywhere simply to follow the old tradition and say that the cause of these tars is olefines. We know practically nothing regarding the constitution of the unsaturated hydrocarbons obtained by the polymerization of simpler olefines by sulphuric acid, zinc chloride, fullers earth and the like, but it is practically certain that aluminum chloride acts much more energetically and that the products obtained by its action do not contain ethylene hydrocarbons.

UTILIZATION OF POLYMERIZATION

Is it worth while, from a practical standpoint, to study this question of polymerization? Personally, I am convinced that it is, and a first attempt to utilize this phenomenon in a practical way was made recently by Brownlee, who during the recent war period made lubricating oils by the polymerization, by means of aluminum chloride, of unsaturated hydrocarbons, made by pyrolytic decomposition of gas oil distillate or other cheaper oils. Dunstan in England has suggested that it is desirable to retain olefines in lubricating oils and that they may have lubricating qualities superior to the saturated hydrocarbons. Every possible means of reducing the present large refining losses must be carefully considered. The refining of lubricating oils should, therefore, be carefully studied with the object of discovering methods of refining which will accomplish

¹J. Am. Chem. Soc., vol. 40, p. 822 (1918).

the particular results desired and *no more*. Whether or not Dunstan's contentions are correct should be easily capable of experimental proof or disproof, and Archbutt has recently suggested that such questions be settled once and for all time by studying the behavior of different types of hydrocarbons, either made by synthesis or isolated from commercial oils. When the days of "slaughtering" crude petroleum are over—and they are rapidly passing—research on such problems will be imperative. A study of our production statistics indicates that if the refining losses of lubricating oils could be halved many millions of gallons would be added annually to our supply of lubricating oils.

Brownlee's process of making lubricating oils by polymerization of oils which by themselves are too fluid for lubrication is particularly suggestive and, it may be noted, is a change diametrically opposed to cracking processes. One of the most valuable features of the Burton process is that it gives considerable flexibility to the refinery operations, and the polymerization process should also be of increasing value on this account.

TESTING FOR LUBRICATING VALUE OF OILS

In connection with Dunstan's claim as to the lubricating value of unsaturated hydrocarbons, it may be pointed out that none of the testing methods now employed are any measure of the film strength of a lubricating oil. Physical chemists have pointed out that for a liquid to lubricate two moving surfaces the liquid must be adsorbed by the solid surface, and that the thickness of the effective lubricating film is of the order of 10^{-7} cm., or, in other words, of the order of one to two molecules in thickness, and that flooding a bearing with more oil does not improve lubrication. During the war the value of castor oil or additions of 1 to 2 per cent of free fatty acids to a lubricating oil was clearly shown, this benefit chiefly consisting in greater tenacity or wetting power of the oil for the metal. So far as I am aware there is no term which expresses precisely this property, although the terms "oiliness" and "body" connote something of this behavior. In a moving bearing, under heavy duty, the tendency is for the oil to be squeezed from between the moving surfaces, and if the oil film has not sufficient tenacity or adhering power the film will be broken and metal to metal friction will result. Viscosity measurements, together with years of observation and experience with lubricating oils, has come to be generally considered as being roughly parallel to, if not a measure of, this film stability or film tenacity. Given this analysis of the problem, any reasonably competent mechanic could devise an instrument which would measure this property of oils in a way which would constitute a much more rational means of determining the lubricating value of different oils.

ECONOMIC VALUE OF RESEARCH

It is not too much to expect that economies which can be effected through better refining methods will more than cover the sum total of the cost of all petroleum investigations, even should these investigations be undertaken on a very large scale indeed. Other possible results of research might, therefore, be reckoned as pure gain, and it is worth pointing out in this connection that the actual experience of manufacturers who maintain research is that the big difficult problems yield by far the greatest financial returns in the long run, as compared with the benefits of solving a multitude of easy little problems.

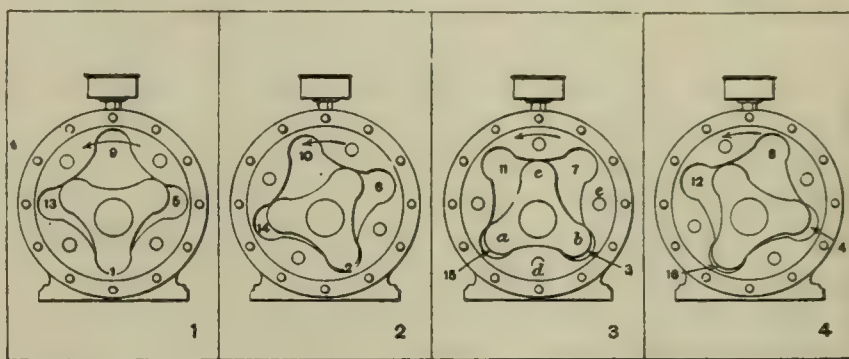
A New Principle of Rotary Pump Construction

BY S. H. FARKAS

THE rotary types of pumps thus far evolved may be divided broadly under the classifications: those using the rotary gear movement, the rotary plunger, and the rotary bucket and packing strip. Practically all these various types require continual replacements, due to the friction taking place either between the moving parts themselves or between the moving parts and the casing.

The illustrations, Figs. 1 to 4, show the two rotating elements of the Exeter rotary pump in sequence of position during one complete revolution. Fig. 5 shows the geometrical construction employed in the design of the two rotors.

Taking Fig. 5 first, an equilateral triangle ABC and a square of equal side are erected on a common base AB .



FIGS 1 TO 4. SEQUENCE OF ROTOR POSITIONS

The angles of the triangle are bisected and the lines produced; the diagonals of the square are also drawn and produced. The circumscribing circles of both triangle and square are also drawn. It will be seen that at the bottom of the figure a distance X is obtained by the intersection of the two circumscribing circles. With the points of the triangle as centers, circles with radii equal to one-fourth of the common side of the triangle and square are described. With O as center and OF as radius, the diagonals of the square are intersected; from the points so found as centers and with one-fourth the common side of the square and triangle as radii, circles are described. The joining arcs for the completion of the square figure are struck with the height of

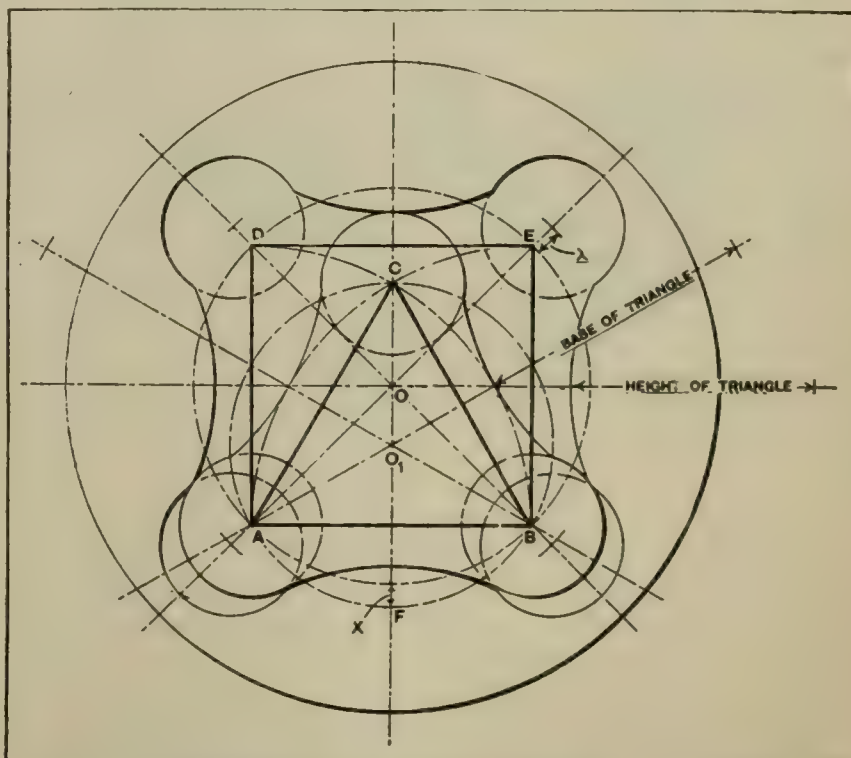


FIG. 5. GEOMETRICAL CONSTRUCTION OF DESIGN

PERFORMANCE TESTS									
Power			Pump						
R.p.m.	Dyn. Scale	B.-Hp.	Disch. Hd., Ft.	Suc. Hd., Ft.	Total Hd., Ft.	Hook Gage	Gal. p.m.	Water, Hp.	Eff., per Cent
500	0.87	0.55	4.0	3.3	7.3	0.296	52.8	0.099	18.0
	1.20	1.50	62.0	2.7	65.7	0.290	51.2	0.85	56.7
	1.57	2.56	126.0	2.6	128.6	0.287	49.9	1.62	63.3
	2.10	4.04	182.0	2.5	184.5	0.283	48.3	2.25	55.8
700	0.82	0.563	4.0	4.7	8.7	0.337	75.2	0.167	24.2
	1.18	2.02	70.5	4.6	75.1	0.334	73.4	1.39	69.0
	1.55	3.50	131.0	4.4	135.4	0.330	71.0	2.43	69.5
	1.95	5.13	199.0	4.3	203.3	0.326	69.0	3.54	69.0
900	0.81	0.675	4.0	6.9	10.9	0.377	100.2	0.276	40.9
	1.16	2.49	67.0	6.6	73.6	0.373	97.8	1.82	73.0
	1.49	4.20	125.0	6.6	131.6	0.368	94.4	3.14	74.7
	1.89	6.28	194.0	6.5	200.5	0.365	92.0	4.65	74.1
1,000	0.87	0.748	4.0	7.0	11.0	0.391	108.7	0.302	40.3
	1.12	2.53	61.5	6.5	68.0	0.389	107.4	1.85	73.0
	1.47	4.55	119.0	6.3	125.3	0.385	105.0	3.32	73.0
	1.82	6.57	175.0	6.2	181.2	0.382	103.2	4.72	71.8
1,200	0.87	1.31	5.0	8.6	13.6	0.420	129.0	0.433	33.8
	1.17	3.39	62.0	8.4	70.9	0.420	129.0	2.31	68.1
	1.52	5.81	124.0	8.3	132.3	0.417	126.6	4.23	72.7
	1.85	8.08	177.0	8.2	186.2	0.413	123.6	5.80	71.8
1,400	0.93	2.01	7.0	9.5	16.5	0.426	133.8	0.557	27.6
	1.25	4.59	64.5	9.5	74.0	0.426	133.8	2.50	54.5
	1.57	7.16	123.0	9.3	132.3	0.423	131.4	4.40	61.3
	2.00	10.6	195.0	9.3	204.3	0.421	129.8	6.70	63.1

the initial triangle as radius, while the similar arcs on the triangular figure are struck with the side of the square or triangle as radius.

The first center found is along the vertical center line and the arc contacts with the extreme top of the triangular figure. The explanation is more involved than the actual construction, which can easily be followed from the diagram and the foregoing text using a pair of compasses. The only variation from the geometrical figures so found is that the recesses in the square figures are paralleled out so that the projections on the inner figure may enter. It will be readily seen that all the curves can be generated with relative ease, and even the variation mentioned presents no particular difficulty.

ROTOR POSITIONS

Taking the illustrations in Figs. 1 to 4, in sequence: in Fig. 1, the space 9 between the two rotors is at the maximum. The inlet port has just closed and the outlet

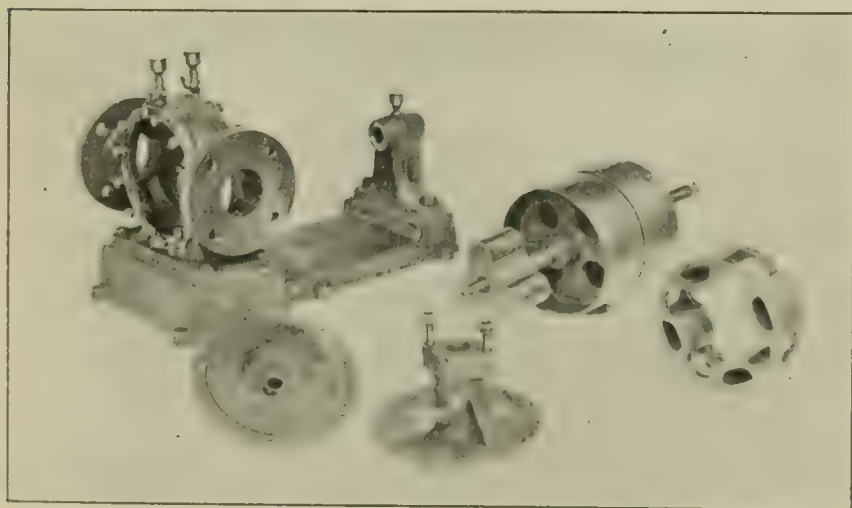


FIG. 6. PARTS OF A 4-IN. PUMP

port is about to open. The entire cycle of movement and variation of one space can be progressively followed through the four diagrams by the numbers 1 to 16. Starting with maximum volume as 9 in Fig. 1, then going to 10, 11, 12, 13, 14, 15, 16, 1, 2, 3, 4, 5, 6, 7, 8 and 9 completes the progression. The capacity of the pump per revolution is three times the volume of space 9.

The pump consists of an outer casing of cylindrical form having a pair of rotors meshing, the inner rotor being keyed to the driving shaft. These two rotors are set eccentric one to the other, the axial line being at the intersection of the bisection lines at O in the geometrical diagram on Fig. 5. The outer rotor has four ports which are open to the chamber of both the suction and discharge side of the pump during rotation. These ports are closed momentarily by a lip at both the top and the bottom of the pump body in order to effect the cut-off between the suction and the discharge of the pump. The liquid is drawn into the pump through the ports of the outer rotor while the pocket is increasing, and forced out at the opposite side of the pump during the last half revolution when the pocket is decreasing.

The rotors themselves are flat acid-resistant castings of suitable thickness, worked on edge to the figures described, their faces being in parallel planes. The outer rotating member is a working fit in the casting at its periphery and is otherwise free, the inner rotor imparting motion to the outer.

The pump is self-priming, easy of installation and can be adapted to almost every pumping condition. Dirt and grit do not seem to affect the pump, inasmuch as there is no rubbing or wearing contact.

Exeter Machine Works, Inc.,
West Pittston, Pa.

Synopsis of Recent Chemical & Metallurgical Literature

Welding Blow-Holes in Steel.—Harry Brearley read a notable paper on this subject before the May meeting of the British Iron and Steel Institute, in which his principal thesis is that the best of welds is never perfect, because the welded surfaces can always be pulled apart, provided the steel is tough naturally, or can be made tough by heat-treatment. Stead's law of welding,¹ "Unless the crystals become common to the two pieces there is no welding," is not rigid on account of the varying amount of interpenetration which may exist, all in apparently good welds, yet all of which can be split apart. Ingots are never quite free from shrinkage cavities, cracks or blow-holes, especially near the axis, and Brearley questions whether these can be welded perfectly—meaning thereby made into metal in all respects as good as any unwelded part of the same piece. In fact, even under most skillful working he feels that such ingot defects are responsible for the "hair-lines" which caused so much trouble during the war in such parts as aero-engine crankshafts. Segregates (especially sulphides) concededly mark their former location; but the trouble lies in the small cavities themselves rather than the sulphide segregate.² In fact, the latter is the telltale witness, in sulphide printing, of the greatest value to metallography, often indicating the pouring temperature, whether top or bottom cast, whether early blow-holes have been subsequently filled by liquid metal, whether axial unsoundness is due to unskillful forging or piped metal; sulphur printing indicates spot segregates on the surface, and "finally it is an indispensable touchstone for the careful steel maker who is making steel for such special purposes as rifle barrels."

As an illustration of the limitations of the present modes of testing welds, several different 3½-in. blooms were drilled axially, a machined 1-in. bar of the same material pressed

¹Jour. Iron & Steel Inst., 1911, vol. 1, p. 54.

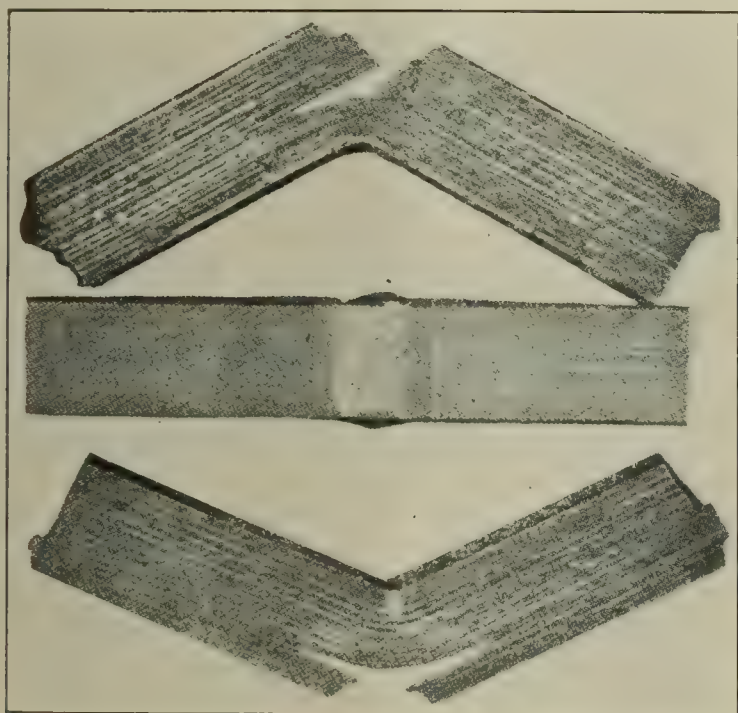
²Dr. Rosenhain, in discussing Stead's paper, said he had some experimental evidence to show that certain impurities, especially soluble impurities, facilitated interpenetration of crystals at surfaces being welded.

in, and welded at the ends, heated and rolled into a bar $\frac{1}{2}$ by $4\frac{1}{2}$ in.

Steel	Microscopic Examination	Nick and Break	Impact on Toughened Bar
0.15 C steel.....	Welded perfectly	Weld split	Weld split
0.35 C steel.....	Welded perfectly	Not split at weld	Weld split
3% Ni steel.....	Welded perfectly	Not split at weld	Weld split
5% Ni casehardening steel.....	Welded perfectly	Weld split	Weld split
3 $\frac{1}{4}$ % Ni-Cr steel.....	Welded perfectly	Not split at weld	Weld split

The "nick and break" test must be used with especial caution since it would show the fallacious result that all rolled and forged bars are the better in welding the higher the hardening elements, including phosphorus.

The author proposes a tentative test of weld-ability. Take Izod test-pieces from the sound edge, and the cored middle part of such a bar. The impact strength of the first will represent in great part the force required to propagate the crack already started by the notch. If no weld has occurred in the second bar, the crack will come to a dead stop when it enters the core or leaves it, and a new crack will have to be started in each case, which, as is known, requires proportionally much more energy. A welded bar will have less impact strength across the joint than one which is not so well made. On the other hand, impact strength varies inversely with the hardness, so very hard steels will break through whether properly welded or not. The same is true of all metal having low impact



BROKEN IMPACT PIECES FROM CORED BARS

values. The proposal therefore is to measure the perfection of a weld in terms of the degree of toughness in Izod foot-pounds which must be induced in a steel by quenching and drawing before the weld will be pulled apart in the impact machine, as in the illustration.

On this basis the results of some steels tested are shown below:

Steel	Analysis			Weld-ability	Tension Fracture
	C	Ni	Cr		
A	0.34	3.26	0.28	28	Cored
B	0.34	3.11	0.28	20	Cored
C	0.32	3.11	0.28	18	Normal
D	0.35	3.57	1.05	14	Cored

Under the microscope all the welded surfaces were distinguishable; after annealing all but steel D showed well defined ferrite strings at the former junction, enclosing minute dark spots or threads supposedly of slag.

Even granting that blow-holes cannot be perfectly welded, it would appear that bars made from open steel would be better than from dead-melted under cross-grained impact. Hence the toughness of wrought iron, due to its slag inclusions which would be an unacceptable defect in steel. Hence also the preference for effervescing steel shown by many makers of leaf springs. However, since Brearley's experiments on cored bars, made under the best circumstances as to cleanliness, do not weld perfectly, he concludes that segregates in cavities are not the cause of imperfect welding, nor the cause of transverse weakness in tension.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Calcium Carbide and Cyanamide.—The heat required for the formation of calcium carbide may be derived from the combustion of an excess of carbon in the charge provided that an oxygen blast is used. Oxygen for this purpose may be available from air separation or reduction apparatus of any well-known type, which will also supply the necessary nitrogen for the conversion of the carbide directly and continuously into cyanamide. Apparatus for accomplishing these results is described by FRED E. NORTON of Worcester, Mass. The charge with its excess of carbon is fed into the top of a vertical retort, the bottom of which is flared into a large chamber. Tuyeres for the introduction of oxygen are situated just above the chamber. Molten carbide which collects in the form of slag in the bottom of the chamber is discharged through a taphole in a continuous stream. If it is desired to make cyanamide, the reaction can be carried continuously as fast as the molten carbide flows out of the furnace, without resort to the heretofore intermediate steps of cooling, pulverizing and reheating the carbide. To this end the spout may discharge the molten substance into a disintegrator consisting of a water-cooled tunnel and a continuous blast of nitrogen from a jet or nozzle. The disintegrated and partly cooled substance passes continuously to a conveyor within a closed nitrogen-filled container in which the cyanamide reaction is completed. (1,374,317; April 12, 1921.)

Temperature Control in Production of Anthraquinone by Catalytic Oxidation.—This invention is for a process of producing anthraquinone from anthracene. By this invention use is made of the principle that vaporizable liquids will absorb latent heat in changing from the liquid to the vapor state without change in temperature, the heat being carried away by the vapors from which it may be extracted, thereby condensing the vapors which may be returned for absorbing more heat.

In Fig. 1 the reference character 1 refers to a container which is provided with a perforated plate 2 upon which a layer of catalyst 3 or carrier such as pumice or asbestos for said catalyst is placed. Electrical heating means are shown at 4 and a series of pipes 5 with closed ends extend into the catalyst 3 or the carrier for the same. The upper ends of the pipes 5 terminate in a header 6, which may be connected to a pump 7, which may be used either to create a vacuum or pressure in the pipe or to introduce a gas, preferably neutral, into the header from a source, not shown. A valve V in the pipe P may be closed, if desired, after the pump 7 has been operated to obtain the desired condition in the system. The lower ends of the pipes 5 are filled with a liquid which may be vaporized and then be condensed in the upper end of the tubes 5 and run back into the lower ends. A deflector 8 is shown in the lower part of container 1, which has an inlet 9, and the container 1 is surrounded by a casing or housing 10 having a partition 11 and an outlet 12.

In the modification shown in Fig. 2, the container 1¹ is provided with an outlet 12¹, and a pipe 13 leads to the inlet 9¹ from the jacket 14 which surrounds the upper portion of the tubes 5¹. The other parts shown in Fig. 2 are similar to the corresponding parts described in connection with Fig. 1.

The operation according to Fig. 1 is as follows: The reaction mixture is introduced through inlet 9 into container 1, where it comes into contact with the catalyst 3. If necessary, the heater 4 may first bring the temperature up to that required to initiate the catalytic reaction which is an exothermic one. The catalyst 3 becomes heated and the heat is conducted through the walls of the tubes 5 to the liquid

therein, which is caused to boil and the vapors rise in the tubes 5, the upper ends of which are cooled in any convenient way so that the vapors become condensed and trickle back into the lower ends of the tubes 5. The liquid in the tubes is not heated above its boiling point, because an increase in the heat transmitted to the same merely causes an increase in the ebullition without a rise in temperature. The pressure in the system may be increased or diminished by means of the pump 7, thereby varying the temperature

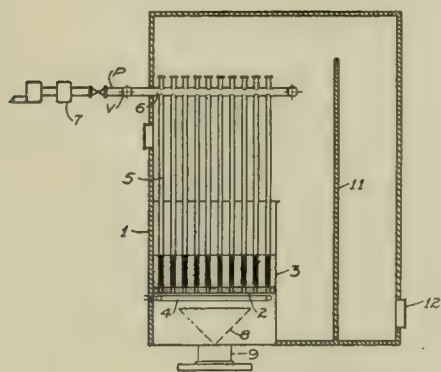


Fig. 1.

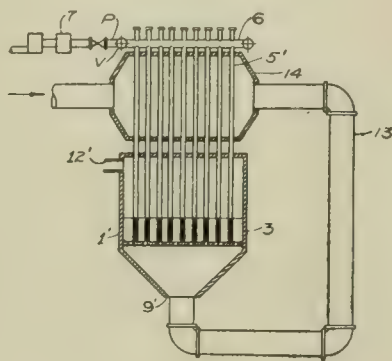


Fig. 2.

at which the liquid will boil. After the reaction mixture has passed through the catalytic zone, the products of reaction pass upward around the wall 11 and out of the outlet 12, so that the products may be collected and used. The operation according to Fig. 2 is the same as that above described in connection with Fig. 1 except that the reaction mixture is passed through jacket 14 so as to come into contact with the catalyst 3'. The products of reaction pass out through the outlet 12'.

A specific application of this invention is in the oxidation of anthracene to anthraquinone in the presence of vanadium oxide as a catalyzer. It has been found that the proper temperature at which this reaction should be carried out is about 375 deg. C., because very much higher temperatures cause the oxidation to progress too far, and the reaction will not take place satisfactorily at very much lower temperatures. Mercury boils at 357 deg. C., and if a proper pressure is applied upon the mercury its boiling point is changed sufficiently so that if a mixture of an oxygen containing gas and anthracene in the vapor phase is passed into the catalyst the exothermic reaction to produce anthraquinone will raise the temperature enough to provide sufficient temperature gradient or head between the catalyst 3 and the liquid in tubes 5 when this liquid is mercury so that the exothermic heat is transmitted from the catalyst to the mercury with sufficient rapidity to keep the temperature of the catalyst at about the proper point, or near 375 deg. C. The temperature will be automatically regulated to a certain extent, for when more heat is evolved the mercury will boil more rapidly and thereby remove heat more rapidly. The cooling surfaces of the pipes 5 will be made large enough to assure condensing of all the vapors, and the pressure maintained in the pipes will be such as to keep the boiling point of the liquid mercury so that it will hold the catalyst at the proper temperature. When mercury or other oxidizable liquid is used as the heat-removing agency it may be advisable to introduce into the tubes 5 a neutral gas, such as nitrogen, to prevent oxidation of the liquid. Further examples of chemical reaction to which this invention is applicable are the oxidation of naphthalene to phthalic anhydride, ethyl alcohol to acetaldehyde, and the chlorination of hydrocarbons, etc. (1,347,721; CHARLES R. DOWNS, of Cliffside, N. J., assignor to The Barrett Co.; April 12, 1921.)

Acid-Resisting Articles.—While an alloy of iron and chromium containing certain proportions of iron and chromium carbides is highly resistant to the action of sulphuric acid, such an alloy is brittle and difficult to machine. ALVAH W. CLEMENT, of Cleveland, Ohio, first prepares an alloy of about 60 per cent Cr and 40 per cent Fe under conditions which make the alloy practically carbonless. Articles formed or machined from this alloy are then carbonized to give an acid-resisting surface. (1,375,673; assigned to Cleveland Brass Mfg. Co.; April 26, 1921.)

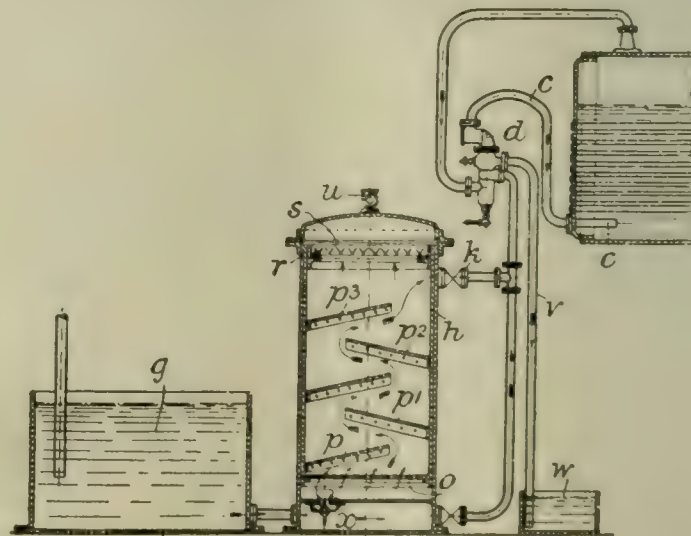
British Patents

For complete specifications of any British patent apply to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Separating Creosote From Tars.—Phenolic bodies are extracted from tars such as lignite, shale, peat, coal, producer and low temperature tars, and from tar distillates and residues and from mineral oils and distillates by washing with a mixture of acetone and water. Acetone extracts of the tars, etc., may be mixed with water or aqueous acetone to cause the separation of the oils, while the creosote remains in solution. (Br. Pat. 156,694; not yet accepted; E. ERDMANN, Halle-on-Salle, Germany. March 16, 1921.)

Zinc White.—Zinc carbonate, oxide and sulphide are prepared from any zinc-containing material by the following reactions. The zinc ore, fume, etc., is first dissolved in acid, preferably hydrochloric, and purified by known means. By passing carbon dioxide in the presence of magnesia or magnesium carbonate into the zinc solution, zinc carbonate is precipitated while magnesium chloride, if hydrochloric acid was used to dissolve the ore, is formed in solution. After filtration and washing, the liquor is concentrated and by the addition of magnesia solid magnesium oxychloride is formed which is readily converted into hydrochloric acid and magnesia for re-use, by heating. Zinc oxide may be obtained from the carbonate by calcination, but preferably by treatment with dilute caustic soda or potash solution which is recovered by means of lime from the resulting alkali carbonate. The precipitated zinc oxide is removed and dried and the solution made by dissolving it in acetic acid or dilute mineral acid is used to prepare zinc sulphide. After the precipitation and removal of the latter, the liquor is used again by redissolving a further quantity of zinc oxide or carbonate and reprecipitating as sulphide. Alternatively the sulphide is prepared by passing sulphuretted hydrogen into a closed mixing device containing a suspension of excess of zinc carbonate in water, or in a dilute solution of hydrochloric acid or zinc salt. Sulphuric acid may be used in the place of hydrochloric for dissolving the ore, but the latter is preferred since it enables the magnesia and acid to be recovered readily. (Br. Pat. 157,860; not yet accepted; C. CLERC and A. NIHOUL, Paris. April 6, 1921.)

Separating Air From Feed Water.—Apparatus of the character described in the parent specification for separating gases from liquids is arranged on the suction side of the water feed to steam-generators. The air-removing



chamber *h* is supplied with water from the tank *g* through the valve *x*, and the purified water is drawn off through the outlet *k* by the injector *d* and forced through the pipe *c* into the boiler. The overflow pipe *v* dips into a reservoir *w*. The air-removing chamber *h* is constructed with a perforated plate *o*, alternating inclined shelves *p*, *p'*, *p''*, *p'''* supporting the turnings, shavings, fibrous material, or other substance for causing the air to separate, and with a series of angle-bars *s* supported on an angle-ring *r* which form a kind of partition between the purified water and the uppermost layer of water which is in contact with the separated air at the top of the chamber. (Br. Pat. 157,790; not yet accepted; C. HULSMAYER, Düsseldorf. April 6, 1921.)

Treating Tin-Bearing Tailings.—Tin-bearing rocks having a small content of stannic oxide, or "tailings" left after the mechanical separation of stannic oxide, are reduced by suitable gases, and the resulting metallic tin associated with a large quantity of gangue subjected to the action of anhydrous chlorine.

The reaction vessel is provided with a jacket through which a cooling medium may be circulated in order to maintain approximately atmospheric temperature. The stannic chloride thus produced is separated by leaching with a solvent such as warm water or caustic soda solution, by distillation preferably at reduced pressure, or by blowing hot air on the heated mass. The volatilized stannic chloride is condensed in water and the hydrated chloride used to prepare other tin salts or metallic tin. The latter is extracted by passing the solution of stannic chloride into a series of boxes each containing zinc turnings; spongy tin is precipitated, while zinc chloride free from tin collects in the last box. The addition of a small amount of stannic chloride is found to facilitate the commencement of the reaction between the metallic tin and the chlorine, and if the ore contains arsenic or sulphur these are removed by roasting before the reduction of the stannic oxide. (Br. Pat. 159,071; J. J. COLLINS, Winsford, Cheshire. April 27, 1921.)

Book Reviews

RESEARCH AND METHODS OF ANALYSIS OF IRON AND STEEL (Second Edition). Pp. 220. By Research Department of the American Rolling Mill Co., Middletown, Ohio, 1920. Price \$4.

This book is a publication of the control practice, along physical and chemical lines, adopted by the well-equipped laboratory of a modern rolling mill producing a specialized product—ingot iron. In addition, chemical methods used by this company in research and investigative work are also described, such as for the determination of the gaseous constituents of iron and steel. Following the introduction and a short chapter given to Ancient Irons and Modern Research, the book is divisioned accordingly: Research on Corrosion; Magnetic Testing; Metallurgical Control; and Chemical Analysis; with subsequent pages including Useful Data and the Index.

The dissertation on research on corrosion is devoted exclusively to the possible or probable effects that gaseous impurities in ferrous metals have on their corrosion. One is first acquainted with the respective works of Miller and Austin relative to the considerable quantities of occluded gases found in both liquid and solid steel, and also with the beneficial results obtained in the physical properties of a steel degasified by vacuum treatment. From these observations arise a conception that possibly the gaseous constituents of steel may have a considerable bearing on its life under corrosive conditions. The results of investigations by the research department on the gas content of materials showing good and poor corrosion resistance are then given, with the fact stressed that in all cases the nitrogen content is higher in the rapidly failing steels than in those that are more resistant. Throughout this chapter are presented photographs of old iron and modern steel fabrications, showing respectively excellent and poor states of preservation after service.

Under Magnetic Testing the description of necessary apparatus and procedure for testing the magnetic properties of steel and iron is essentially the same as found in the standards of one of our national societies. The heading Metallurgical Control covers principally a description of the equipment used by the American Rolling Mill Co. for the pyrometric, metallographic and physical control of its output during and at completion of production, with a general outline of the work entailed in the mill and laboratory. More than half of the volume is devoted to Chemical Analysis, where are given in alphabetical sequence methods for the determination of all elements, common and rare, encountered as impurities in iron and steel.

This includes the gaseous elements, hydrogen, oxygen, nitrogen (as nitride), and also the compound carbon monoxide. Considerable space is allotted to different procedures for carbon, with the inclusion of a detailed description of the gasometric method devised and used by T. D. Yensen for the separate determination of the different forms of carbon in iron—viz., gaseous and solid. Besides the procedures for determining the constituents occurring in iron and steel, complete instructions are given for the evaluation of the metallic coatings commonly applied to ferrous products. Details are presented regarding the selection of samples, with particular reference to sheets. A description of Dr. A. S. Cushman's new method for determining the weight of spelter coating by measuring the hydrogen evolved brings up to date this branch of testing.

Taken as a whole, the book can scarcely be recommended as a general text for the iron and steel chemist or metallurgist. While true to the title, in that methods are given for the determination of practically every constituent encountered in iron, in many cases valuable details or notes are lacking, a fact at least partly recognized by the authors, who state in the preface, "Where well-known methods have been described, we have omitted details which are well understood by the skilled chemist. Where new methods are described, we have entered into minute details." Therefore the value of the book revolves largely about the call the user has for these uncommon procedures. As the treatise Research on Corrosion deals only with the rôle that may be played by gaseous inclusions in iron or steel and no mention is made of those constituents whose presence in ferrous metals has been more or less generally recognized as inhibiting corrosion, the non-inclusion of these types in the data exhibited militates seriously against the significance that might otherwise attach to the interesting findings here presented.

This handsomely finished little volume is palpably a medium of publicity; however, since it contains some uncommon technical data of value and a contribution of new thoughts and work, it has a certain value in the library of those interested in iron and steel.

R. H. NEALE.

* * *

PYROMETRIC PRACTICE; Technologic Paper 170, Bureau of Standards. By *Paul D. Foote, C. O. Fairchild and T. R. Harrison*. 326 pages, 7 in. x 10 in. Price, 60c., from the Superintendent of Documents, Government Printing Office.

Pyrometric practice has become so widespread in recent years that a real need has been felt for a supplement to the standard work of Burgess and LeChatelier on "Measurement of High Temperatures," describing the many successful instruments which have been recently marketed. It is only fitting that such a book should come from men attached to Dr. Burgess' division of the Bureau of Standards, men who have had every opportunity to compare the various types and who have already written much helpful information on various phases of this subject in technical journals and society proceedings.

The Burgess-LeChatelier work is indispensable for its treatment of fundamentals; indeed there seem to be no instruments described in "Pyrometric Practice" which are not directly traceable to the types discussed in the older book. However, the new publication illustrates the large number of available pyrometers, indicators, recorders and fittings by photographs and diagrams of actual instruments or installations, whereas the sketches as well as the discussions in the older book are more of ideals.

In recent years there has come into being a type of metallurgist who must know about temperature control of industrial operations; some men are so specialized that the care of pyrometer installations occupies their whole time. All such will welcome the new book, and find in it a clear, unbiased description of practically every type of temperature-measuring device now on the market, invaluable information on the proper installation and use of all this various equipment, and a large number of helps in keeping it operating correctly. Burgess and LeChatelier and Foote, Fairchild and Harrison will be the pyrometricians' Old and New Testaments.

E. E. THUM.

Current Events

in the Chemical and Metallurgical Industries

Hotel Accommodations for Fall Meeting, A. C. S.

Hotel headquarters for the meeting of the American Chemical Society in New York City, Sept. 6-10, 1921, will be at the Waldorf-Astoria Hotel, Fifth Ave. and Thirty-third St. Through the courtesy and co-operation of the Hotel Association of New York City the committee has arranged to receive applications and make reservations at the various hotels throughout the city. Applications should be made promptly, and it is suggested that two or more persons take advantage of double rooms and suites wherever possible. Prices at the various hotels range from \$1.50 to \$5 per day for single rooms and from \$3 to \$10 for double rooms.

Columbia University has offered the facilities of its dormitories to aid in meeting the requirements of those desiring to attend the meeting. Rooms for men, rooms for women and rooms for married couples have been reserved in the dormitories at the rate of \$1.50 per day per person, with a maximum per person of \$10 for the period Sept. 6 to 16, for those wishing to stay for the Chemical Exposition.

Applications, giving the following information, should be forwarded as soon as possible to Charles F. Lindsay, chairman of the hotels committee, c/o United States Rubber Co., 1790 Broadway, New York City:

Application for.....persons.
Names of those in party.
Type of reservation desired.
Maximum price per day per person.
Time of arrival.
Expected departure.

Reservations will be confirmed from the designated hotels.

Young Opposes Longworth Resolution

The only Republican member of the Committee on Ways and Means of the House of Representatives who objected to the Longworth resolution, which has as its object the placing in immediate effect the duties carried in the forthcoming tariff bill, was Representative Young of North Dakota. He did not submit a minority report, but in a statement he takes the position that such legislation would be unconstitutional. He says that the decisions of the United States Supreme Court always have been that Congress cannot delegate legislative authority. Representative Young contends that it will require a faith in the Ways and Means Committee nothing short of sublime to give rates of duty force of law before those rates are known to members of Congress. He points out that the agitation of the question is likely to result in waste of time. He doubts if the resolution will pass the House and he feels very certain that the Senate will not abdicate and calmly allow a general tariff bill to become a law for a period of five months without its having been considered by the upper house. He also doubts if the President will tie his own hands in matters not only affecting economic considerations but possible complications with foreign countries.

Representative Young contends that the proposed action does not have a parallel in the somewhat similar procedure of certain foreign governments. "The government" in those countries, he points out, holds office at the pleasure of the popularly elected branch of the legislature and can be voted out of office promptly if it reports customs rates or provisions which are unsatisfactory. The government or ministry in these foreign countries, Mr. Young points out, is charged with executive functions and responsibilities, whereas the Ways and Means Committee has no such responsibility.

Final Program, American Leather Chemists Association Meeting

The eighteenth annual meeting of the American Leather Chemists Association will be held at the Hotel Ambassador, Atlantic City, June 9, 10 and 11. Morning sessions will convene at 10 o'clock, afternoon sessions at 2 o'clock.

THURSDAY MORNING, JUNE 9

Opening remarks by the president, F. H. Small.

Report of secretary-treasurer, H. C. Reed.

The Effect of Atmospheric Humidity on the Determination of Moisture in Leather, T. D. Jarrell.

Committee report: Determination of Epsom Salts in Leather, R. W. Frey.

Committee report: Determination of the Sugar Content of Leather, J. S. Rogers.

THURSDAY AFTERNOON, JUNE 9

Relation of South America to the Leather Industry, G. A. Kerr.

Committee report: Sampling and Preparation of Leather for Analysis, F. H. Small.

Soaking and Liming Hides, C. M. Morrison.

Some Applications of Synthetic Tanning Extracts, J. B. Hill and G. W. Merryman.

Some Effects of Post-Mortem Changes in Fresh Hides, G. D. McLaughlin.

Demonstration of the Explosiveness of Tannery Dusts, R. W. Frey.

FRIDAY MORNING, JUNE 10

Committee report: The Determination in Leather of Matter Extractable by Water, J. A. Wilson.

Notes on the Extraction of Leather, F. P. Veitch and R. W. Frey.

Further Observations on the Wilson-Kern Method of Tanning Analysis, G. W. Schultz.

Committee report: The Direct Measurement of the Plumping Power of Tan Liquors by the Clafin Method, A. A. Clafin.

Rapid Washing of Chromed Hide Powder, R. W. Frey and I. D. Clarke.

FRIDAY AFTERNOON, JUNE 10

Chestnut Wood Tanning, R. W. Griffith.

Colloids, H. N. Holmes.

Conditions in the Leather Industry, L. J. Robertson.

Tanning Materials in the Far East, L. Balderston.

Determination of Available Calcium Oxide in Lime Used for Unhairing Hides, F. P. Veitch and T. D. Jarrell.

SATURDAY MORNING, JUNE 11

Committee report: The Color Measurement of Vegetable Tanning Solutions, T. Blackadder.

Committee report: Estimation of Oils and Greases in Leather, F. P. Veitch.

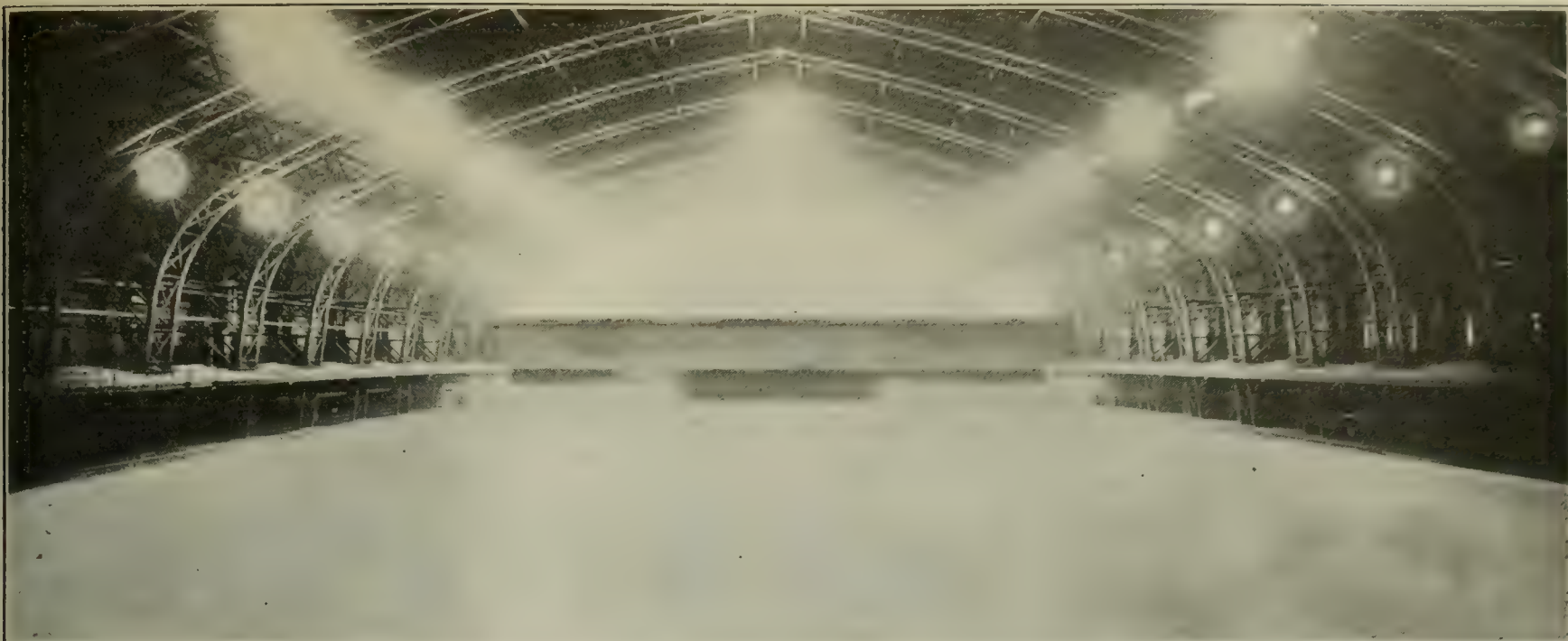
Executive session.

Election of officers.

Council meeting.

Research Chemicals Committee Named

The National Research Council has approved the appointment of a committee to prepare a list of research chemicals. The membership of the committee is as follows: W. D. Collins, chairman; Roger Adams, Captain D. B. Bradner, H. T. Clarke, W. F. Hillebrand, George C. Spencer and Clarence J. West. This committee will prepare a list of sources of various materials not commonly available, particularly those needed for special researches.



INTERIOR EIGHTH COAST ARTILLERY ARMORY

Seventh National Exposition of Chemical Industries

Announcement has just been made that the Seventh National Exposition of Chemical Industries will be held in the Eighth Coast Artillery Armory, Jerome Ave. and Kingsbridge Road, New York City, during the week beginning Sept. 12. Some idea of the facilities available may be obtained from the accompanying illustration showing the drill floor of the armory. There will be ample room for the 400 or more exhibits on this floor, which, it will be noted, is entirely free from obstructing posts and pillars. The armory is readily accessible from all parts of the city, the running time from Grand Central by way of the Jerome Ave. extension of the Lexington Ave. subway being about 30 minutes. It is also provided with an auditorium in which the symposiums and exhibitions of motion pictures will be held and with a dining room that will accommodate 1,400 persons.

During the week preceding the Exposition, chemists and chemical engineers from all parts of this country and from abroad will gather in New York for the joint meeting of the Society of Chemical Industry and the American Chemical Society. Those present at this meeting will thus be able to attend the Exposition as well.

Dr. Charles H. Herty, editor of the *Journal of Industrial and Engineering Chemistry*, is chairman of the advisory committee in charge of the 1921 Exposition. Others on this board include Raymond F. Bacon, director, Mellon Institute; L. H. Baekeland, honorary professor chemical engineering, Columbia University; Henry B. Faber, consulting chemist; John E. Teeple, president, the Chemists Club; Bernhard C. Hesse, chemist, General Chemical Co.; Acheson Smith, president, American Electrochemical Society; A. D. Little, president, Arthur D. Little, Inc.; William H. Nichols, chairman of the board, General Chemical Co.; H. C. Parmelee, editor, *CHEMICAL & METALLURGICAL ENGINEERING*; Fred W. Payne, co-manager of the Exposition; R. P. Perry, vice-president, The Barrett Co.; Charles F. Roth, co-manager of the Exposition; Edgar F. Smith, president, American Chemical Society; T. B. Wagner, vice-president, U. S. Food Products Corporation; David Wesson, president, American Institute of Chemical Engineers, and M. C. Whitaker, president, United States Industrial Chemical Co. The headquarters of the Exposition are now located at 342 Madison Ave., New York City.

Helium Repurification

The U. S. Bureau of Mines has undertaken to complete the installation of apparatus for the repurification of helium at the Langley Field plant. The work is being done in co-operation with the Army and is under the general direction of Dr. R. B. Moore, chief chemist of the Bureau of Mines. D. M. Ferris is the engineer in immediate charge.

Bureau of Mines Technical Motion Pictures

Motion pictures of ingot iron manufacture and of sulphur production formed the program of the 320th meeting of the Chemical Society of Washington on May 25. These films were furnished by the Bureau of Mines, which has a long list of such technical motion pictures for distribution. Any society or local section desiring the use of this sort of an entertainment should apply to T. T. Read, Division of Education and Publications, Bureau of Mines, Washington. There is no charge made by the bureau for this use of the various pictures which have been prepared in co-operation with the industry.

American Society of Mechanical Engineers Spring Meeting

The spring meeting of the American Society of Mechanical Engineers convened at the Congress Hotel, Chicago, Ill., May 23-26. A large attendance held a number of activities which were of direct interest to operators and owners in the chemically-controlled industries. Some of the papers presented are briefly abstracted in the following report.

FUEL SESSION

E. G. Bailey in an exhaustive paper on recording ash-pit loss from chain-grate stokers gave data obtained from a recently-developed device which enables firemen to effectively control this factor. The device in the main consists of a steel tube or bulb filled with nitrogen and connected through a capillary tube to a recorder consisting of a mercury U-tube, one leg of which is open to the atmosphere and carrying a float to which the recorder pen is attached. It has been found that when this bulb is properly located near the rear of a chain-grate stoker, its temperature will respond definitely to changes in the amount of combustible matter going to the ash-pit and will vary in direct proportion to the heat thus lost. This relation between temperature and ash-pit loss is not materially affected by grate feed, rate of combustion or percentage of ash in coal, but should be determined for different types of installations by actual tests.

Recording instruments have been devised which show on the same chart the ash-pit loss, excess air, unburned gas, flue-gas temperature and steam flow. The records thus obtained make it possible to plot characteristic performance curves for stokers showing the losses due to unburned combustible, unburned gases and excess air, and to determine the proper amount of excess air to be maintained and also the most efficient capacity. These curves can be used to compare the relative efficiencies of different types of stokers, the suitability of different kinds of coal, and the effectiveness of the control by the fireman.

Henry Kreisinger and John Blizzard presented a summary of the results obtained in an extended series of tests on a

468-hp. water-tube boiler fired with pulverized Illinois coal which showed that contrary to the customary specifications it is not necessary to pulverize the coal to the extreme fineness of 85 per cent through a 200-mesh screen in order to get good combustion and good efficiency. This ability to burn coarser coal means increased capacity of the pulverizing mills and decreased cost of coal preparation. The results also show that it is not necessary to dry coal to about 1 per cent moisture in order to burn it successfully in pulverized form and it is stated that with most Eastern coals drying is not at all necessary. Good results can be obtained when the coal is burned at rates varying from 0.5 lb. to 2 lb. per cu.ft. of combustion space per hour, and the best results at a rate of 1 to 1.5 lb.

Edward H. Tenney discussed the limitations imposed on mechanical stokers by the use of Mid-West coals, which are characterized by higher moisture, volatile and ash contents as compared with Eastern coals; the limits imposed by air supply and by the design of the furnace; and the effect of these various limitations on stoker operation. In general the application of mechanical stoking equipment to the use of Mid-West coals has proved to be eminently successful. Specially designed arrangements for air supply and to facilitate ignition of the fuel have been provided, and furnace volumes and gas passes have been scientifically studied, with the result that the most difficult problems—namely, those incident to operation at high rates of combustion—have been satisfactorily solved.

John E. Wilson, of Swift & Co., in speaking of capacity and efficiency limitations of stokers using Mid-West coals, said that less progress had been made in the direction of securing efficient combustion than in any other direction immediately connected with stoker service. In the case of natural draft chain-grate stokers the greatest losses are those due to the dry chimney gases and carbon in the ash, and the possibility of making a material gain in the efficiency lies to a great extent in ability to reduce these two losses. A certain amount of air admitted over the fire has been found advantageous when high volatile coals are used, such as those found in the Middle West. Chain-grate stokers provided with forced draft operate successfully under continuous high rating, respond quickly to load requirements and will successfully burn coal containing a large percentage of ash which fuses at a comparatively low temperature.

Underfeed forced-draft stokers in the Mid-West district have a large number of very satisfactory operating records to their credit both from an efficiency and a capacity standpoint. Some types of overfeed stokers have also been used with success in this section where only a limited capacity was required and suitable coal was available. The necessity of securing improved refractories as well as improving the furnace design is emphasized by the difficulties encountered with the brickwork when forced-firing is employed, and it is possible that these may prove factors governing the capacity which will be obtained in future installations.

A paper by Frank Chambers on the "Latest Requirements of Chicago in Furnace Design" with special reference to hand-fired boilers was presented in abstract by Robert Kuss. It contained some data on draft drop through the setting and in the gas passages, velocity of gas flow, area and height of stack, city requirements and typical designs of furnace.

GENERAL SESSION

Snowden B. Redfield described some capacity tests of dry vacuum pumps by the low-pressure nozzle. A nozzle was used in which the downstream or back pressure is higher than the critical. This permitted the determination of several values of volumetric efficiency over a range of vacua without changing the nozzle. Graphic proofs of the accuracy of the theory of the nozzle were presented, showing clearly that the method of plotting results permits ready estimation of approximate performance of any given pump.

Magnus W. Alexander and Dugald C. Jackson, in a paper on "The Engineering Industries and Engineering Education," stated that a combination of empiricism and training in rational science is needed in engineering education, because it is needed in the engineering industries. This consideration has led to various plans for placing engineering stu-

dents within the influence of industrial operation, the most common being for engineering college graduates to enter industrial establishments as engineering apprentices or student engineers. The plans put into effect at the Massachusetts Institute of Technology and the University of Cincinnati were outlined. It is believed that these experiments in co-operative engineering training will exert a most beneficial influence upon the relation of the engineering college to industry upon the activities of each. While co-operative training in engineering cannot replace the regular engineering courses at colleges, it is nevertheless destined to become a vital integral part of a comprehensive system of engineering education to the detriment of none of the other parts, but to the mutual benefit of all, and is particularly important to the manufacturing industries of the nation.

R. S. Johnston, of the Bureau of Mines, Washington, reported the results and conclusions from an elaborate series of tests on oxy-acetylene welding and cutting blowpipes. This paper, without doubt, described the most complete series of tests on oxy-acetylene welding that has ever been published. The general conclusions were that there is a great deal of difference between the characteristics of different designs of cutting blowpipe and that there is no make of apparatus which is equally efficient and economical for all thicknesses of metal.

J. R. McDermet, in a discussion on the "Interpretation of Boiler-Water Analyses," emphasized the importance of taking into consideration the corrosive properties of a boiler-feed water as well as its scale-forming tendencies. Feed-water impurities fall into at least one of three groupings: dissolved solids, pollution products, and dissolved gases. The dissolved products determinable under a technical analysis naturally group themselves into corrosive and scale-forming constituents according as they are or are not highly ionized in aqueous solutions. Pollution products are detected by inferential methods in a partial sanitary analysis, but the effects of various types of pollution other than manufacturing wastes as indicated by the analysis are concretely set forth. Dissolved-gas analyses (meaning in the main dissolved-oxygen analyses) were discussed in relation to the safe operating limits of hot-water feed lines, boilers, and cast-iron steel-tube economizers.

An appendix to this paper translates the facts into a working plan for use in the chemical laboratory.

POWER SESSION

Samuel Insull, presiding officer, opened the power session with the remark that it took a great war and a British commission to convince this country that concentration in the production of electrical energy was an economic gain. Superpower plan proposed for the East was good and well worth considering, but if engineers in general would pay more attention to the forwarding of similar projects in their respective localities their efforts would be more effective. In the Mississippi Valley there are few locations where large plants can be located at the mouth of the coal mine due to the lack of water, and they must therefore be placed at the centers of distribution with no waste or duplication, each serving the surrounding territory and all tied together with a network of transmission lines. This can be done economically. Prominent factors, then, in this territory where relatively small water power is available, are cheap transportation and ample water facilities for cooling and boiler-feed water.

W. L. Abbott, in discussing the location and distribution of central station power in the Middle West, stated that this section of the country contained only 18 per cent, or 776,000 kw., of the water power of the United States, the greater part of this lying in the States of Michigan, Wisconsin and Minnesota. Ohio, Indiana and Illinois, which are the richest in coal, are poorest in water power. It is cheapest to ship coal by rail to plants advantageously located than to generate at the mouth of the mine and have a standby station in the city with a transmission line between, this being true even with the excessive and unequal freight rates now in force.

C. W. Place, speaking of the future power development in the Middle West, pointed out that in this territory large centers of generation have been developed, but they are

far apart, and each has its tributary country of low load density made up of towns and villages with farming country drained by innumerable streams that should supply power to the towns and villages near them. In the fourteen central states there are 102 cities of over 25,000 people each with a fairly efficient steam plant. It is proposed that the power houses of these cities be connected together not by heavy high-voltage lines, but by lines which will pick up the small town and village loads to the point where its next large neighbor would take its share. Hydro-electric plants along these lines would be automatically connected in.

BUSINESS SESSION

The following nominations were announced for officers of the society: President, Dexter S. Kimball; vice-presidents, Colonel E. A. Deeds, Robert Sibley, L. E. Strothman; managers, Sherwood F. Jeter, Horace P. Liversidge; treasurer, William H. Wiley. Members of American Engineering Council, Francis Closson, Charles A. Booth, Gano Dunn, H. H. Esselstyn, W. S. Lee, Irving E. Moulthrop, John A. Stevens, A. E. Walden and Perley F. Walker. Atlanta, Ga., was named as the place at which the next spring meeting would be held.

Subjects for Papers Before the American Society for Steel Treating

Prof. H. L. Campbell, Ann Arbor, Mich., has been appointed chairman of the meetings and papers committee of the American Society for Steel Treating. Associated with Prof. Campbell on this committee are: George O. Desautels, president of the Imperial Drop Forge Co., Indianapolis, Ind., and Victor Hillman, metallurgist, Crompton & Knowles Loom Works, Worcester, Mass.

The board of directors has authorized the awarding of a gold medal for the best paper presented at the Indianapolis convention and a silver medal for the second best paper. While the awarding of these medals for this year has been made to apply to those papers presented for this year's convention, the policy in future will be to award the medals to the first and second best papers presented before the society during the year.

A list of subjects upon which papers will be presented follows:

GENERAL TOPICS

1. The Organization and Management of a Heat-Treating Department.
2. Practice of Handling and Checking Materials to and From Heat-Treating Department.
3. Quantity Production Methods for Forging and Heat-Treating Tools.
4. Methods for Heat-Treatment of Very Small Machine Parts.
5. Heat-Treatment of Sheet Steel Parts as Saws, Hack Saw Blades, etc.
6. The Artificial Seasoning of Hardened Steel.
7. Furnace Design With Reference to Fuel Economy.
8. Metallography and Its Application.
9. Comparative Study of Methods for Heating Furnaces by (a) Coal, (b) Fuel Oil, (c) Gas, (d) Electricity.

ALLOY STEELS

1. Topical Discussion of Alloy Steels and Their Heat-Treatments for Specific Purposes; as (a) Springs, (b) Gears, (c) Finishing Tools, (d) High-Speed Cutting Tools, (e) Dies.
2. Practice of Ordering Tool Steel on Specifications.
3. Cutting Efficiency of High-Speed Steel Which Has Received Different Methods of Hardening.
4. Die Blocks and Their Heat-Treatment.

CARBURIZING

1. Carburizing Practice Adapted to Alloy Steel Parts.
2. Determination of Unit Cost of Carburizing Steel Parts.
3. Efficiencies of Different Mixtures for Cyanide Hardening.
4. Practice of Cyanide Hardening.
5. The Service of Annealing Boxes Made of Different Materials.

Personal

C. L. BRYDEN, chief engineer for the Kelly Filter Press Co., New York City, has associated himself with W. P. Heineken, engineer and manufacturer, New York City.

PAUL H. HSU, a graduate of the Massachusetts Institute of Technology and formerly research chemist with the Larkin Co., Buffalo, N. Y., and the chemical division of the Procter & Gamble Co., Cincinnati, Ohio, is now on his way to China, where he expects to engage in consulting work and marketing of chemical machinery and materials.

Dr. R. B. MOORE, chief chemist of the Bureau of Mines, delivered the Sigma Xi lecture at the University of North Carolina on June 3. His subject was "Helium."

O. C. RALSTON has been named assistant chief metallurgist by the Bureau of Mines. His appointment will become effective July 1. His headquarters will be at Berkeley, Cal., where he also will have charge of the work at the Berkeley station. He will direct all the work of the bureau on non-ferrous metals. Since Jan. 1 Mr. Ralston has been superintendent of the Seattle Experiment Station.

Dr. R. E. ROSE, of the chemical division of the du Pont Co. has been transferred to the dyestuff division, as assistant director of the technical laboratory.

JOHN J. RUTLEDGE has been transferred from station superintendent at St. Louis to the position of superintendent of the Urbana Experiment Station. G. J. Salmon has been designated to be acting superintendent at St. Louis.

O. V. URBAN took charge of the chemical work of the Guttenberg refinery of the American Cotton Oil Co. on June 1.

E. R. WILES has resigned his position as chief chemist of the Southern Oil Corporation to assume the position of chief chemist with the Barnsdall Refining Co., Bigheart, Okla.

J. C. WITT of the Structural Materials Research Laboratory, Chicago, recently returned from an inspection trip to the arid regions of Colorado, in connection with research on the effect of alkali on concrete.

Obituary

FRANK D. BAKER, for twenty years chief engineer for the Colorado department of the American Smelting & Refining Co., died in Denver on April 29, at the age of sixty-three, following an operation for ulcer of the stomach. During his long service with the smelter company Mr. Baker was in charge of or intimately connected with much of the metallurgical plant construction in the state, and was widely known and admired by Western metallurgical and mechanical engineers. He was the inventor of numerous metallurgical devices, of which the best known is the Baker cooler, for cooling calcined materials on a large scale. Mr. Baker was graduated in 1888 from the course in mechanical engineering at the University of Illinois. He was a member of the American Society of Mechanical Engineers and the Colorado Society of Engineers. He is survived by his wife and five children.

Colonel THOMAS CURTIS CLARKE of New York City, a metallurgical and civil engineer, died suddenly May 26 at the Roosevelt Hospital, of pneumonia following an operation. Colonel Clarke had engineering charge of special work for the Illinois Steel Co., was formerly general superintendent of the Lackawanna Iron & Steel Co., supervising engineer of the Deutsche Bank of Berlin and was a consulting engineer, located in New York City, specializing in coal and coke and its byproducts until the entry of the United States into the war. He served in the A. E. F. as Colonel of the 110th Engineers, 35th Division.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, June 6, 1921.

Trade conditions have been decidedly better in the chemical market, even though the week-end holiday intervened. Business has been going along in extremely good fashion and interest from consumers seems to be growing. The strengthening of the resale market for alkalis is probably the most hopeful sign in the market. Although alkalis are being imported in good-sized quantities, the demand has increased to such an extent that prices on the spot are noticeably firming up. All general indications point to a steady improvement with the present market as a basis. The most important occurrence of the week was the pronounced advance of *caustic soda* and *soda ash* with higher prices asked despite offers from abroad of large quantities. The market on caustic opened at \$3.85 per 100 lb., and at the close there was enough odd lot buying to lift prices up to 4c. per lb. Along with these two leading chemicals has been a stronger market for bichromate of soda and potash, prussiate of soda and other items of varying importance. On the other hand, some chemicals have remained in a somewhat dormant position, with consumers still following the hand-to-mouth buying policy. Signs of improvement are apparent in many of the more important industries and it must be admitted that while there is a certain amount of this improvement taking place in basic conditions, buying confidence has been so badly shattered during the recent business depression that expansion can be along gradual lines only. Sellers feel encouraged that the long period of hand-to-mouth buying is visibly dwindling away and that shelves among the consuming element are well cleared. The tendency among leading industrial plants is to increase capacity. Soap factories are buying in freer style and glass-makers seem to be working toward a more normal output. Paper mills and tanneries are still lagging behind in production.

CHEMICALS

Resale lots of domestic *chlorate of potash* were quoted by second hands at 8½¢@9½¢. per lb., according to seller. Prime domestic material is quoted by producers at the former price of 12c. per lb., f.o.b. works. German shipments were quoted at 8½¢. per lb. The *muriatic acid* situation is extremely sluggish, with consumers contenting themselves with only minimum quantities. Makers are still holding prices at the former levels, as it is expected that consumers will sooner or later come into the market for more normal requirements. The present basis is quite close to the cost of production. Quotations on the 20 deg. are based on \$1.50@1.75 per 100 lb. Prices on *sulphuric acid* remained unchanged at recent levels, with the demand very light. Quotations on 60 deg. acid in tank cars f.o.b. works are around \$11@13 per ton. The 66 deg. strength is quoted at \$18@\$20 per ton. Demand for *oleum* has been very slow, with quoted prices for the 20 per cent in tank cars at \$22@\$25 per ton. Consumers are showing very little interest in this item. Makers of *aluminum sulphate* are quoting the iron free at \$3 per 100 lb. in the face of a very slow demand. The commercial grade could be obtained all the way down to \$1.75 per 100 lb. The market on *ammonium sulphate* continues very dull, with stocks heavy and only a few buyers in the market. Prices are subject to shading on any firm business. The spot price is around \$2.75 per 100 lb. *Bleaching powder* is very sluggish, with resale material offered at \$2.15 per 100 lb. f.o.b. works. Makers are still holding their prices around \$2.75 per 100 lb. There were only a very small number of buyers during the week. Resale lots of *carbon bisulphide* were offered on the spot down to 6c. per lb., against a producers' price of 8c. The manufacturers were given the preference, however, as resale stocks at low figures are of a limited nature. Prices on *caustic potash* remained with-

out any quotable change at former levels. The demand has been very slow. Resale caustic of American manufacture is offered around 5½¢. per lb. German caustic is held at 6½¢@7½¢. per lb. on spot.

Yellow prussiate of soda appeared firm, and dealers reported sales at 12½¢. per lb. ex-store. Shipments are offered at 12½¢. per lb. N. Y. Spot material is not so plentiful at the moment and several large sellers quote 12½¢@13c. per lb., according to quantity. Dealers of *bichromate of soda* are not willing to quote below 8c. per lb. for standard brand material and in some quarters 8½¢. is being asked. A scarcity of round lot offerings is holding the market in a firm position. Resale solid *caustic soda* reached 4c. per lb. in the late trading on all standard brands. Sales were made earlier in the week at \$3.85@ \$3.95 per 100 lb., and it was reported that some large tonnages were closed at the inside figure. Those close to the pulse of trading stated that shelves have been well cleared of resale material and some of the large dealers admitted that their surplus has been exhausted. The final offering was firm with 4c. per lb. quoted for limited quantities.

Resale light *soda ash* in single bags continued to be in limited supply on spot and dealers are holding the market at \$2.20@\$2.25 per 100 lb. At the works it was stated that small quantities of resale stock could be purchased at \$1.90@\$2 per 100 lb. Small lots of ash in barrels are moving at 2½¢. per lb. ex-store N. Y., while at the works limited quantities were quoted by second hands at 2½¢. per lb. Producers quote \$1.65 per 100 lb., basis 48 per cent, in single bags and 2c. per lb. in barrels, basis 48 per cent. Special quotations are being made for contracts, the price varying according to quantity. Prices on *carbonate of potash* are still very uncertain, with supplies rather heavy. It is possible to shade any quoted figures on either the 80-85 per cent or the 96-98 per cent material on the spot market. Quotations on the former grade are around 6c. per lb. and on the latter about 9c. per lb. The announcement of the passage of the emergency tariff measure has so far had no pronounced effect on *nitrite of soda*. Prices are around 7½¢@8c. per lb., although some factors are quoting as high as 10c. per lb. The prospect of the inclusion of a 2c. duty on nitrite in the permanent tariff will undoubtedly have a better effect than the present measure. Sales of *formaldehyde* are reported at 14½¢@14¾¢. per lb. in barrels on spot. The call is limited mostly to small lots, while in general a rather satisfactory amount of business is reported.

Considerable business of small lot nature is passing in *oxalic acid* at prices ranging from 16½¢@18c. per lb. Some sellers are not meeting these figures, but others state they are in a position to fill inquiries and say the demand is rapidly increasing.

The consuming demand for the various forms of *alcohol* still continues to be along light routine lines. Consumers are still unsettled in their ideas as to future needs and are buying only from hand to mouth. *Ethyl alcohol* is readily available in most directions and prices range from \$4.65@\$4.90 per gal. Supplies of *denatured alcohol* are easy and moving very slowly, while prices range from 31¢@42c. per gal., depending on formula. Consumers of *methanol* are not showing any interest in future needs and confine themselves to picking up small odd lots at cheap prices.

COAL-TAR PRODUCTS

The market in the coal-tar products industry presented a steady tendency during the week, but trading was confined to the usual small-lot requirements for immediate use. The speculative boom in *beta naphthol* has been the feature of the intermediate market. Trading otherwise has been spotty along more or less routine lines. Stocks of *beta naphthol* have passed into firmer hands, but it is still questionable whether they will be able to hold out until the consuming demand returns. Manufacturers now quote 40c. per lb. for *beta*, while second hands in most quarters are not far below with 38c. as their asking price. Sellers are generally quoting 85c. per lb. on *para-nitraniline* for spot goods. The tone of the market is firmer and contract busi-

ness ranges around 90@95c. per lb. *Aniline oil* is being neglected, but prices are still unchanged and range from 20@25c. per lb.

Crude prices have shown no special changes during the week, although the tone is firmer on some items, while on others irregularities are noticeable. Spot and nearby stocks of *benzene* remain uncertain. Loose lots have been pretty well cleared away by consumers and the inquiry has subsided to a great extent. Occasional lots are offered by producers at 27@33c. per gal. for the pure in tank cars and drums. The *naphthalene* market is very dormant with all quoted prices subject to shading on firm business. The resale market is quoted around 7½@8c. per lb., but it is understood that bids as low as 7c. would receive consideration. Manufacturers are still holding to their former quotations. Prices on *dimethylaniline* are still more or less irregular in the absence of any noted demand. Odd lots are to be had at 40c. per lb., with stocks in resale hands quite plentiful at 42c. per lb. Makers are quoting up to 60c. per lb. for quantities. Speculative interests have taken over practically all the *beta-naphthol* in weak hands on the spot market and are holding for 38c. per lb. Occasional bona fide inquiries came in during the flurry, but these were very few and far between. Producers are holding their stocks, which are known to be quite heavy, at 40c. per lb. and up, according to quantity. Prices on *aniline oil* are unchanged from the former weak basis. Odd lots are to be had from resellers down to 18c. per lb. Others are asking 19@20c. per lb., drums extra. Manufacturers' figures ranged from 20@25c. per lb., according to brand and quantity, but actual business would bring about better prices. Few inquiries have been noted. Prices on *sulphanilic acid* are held around 30@32c. per lb. in spite of the weakness in aniline. No stocks of any magnitude could be located, so that producers are able to maintain the price level, even though the consuming demand is far below normal.

MISCELLANEOUS MATERIALS

The movement of miscellaneous materials into consuming channels was of fair proportions, some factors reporting that the demand was quite active for such items as litharge and blanc fixe. In fact the entire list of basic materials closed the week with no decline in prices. Traders reported a good outlet for *blanc fixe* and the market at the close was steady at 4½c. per lb. asked for carlots, immediate shipment. Production has been restricted in some directions. There was a moderate inquiry for litharge, and leading interests reported the market as steady on the basis of 8½c. per lb., in casks, for immediate and nearby delivery in carlots. Smaller quantities were quoted at 8½@8¾c. per lb. With no important change in zinc ores and the demand for *zinc oxide* improving, prices ruled steady. Tire manufacturers are taking on supplies in a freer manner. Leading producers quote the market for XX grade unchanged on the basis of 9c. per lb., nearby delivery.

WAXES

A moderate inquiry was noted for *beeswax* and prices in most instances ruled steady. African crude closed at 16@17c. per lb., according to quantity and seller, with Brazilian crude at 22@24c. per lb. Pure white wax was held at 42@45c. per lb. Further irregularity was noted in prices on *carnauba wax*, offerings being quite liberal, with the demand rather quiet. No. 2 North Country was offered at 26@28c. per lb., with quotations easy. No. 3 North Country was quoted at 16@17c. per lb., with the No. 3 chalky at 17@18c. Offerings of *Japan wax* were noted on the basis of 18@18½c. per lb. spot delivery. The market was reported rather dull. The market for *paraffine wax* was quiet and prices were subject to shading where round lots were involved. Prospective buyers restricted operations to a minimum on the assumption that the weakness in crude oil and the quiet export conditions could hardly bring about much of a change in the general situation. Scale wax, 122-124 deg. melting point, closed at 2½c. per lb. for carlots. Refined, 123-125 deg. melting point, was offered at 4c. per lb., with the 130-132 deg. melting point at 5@5½c. per lb.

The Chicago Market

CHICAGO, June 4, 1921.

There was a slow but steady improvement during the past two weeks in the tone of the industrial chemical market. Nearly all of the larger factors report a better inquiry and a larger volume of orders. It is also noticeable that the buyers are demanding immediate delivery, showing that present stocks in consumers' hands are either exhausted or very low. Prices as a rule are quite firm, with a few advances. There is but little distressed material left in the local market and the manufacturers or their agents are finding a steady inquiry for their products.

GENERAL CHEMICALS

Caustic soda is quoted at a slightly lower figure, although the inquiry is good for small lots. The solid 76 per cent is offered at 4c. and the ground at 4½@4¾c. per lb. There is a fair movement of *soda ash*, and supplies are available at \$2.60 per 100 lb. for barrels. The inquiry for *aluminum sulphate* is light and it is possible to get supplies of the ground technical at 2½c. per lb. *Ammonium carbonate* is quiet and the price is unchanged at 11c. per lb. for single casks. *Sal ammoniac* is firmer, although it is still possible to obtain small lots of the white granulated at 8½c. *Ammonium sulphate* is very quiet and the technical grade is offered at 3¾c. in bags. *Barium chloride* is dull and remains unchanged at \$75@\$85 per ton, according to the quantity. A fair demand for *epsom salts* was noted in some quarters, the prevailing price being 3¼c. per lb. for the U.S.P. in barrels. *Formaldehyde* is lower, the new basis being 14½c. per lb. in barrels. The principal dealers report a fair volume of small orders and a few good inquiries.

Caustic potash remains in the same unsteady position, and ample supplies of the imported material are offered at 7½c. per lb., single casks. *Potassium permanganate* is unchanged and the inquiry is rather light. Material of foreign origin is offered at 33½@36c. per lb. *Bichromate of potash* is in a firmer position, and it is doubtful if supplies could be located at less than 15½c. per lb. *Sodium bichromate* has also shown a firmer tendency and material to arrive is offered at 9c. *Sodium bicarbonate* continues to move in a small way and dealers are maintaining prices at 2½@2¾c. per lb. *Nitrite of soda* is very firm and it is doubtful if supplies could be had at a figure lower than 8½c. There were several large inquiries for *zinc chloride* and the price was firm at 11½c. for spot material.

The general list of acids is quiet and unchanged as to price. *Glacial acetic* is very quiet, manufacturers quoting 11@11½c. per lb. The 28 per cent is moving in a fair way and is offered at 2¾@3c. per lb. for barrels. The warm weather affected the *citric acid* market and several good sales were noted. This material is offered by first hands at 47@48c. per lb., according to the size package. *Oxalic acid* is firm and quiet, foreign goods being held for 19c. in large casks and 20c. for the small barrels. *Sulphuric acid* is unchanged and makers continue to quote the 66 deg. at \$19@\$20 per ton in tank cars f.o.b. works.

VEGETABLE OILS, NAVAL STORES, COAL-TAR PRODUCTS

Quiet conditions still prevail in the vegetable oil trade and the only item worthy of attention is *linseed oil*. This material has fluctuated considerably during the past two weeks and the latest quotation noted was 85c. per gal. in barrels for the boiled and 83c. for the raw. Some factors report a fairly good volume of business.

The naval stores branch of the trade shows no signs of steadiness and prices are changing every day. *Turpentine* is now quoted at 71c. per gal. in drums and while the movement is not large, dealers are reporting an increase in orders. *Rosins* are steadier, although little or no business is reported. Prices as a rule are nominal and cover a wide range.

There was a slightly better inquiry noted for coal-tar products and dealers are hopeful of better times in the near future. Prices on *benzene* are unchanged and 31c. per gal. for the 100 per cent in drums was the best offer noted. *Toluene* is available at the same price, but the movement is slight.

The Iron and Steel Market

PITTSBURGH, June 3, 1921.

The case of the steel market seems to be that the particularly dull season usually beginning about July 1 has come a month ahead of time. In all quarters the volume of buying has decreased and in the past week the turnover has been unprecedentedly light. If the present volume of steel buying is the natural volume for an industrial depression, for a period of hard times, then the amount of business last winter was phenomenally large, although at the time it was considered very small.

The natural appraisal is that the present is a temporary condition, not characteristic of an industrial depression in general. Most business historians regard the period 1893 to 1898 inclusive as a period of industrial depression, yet three of those six years witnessed new records in pig-iron production.

Instead of being disappointed by the fresh degree of stagnation the iron and steel market now exhibits, producers are encouraged in their hope that August would witness a revival, and in most quarters the hope has turned into a definite prediction. Full activity is not expected for any time this year.

The rate of steel production has dropped to about 25 per cent of capacity, against rates of 30 or 31 per cent in April and about 80 per cent during the first nine months of last year.

One influence that has often helped in a revival in steel buying cannot be counted upon this time, and that is replenishment of buyers' stocks due to buyers acquiring the fear that prompt deliveries cannot be secured. Very prompt mill shipment is possible now, many carload orders being shipped within a day or two of their receipt, the chief cause of delay being that a mill is temporarily idle. With an increase in buying, therefore, shipments would not become less prompt.

STEEL PRICES

The ordinary transactions of the day in steel products are in carload lots, any order of larger size being more or less exceptional. On carload orders, as a rule, the steel prices developed about the middle of April are being maintained, 2.10c. for bars, 2.20c. for shapes and plates, and so on. In some commodities concessions are possible on larger orders, but in a strong and active market occasional concessions are not unknown.

Evidently all or nearly all buyers are convinced that steel prices will be lower within a short time, probably within two months. Steel producers naturally do not make definite predictions, but they show no disposition to take issue with this view. What the mills would prefer would be a reduction, perhaps a fairly heavy reduction, so timed as to stimulate a buying movement. Such a reduction could not be timed this month or in July, as buyers would take no interest. August would be different. The principle involved is that costs are particularly high now, both on account of poor distribution of overhead and on account of labor employment per ton of output being particularly heavy with so light an operation, and that an increase in buying, leading to a heavier operation, would reduce costs and thus pay for the price reduction involved.

PIG IRON AND COKE

Buying of pig iron remains of very small proportions, and with the present rate the stocks at merchant furnaces will last for several months. Carload lot sales of bessemer iron show a price of \$23 valley, against the nominal market of \$24 hitherto quoted. Basic, formerly quotable at \$22 valley, has sold at \$21.75 if not at \$21.50. Foundry is quotable at \$23 against \$23.50.

Connellsville coke for spot shipment remains at \$3.25@ \$3.50 for furnace, while foundry is down 25c., at \$4.75@ \$5.25. The Robeson Iron Co., which makes low-phosphorus pig iron, is understood to have bought a four months' supply of the low-phosphorus coke requisite, available from only about three works in the Connellsville region, at a shade under \$3.75.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.			\$0.40 -	\$0.45
Acetone.....lb.	\$0.12½ -	\$0.12½	.13 -	.13½
Acid, acetic, 28 per cent.....100 lbs.	2.50 -	2.75	3.00 -	3.25
Acetic, 56 per cent.....100 lbs.	4.00 -	4.25	4.50 -	5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	9.75 -	10.00	10.25 -	10.50
Boric, crystals.....lb.	.13½ -	.14	.14½ -	.15
Boric, powder.....lb.	.15 -	.15½	.16 -	.16½
Citric.....lb.			.44 -	.45
Hydrochloric.....100 lb.	1.50 -	1.65	1.75 -	2.00
Hydrofluoric, 52 per cent.....lb.	.12½ -	.12½	.12½ -	.13
Lactic, 44 per cent tech.....lb.	.10 -	.11	.11½ -	.12
Lactic, 22 per cent tech.....lb.	.04½ -	.05½	.06 -	.07
Molybdic, C. P.....lb.	4.00 -	4.50	4.50 -	5.00
Muriatic, 20 deg. (see hydrochloric).....				
Nitric, 40 deg.....lb.	.06½ -	.06½	.07 -	.07½
Nitric, 42 deg.....lb.	.07½ -	.07½	.07½ -	.08½
Oxalic, crystals.....lb.	.16½ -	.17	.17½ -	.17½
Phosphoric, Ortho, 50 per cent solution.....lb.	.17 -	.17½	.18 -	.19
Picric.....lb.	.20 -	.25	.27 -	.35
Pyrogallol, resublimed.....lb.			1.90 -	2.15
Sulphuric, 60 deg., tank cars.....ton			11.00 -	12.00
Sulphuric, 60 deg., drums.....ton			13.00 -	15.00
Sulphuric, 66 deg., tank cars.....ton	18.00 -	20.00		
Sulphuric, 66 deg., drums.....ton	22.00 -	22.50	23.00 -	23.50
Sulphuric, 66 deg., carboys.....ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	23.00 -	24.00		
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 -	26.00	26.50 -	27.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 -	32.00	33.00 -	34.00
Tannic, U. S. P.....lb.			.90 -	1.00
Tannic (tech.).....lb.	.50 -	.52	.54 -	.57
Tartaric, crystals.....lb.			.30 -	.32
Tungstic, per lb. of WO.....lb.			1.30 -	1.40
Alcohol, Ethyl.....gal.			4.65 -	4.90
Alcohol, Methyl (see methanol).....gal.				
Alcohol, denatured, 188 proof.....gal.			.31 -	.36
Alcohol, denatured, 190 proof.....gal.			.38 -	.42
Alum, ammonia lump.....lb.	.03½ -	.04	.04 -	.04½
Alum, potash lump.....lb.	.04 -	.04½	.04½ -	.05
Alum, chrome lump.....lb.	.13 -	.13½	.14 -	.14½
Aluminum sulphate, commercial.....lb.	.01½ -	.02	.02 -	.02½
Aluminum sulphate, iron free.....lb.	.03 -	.03½	.03½ -	.04
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07½ -	.07½	.08 -	.08½
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 -	.32	.33 -	.35
Ammonium carbonate, powder.....lb.	.08 -	.08½	.09 -	.10
Ammonium chloride, granular (white salamoniac).....lb.	.06½ -	.06½	.07 -	.07½
Ammonium chloride, granular (gray salamoniac).....lb.	.07½ -	.08	.08 -	.08½
Ammonium nitrate.....lb.	.08 -	.08½	.09 -	.10
Ammonium sulphate.....100 lb.	2.50 -	2.75	2.80 -	2.90
Amylacetate.....gal.			4.00 -	4.25
Amylacetate tech.....gal.			2.50 -	3.00
Arsenic oxide, (white arsenic) powdered lb.	.07½ -	.08	.08½ -	.08½
Arsenic, sulphide, powdered (red arsenic) lb.	.12 -	.12½	.13 -	.14
Barium chloride.....ton	60.00 -	62.00	63.00 -	65.00
Barium dioxide (peroxide).....lb.	.19 -	.20	.21 -	.22
Barium nitrate.....lb.	.08½ -	.09	.09½ -	.10
Barium sulphate (precip.) (blanc fixe).....lb.	.04½ -	.05	.05½ -	.06
Bleaching powder (see calc. hypochlorite).....				
Blue vitriol (see copper sulphate).....				
Borax (see sodium borate).....				
Brimstone (see sulphur, roll).....				
Bromine.....lb.	.41 -	.42	.43 -	.45
Calcium acetate.....100 lbs.	2.00 -	2.05		
Calcium carbide.....lb.	.05½ -	.05½	.06 -	.06½
Calcium chloride, fused, lump.....ton	24.00 -	25.00	26.00 -	27.00
Calcium chloride, granulated.....lb.	.01½ -	.02	.02½ -	.02½
Calcium hypochlorite (bleach'g powder) 100lb.	2.25 -	2.40	2.50 -	2.75
Calcium peroxide.....lb.			1.40 -	1.50
Calcium phosphate, tribasic.....lb.			.15 -	.16
Camphor.....lb.			.68 -	.70
Carbon bisulphide.....lb.	.06½ -	.07	.07½ -	.08
Carbon tetrachloride, drums.....lb.	.10½ -	.10½	.11 -	.12
Carbonyl chloride (phosgene).....lb.			.75 -	1.00
Caustic potash (see potassium hydroxide).....				
Caustic soda (see sodium hydroxide).....				
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08 -	.09	.09½ -	.10
Chloroform.....lb.			.42 -	.44
Cobalt oxide.....lb.			3.00 -	3.10
Copperas (see iron sulphate).....				
Copper carbonate, green precipitate.....lb.	.20 -	.21	.22 -	.23
Copper cyanide.....lb.			.50 -	.62
Copper sulphate, crystals.....lb.	.05½ -	.05½	.06 -	.06½
Cream of tartar (see potassium bitartrate).....				
Epsom salt (see magnesium sulphate).....				
Ethyl Acetate Com. 85%.....gal.			1.00 -	1.05
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.			.50 -	.52
Formaldehyde, 40 per cent.....lb.	.14½ -	.14½	.15 -	.15½
Fusel oil, ref.....gal.			3.00 -	3.25
Fusel oil, crude.....gal.			1.75 -	2.00
Glauber's salt (see sodium sulphate).....				
Glycerine, C. P. drums extra.....lb.			.16½ -	.17
Iodine, resublimed.....lb.			3.65 -	3.75
Iron oxide, red.....lb.			.10 -	.20
Iron sulphate (copperas).....100 lb.	1.00 -	1.25	1.50 -	1.75
Lead acetate.....lb.			.11½ -	.13
Lead arsenate, paste.....lb.	.09 -	.09½	.10 -	.11
Lead nitrate.....lb.			.15 -	.20
Litharge.....lb.	.38½ -	.08½	.08½ -	.09
Lithium carbonate.....lb.			1.30 -	1.40
Magnesium carbonate, technical.....lb.	.09 -	.09½	.10 -	.11
Magnesium sulphate, U. S. P.....100 lb.	2.75 -	3.00		
Magnesium sulphate, technical.....100 lb.			1.10 -	2.25
Methanol, 95%.....gal.			.75 -	.77
Methanol, 97%.....gal.			.78 -	.82
Nickel salt, double.....lb.			.14 -	.14½
Nickel salt, single.....lb.			.15 -	.15½
Phosgene (see carbonyl chloride).....				
Phosphorus, red.....lb.	.45 -	.46	.47 -	.50
Phosphorus, yellow.....lb.			.35 -	.37
Potassium bichromate.....lb.	.12 -	.12½	.12½ -	.13

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$.31 — .32	
Potassium bromide, granular..... lb.	.16 — .25	
Potassium carbonate, U. S. P..... lb.	.35 — .40	.45 — .50
Potassium carbonate, 80-85%..... lb.	.06 — .06½	.06½ — .07½
Potassium chlorate, crystals..... lb.	.08½ — .10	.10½ — .14
Potassium cyanide..... lb.	.26 — .28	
Potassium hydroxide (caustic potash)..... lb.	.05½ — .05¾	.06 — .08
Potassium muriate..... ton	50.00 — 53.00	
Potassium iodide..... lb.	2.75 — 3.00	
Potassium nitrate..... lb.	.09½ — .09¾	.10 — .12½
Potassium permanganate..... lb.	.35 — .36	.37 — .38
Potassium prussiate, red..... lb.	.35 — .37	.38 — .40
Potassium prussiate, yellow..... lb.	.26 — .26½	.27 — .28
Potassium sulphate (powdered)..... per unit	1.50 — 1.75	
Rochelle salts (see sodium potas. tartrate).....		
Sal ammoniac (see ammonium chloride).....		
Salt soda (see sodium carbonate).....		
Salt cake..... ton	32.00 — 33.00	
Silver cyanide..... oz.	1.35 — 1.38	
Silver nitrate..... oz.	.40 — .41	
Soda ash, light..... 100 lb.	2.20 — 2.25	2.30 — 2.70
Soda ash, dense..... 100 lb.	2.45 — 2.50	2.60 — 2.75
Sodium acetate..... lb.	.04½ — .04¾	.05 — .05½
Sodium bicarbonate..... 100 lb.	2.25 — 2.40	2.50 — 2.75
Sodium bichromate..... lb.	.08 — .08½	.08½ — .09
Sodium bisulphate (nitre cake)..... ton	5.00 — 5.25	5.50 — 6.50
Sodium bisulphite powdered, U.S.P..... lb.	.05½ — .05¾	.05¾ — .06½
Sodium borate (borax)..... lb.	.06½ — .06¾	.07 — .07½
Sodium carbonate (sal soda)..... 100 lb.	1.90 — 2.00	2.10 — 2.40
Sodium chlorate..... lb.	.07½ — .07¾	.08 — .08½
Sodium cyanide..... lb.	.22 — .24	.25 — .30
Sodium fluoride..... lb.	.12 — .12½	.13 — .14
Sodium hydroxide (caustic soda)..... 100 lb.	4.00 — 4.05	4.10 — 4.50
Sodium hyposulphite..... lb.	.03½ — .03¾	
Sodium nitrate..... 100 lb.	2.90 — 3.00	
Sodium nitrite..... lb.	.07½ — .08	.08½ — .10
Sodium peroxide, powdered..... lb.	.25 — .26	.27 — .30
Sodium phosphate, dibasic..... lb.	.04½ — .04¾	.05 — .05½
Sodium potassium tartrate (Rochelle salts) lb.	.26 — .27	
Sodium prussiate, yellow..... lb.	.12½ — .13	.13½ — .14
Sodium silicate, solution (40 deg.)..... lb.	1.25 — 1.35	1.40 — 1.50
Sodium silicate, solution (60 deg.)..... lb.	.02½ — .03	.03½ — .03¾
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	1.50 — 1.75	2.00 — 2.25
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.05 — .05½	.06 — .06½
Sodium sulphite, crystals..... lb.	.03 — .04	.04½ — .04¾
Strontium nitrate, powdered..... lb.	.15 — .15½	.16 — .17
Sulphur chl. ride, red..... lb.	.07 — .07½	.07½ — .08
Sulphur, crude..... ton	20.00 — 22.00	
Sulphur dioxide, liquid, cylinders extra..... lb.	.08 — .08½	.09 — .10
Sulphur (sublimed), flour..... 100 lb.	2.25 — 3.10	
Sulphur, roll (brimstone)..... 100 lb.	2.00 — 2.75	
Tin bichloride, 50 per cent..... lb.	.18 — .19	
Tin oxide..... lb.	.40 — .42	
Zinc carbonate, precipitate..... lb.	.16 — .18	.19 — .20
Zinc chloride, gran..... lb.	.11 — .11½	.11½ — .12
Zinc cyanide..... lb.	.45 — .49	.50 — .60
Zinc dust..... lb.	.12 — .13	.13½ — .14
Zinc oxide, XX..... lb.	.09 — .09½	.09½ — .10
Zinc sulphate..... lb.	.03½ — .03¾	.04 — .05

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 — \$1.15
Alpha-naphthol, refined..... lb.	1.25 — 1.30
Alpha-naphthylamine..... lb.	.35 — .40
Aniline oil, drums extra..... lb.	.19 — .25
Aniline salts..... lb.	.26 — .29
Anthracene, 80% in drums (100 lb.)..... lb.	.75 — 1.00
Benzaldehyde U.S.P..... lb.	1.50 —
Benzidine, base..... lb.	.85 — 1.00
Benzidine sulphate..... lb.	.75 — .85
Benzoic acid, U.S.P..... lb.	.60 — .65
Benzoate of soda, U.S.P..... lb.	.65 — .70
Benzene, pure, water-white, in drums (100 gal.) gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 — .28
Benzyl chloride, 95-97%, refined..... lb.	.28 — .30
Benzyl chloride, tech..... lb.	.20 — .25
Beta-naphthol benzoate..... lb.	3.50 — 4.00
Beta-naphthol, sublimed..... lb.	.70 — .75
Beta-naphthol, tech..... lb.	.38 — .40
Beta-naphthylamine, sublimed..... lb.	2.00 — 2.25
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)..... lb.	.25 — .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.70 — .80
Cresylic acid, 95-97%, dark, in drums..... gal.	.65 — .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 — .50
Dichlorobenzene..... lb.	.06 — .09
Diethylaniline..... lb.	1.20 — 1.25
Dimethylaniline..... lb.	.41 — .50
Dinitrobenzene..... lb.	.32 — .35
Dinitrochlorobenzene..... lb.	.20 — .30
Dinitronaphthalene..... lb.	.30 — .40
Dinitrophenol..... lb.	.35 — .40
Dinitrotoluene..... lb.	.27 — .30
Dip oil, 25%, car lots, in drums..... gal.	.40 — .45
Diphenylamine..... lb.	.60 — .65
H-acid..... lb.	1.25 — 1.35
Meta-phenylenediamine..... lb.	1.15 — 1.20
Monochlorobenzene..... lb.	.12 — .14
Monoethylaniline..... lb.	1.75 — 1.85
Naphthalene crushed, in bbls..... lb.	.07 — .08½
Naphthalene, flake..... lb.	.07 — .08½
Naphthalene, balls..... lb.	.08 — .09½
Naphthionic acid, crude..... lb.	.70 — .75
Nitrobenzene..... lb.	.12 — .15
Nitro-naphthalene..... lb.	.30 — .35
Nitro-toluene..... lb.	.16 — .18
Ortho-amidophenol..... lb.	3.10 — 3.20
Ortho-dichlor-benzene..... lb.	.15 — .20
Ortho-nitro-phenol..... lb.	.80 — .85
Ortho-nitro-toluene..... lb.	.15 — .20
Ortho-toluidine..... lb.	.20 — .25
Para-amidophenol, base..... lb.	1.50 — 1.60
Para-amidophenol, HCl..... lb.	1.75 — 1.80

Para-dichlorobenzene..... lb.	.15 — .20
Paranitroaniline..... lb.	.85 — 1.00
Para-nitrotoluene..... lb.	.90 — 1.00
Para-phenylenediamine..... lb.	1.95 — 2.00
Para-toluidine..... lb.	1.25 — 1.40
Phthalic anhydride..... lb.	.50 — .60
Phenol, U. S. P., drums..... lb.	.09 — .12
Pyridine..... gal.	2.00 — 3.50
Resorcinol, technical..... lb.	1.75 — 1.85
Resorcinol, pure..... lb.	2.25 — 2.30
Salicylic acid, tech., in bbls..... lb.	.22 — .24
Salicylic acid, U. S. P..... lb.	.26 — .28
Salol..... lb.	.80 — .85
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 — .16
Sulphanilic acid, crude..... lb.	.30 — .35
Tolidine..... lb.	1.25 — 1.35
Toluidine, mixed..... lb.	.40 — .45
Toluene, in tank cars..... gal.	.25 — .28
Toluene, in drums..... gal.	.28 — .31
Xylidines, drums, 100 gal..... lb.	.40 — .45
Xylene, pure, in drums..... gal.	.40 — .45
Xylene, pure, in tank cars..... gal.	.45 — .50
Xylene, commercial, in drums, 100 gal..... gal.	.33 — .35
Xylene, commercial, in tank cars..... gal.	.30 —

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.23 — \$0.25
Beeswax, refined, light..... lb.	.25 — .27
Beeswax, white pure..... lb.	.42 — .45
Carnauba, Florida..... lb.	.61 — .62
Carnauba, No. 2, North Country..... lb.	.27 — .28
Carnauba, No. 3, North Country..... lb.	.16 — .17
Japan..... lb.	.18 — .18½
Montan, crude..... lb.	.07 — .07½
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03½ — .03¾
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.02½ — .03
Paraffine waxes, refined, 118-120 m.p..... lb.	.03½ — .03¾
Paraffine waxes, refined, 125 m.p..... lb.	.04 — .04½
Paraffine waxes, refined, 128-130 m.p..... lb.	.04 — .05
Paraffine waxes, refined, 133-135 m.p..... lb.	.05 — .05½
Paraffine waxes, refined, 135-137 m.p..... lb.	.05½ — .06
Stearic acid, single pressed..... lb.	.09½ —
Stearic acid, double pressed..... lb.	.10 —
Stearic acid, triple pressed..... lb.	.11 — .11½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.00 —
Rosin E-I..... 280 lb.	5.80 — 6.00
Rosin K-N..... 280 lb.	6.50 — 6.70
Rosin W. G.-W. W..... 280 lb.	6.80 —
Wood rosin, bbl..... 280 lb.	6.25 —
Spirits of turpentine..... gal.	.61 —
Wood turpentine, steam dist..... gal.	.59 —
Wood turpentine, dest. dist..... gal.	.57 —
Pine tar pitch, bbl..... 200 lb.	— 6.75
Tar, kiln burned, bbl. (500 lb.)..... bbl.	— 12.00
Retort tar, bbl..... 500 lb.	— 12.00
Rosin oil, first run..... gal.	.36 —
Rosin oil, second run..... gal.	.38 —
Rosin oil, third run..... gal.	.43 —
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.80
Pine oil, pure, dest. dist..... gal.	1.50
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75
Pine tar, ref., thin, sp.gr. 1.080-1.060..... gal.	.35
Turpentine, crude, sp. gr. 0.900-0.970..... gal.	1.20
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.35
Pinewood creosote, ref..... gal.	.52

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41
70-72 deg., steel bbls. (85 lb.)..... gal.	.39
68-70 deg., steel bbls. (85 lb.)..... gal.	.38
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30

Crude Rubber

Para-Upriver fine..... lb.	\$0.16 — .17
Upriver coarse..... lb.	.09 — .09½
Upriver caocho ball..... lb.	1.1½ — 1.2
Plantation—First latex crepe..... lb.	.17 —
Ribbed smoked sheets..... lb.	.15 — .15½
Brown crepe, thin, clean..... lb.	.15 —
Amber crepe No. 1..... lb.	.17 —

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.08½ — \$0.09½
Castor oil, AA, in bbls..... lb.	.10 — .10½
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.12 — .12½
Cocoonut oil, Ceylon grade, in bbls..... lb.	.10½ — .10¾
Cocoonut oil, Cochon grade, in bbls..... lb.	.11½ — .11¾
Corn oil, crude, in bbls..... lb.	.07½ — .08
Cottonseed oil, crude (f. o. b. mill)..... lb.	.05 — .05½
Cottonseed oil, summer yellow..... lb.	.07½ — .07¾
Cottonseed oil, winter yellow..... lb.	.08 —
Linseed oil, raw, car lots (domestic)..... gal.	.73 — .73
Linseed oil, raw, tank cars (domestic)..... gal.	.67 —
Linseed oil, in 5-bbl lots (domestic)..... gal.	.76 — .76

Olive oil, Denatured.....	gal.	\$1.35	—	\$1.50
Palm, Lagos.....	lb.	.07 ¹ / ₈	—	.07 ¹ / ₄
Palm, Niger.....	lb.	.05 ³ / ₄	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.06	—	.06 ¹ / ₂
Peanut oil, refined, in bbls.....	lb.	.10 ¹ / ₂	—	.10 ³ / ₄
Rapeseed oil, refined in bbls.....	gal.	.86	—	.88
Rapeseed oil, blown, in bbls.....	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07 ³ / ₄	—	.....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.05 ³ / ₄	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.40	—	\$0.41
Yellow bleached menhaden.....	gal.	.42	—	.....
White bleached menhaden.....	gal.	.44	—	.....
Blown menhaden.....	gal.	.80	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	1.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	.....
Blanc fixe, dry.....	lb.	.05	—	.05 ¹ / ₂
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.16
Chalk, domestic, extra light.....	lb.	.05	—	.05 ¹ / ₂
Chalk, domestic, light.....	lb.	.04 ¹ / ₂	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04 ¹ / ₂	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07 ¹ / ₂	—	.08
Graphite, Ceylon chip.....	lb.	.06	—	.06 ¹ / ₂
Graphite, high grade amorphous crude.....	lb.	.02 ¹ / ₄	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05 ¹ / ₂
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1 ¹ / ₂ @2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.75	—	.....
Shellac, orange superfine.....	lb.	.79	—	.82
Shellac, A. C. garnet.....	lb.	.55	—	.58
Shellac, T. N.....	lb.	.70	—	.72
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	35.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$35.00—50.00
Carborundum refractory brick, 9-in. { less than carlot	1,000	1250.00
Carborundum refractory brick, 9-in. { carload lots	1,000	1100.00
Chrome brick, f.o.b. Eastern shipping points.....	net ton	75—90
Chrome cement, 40-45% Cr ₂ O ₃	net ton	45—50
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	 55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	40—50
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	40—50
Magnesite brick, 9-in. straight.....	net ton	90
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	100
Magnesite brick, soaps and splits.....	net ton	110
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	45—55
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	45—55
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,090	45—55

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00 — \$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.15 — .16
Ferrochrome per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.16 — .17
Ferromanganese, 76-80% Mn, domestic.....	gross ton	80.00 — 82.00
Ferromanganese, 76-80% Mn, English.....	gross ton	80.00 — 82.00
Spiegeleisen, 18-22% Mn.....	gross ton	30.00 — 32.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50 —
Ferrosilicon, 10-15%.....	gross ton	50.00 — 55.00
Ferrosilicon, 50%.....	gross ton	80.00 — 85.00
Ferrosilicon, 75%.....	gross ton	145.00 — 150.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45 — .50
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	6.00 —
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00 — 6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$8.00 — \$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.45 — .50
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.45 — .50
Coke, foundry, f.o.b. ovens.....	net ton	4.50 — 5.00
Coke, furnace, f.o.b. ovens.....	net ton	3.25 — 3.75
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00 — 16.00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	15.00 —
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00 — 22.50
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 ¹ / ₂ — .01 ¹ / ₄
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.25 —
Manganese ore, chemical (MnO ₂).....	gross ton	60.00 — 65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55 — .60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00 —
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.14 — .14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.14 — .14
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12 — .13
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15 —
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75 — 3.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00 — 3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50 — 2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25 — 2.50
Vanadium pentoxide, 99%.....	lb.	12.00 — 14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50 —
Zircon, washed, iron free.....	lb.	.03 —

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	13.25-13.50
Aluminum, 98 to 99 per cent.....	28.00@28.5
Antimony, wholesale lots, Chinese and Japanese.....	5 ¹ / ₂
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	35.00
Monel metal ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, Straits.....	31.25
Lead, New York, spot.....	4.75-4.85
Lead, E. St. Louis, spot.....	4.60-4.75
Zinc, spot, New York.....	5.20
Zinc, spot, E. St. Louis.....	4.70

OTHER METALS

Silver (commercial).....	oz.	\$0.58
Cadmium.....	lb.	1.00-1.25
Bismuth (500 lb. lots).....	lb.	1.50@1.55
Cobalt.....	lb.	4.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	75.00
Iridium.....	oz.	250.00@300.00
Palladium.....	oz.	70.00
Mercury.....	.75 lb.	46.00-47.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	20.50-20.75
Copper bottoms.....	28.00-28.25
Copper rods.....	19.25-20.00
High brass wire.....	18.25
High brass rods.....	15.25
Low brass wire.....	20.25
Low brass rods.....	20.25
Brazed brass tubing.....	29.00
Brazed bronze tubing.....	34.25
Seamless copper tubing.....	22.00
Seamless high brass tubing.....	21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	8.50@9.00	9.00	9.50
Copper, heavy and wire.....	8.00@8.25	8.50	8.50
Copper, light and bottoms.....	7.00@7.50	7.50	7.00
Lead, heavy.....	3.25@3.50	3.25	3.25
Lead, tea.....	2.15@2.30	2.00	2.00
Brass, heavy.....	4.25@4.50	4.50	5.00
Brass, light.....	3.00@3.25	3.00	3.50
No. 1 yellow brass turnings.....	4.00@4.25	4.00	4.50
Zinc.....	2.00@2.50	2.00	2.50

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.50	\$3.23	\$3.23
8 ft steel bars.....	2.50	3.00	3.13
Soft steel bar shapes.....	2.50	3.13	3.13
Soft steel bands.....	2.85	3.83	3.78
Plates, 1/2 to 1 in. thick.....	2.50	3.30	3.23

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

DOTHAN—The Home Guano Co. is planning for the rebuilding of its fertilizer manufacturing plant, recently destroyed by fire. A complete new machinery installation will be made, including considerable transmission equipment as pulleys, hangers, gearing, etc. M. L. Hanahan is treasurer and general manager.

Alberta

EDMONTON—The Imperial Oil Co. is planning for the construction of a new oil refinery near Fort Norman, Alta.; operations will be concentrated in a large measure to gasoline production at the new works.

Arkansas

MENA—The Cora C. Mining Co., is planning for the installation of considerable new machinery at its manganese properties in the vicinity of Hatten, Ark. The company has a tract of about 600 acres of land in this section. J. D. Budd is president and general manager.

LITTLE ROCK—The Rose City Petroleum Co., 407 Donaghey Bldg., has awarded a contract to Edwards & Dore, Little Rock, for the erection of its proposed new oil refinery, estimated to cost about \$55,000, and of which amount approximately \$25,000 will be expended for machinery. The plant will have an initial output of about 1,000 bbl. of oil per day. The company was recently incorporated with a capital of \$500,000. E. B. Fowler is secretary and treasurer.

EL DORADO—The Transcontinental Oil Co., Tulsa, Okla., is considering the construction of a new oil refinery in the vicinity of El Dorado.

California

VISALIA—The Central Counties Gas Co. has plans under way for extensions and improvements in its local gas plant, to cost about \$150,000, with machinery. The work will include new generating equipment, gas holder apparatus, etc.

Colorado

DENVER—The Radium Co. of Colorado and the Carnotite Products Co. have been merged under the name of the first noted organization. Headquarters will be maintained at Denver, and it is said that plant facilities will be increased.

Delaware

WILMINGTON—The United States Flashless Powder Co. is reported to be planning for the rebuilding of the several units at its plant, recently destroyed by fire. An official estimate of the loss has not been made.

Florida

TAMPA—The Southern Glass Mfg. Co. has plans under way for the construction of a new glass-manufacturing plant in the vicinity of Bartow, Fla., to be 1-story, 60 x 148 ft., with wing extension 36 x 100 ft.

Georgia

ATLANTA—The J. M. Tull Rubber & Supply Co., 84 North Pryor St., has awarded a contract to A. K. Adams & Co., Grant Bldg., for the construction of a new 2-story and basement plant. J. M. Tull is president and general manager.

SANDERSVILLE—The Sandersville Cotton Oil Mill is planning for the rebuilding of the portion of its plant destroyed by fire, May 20, with loss estimated at about \$100,000, including machinery.

Illinois

CHICAGO—The Advanced Forging & Tool Co., 35 South Dearborn St., has had plans prepared for the construction of a new 1- and 2-story plant at Central Park, near Addison St.

Indiana

COLUMBUS—The Indiana Oil Refining Co. has taken bids for the construction of its proposed new oil refinery on a local site, estimated to cost about \$500,000, with machinery. Preliminary work has recently been placed under way, including foundations for stills, condensers and other equipment. It is proposed to have the plant ready for operation in November.

Kansas

KANSAS CITY—The Kansas City Foundry Co., manufacturer of small metal castings, will defer the erection of the proposed 1-story addition to its foundry, 65 x 130 ft., at Water and Walker Sts. It is planned to build the structure early in the fall. E. C. Austin is secretary.

Maryland

BALTIMORE—The American Steel Rolling Co., 1203 North Charles St., is considering the construction of a new plant at Eighth and Monument Sts., for the manufacture of iron and steel rods and other rolled steel specialties. The plant will be electrically operated in the different departments, and will include a small open-hearth furnace. It is proposed to develop an initial annual capacity of about 15,000 tons of material, which will be increased at a later date. R. S. Baldwin is general manager.

BALTIMORE—The American Sugar Refining Co. has filed plans for the construction of a new 1-story brick and steel building, at Woodall and Clement Sts., 107 x 405 ft., to be used in connection with its new plant at this location.

Massachusetts

WORCESTER—The American Steel & Wire Co. has completed foundation work for its proposed new plant at its South Works, and will handle the erection of the superstructure by day labor. The plant will be 3-story, 144 x 120 ft., brick, steel and reinforced concrete, and is estimated to cost about \$150,000, with equipment.

FRAMINGHAM—The Dennison Mfg. Co., manufacturer of paper products, has construction under way on its proposed new 4-story and basement addition, 70 x 100 ft. The Aberthaw Construction Co., 27 School St., Boston, is the building contractor.

Maine

RUMFORD—The Rumford Pulp Products Co. has acquired a local mill, formerly used for magnesia production, and will remodel the structure for a new works for the manufacture of pulp products in the form of leatherboard specialties. Machinery for production will be installed at an early date.

Michigan

BAY CITY—The Wildman Rubber Co. has awarded a contract to the Bay City Stone Co. for the construction of the first unit of its new local plant, to be used for the manufacture of automobile tires and tubes, and other rubber products. The works will be 3-story and basement, 161 x 365 ft. It will be equipped for a production of about 2,500 automobile tires and 5,000 tubes per day. With the erection of additional units it is proposed to increase this capacity to an output of 50,000 tires and 100,000 tubes daily. W. W. Wildman is president.

GRAND RAPIDS—The E. S. Kiefer Tanning Co., Front St., is planning for the construction of a three-story addition to its tannery, 30 x 40 ft., estimated to cost close to \$20,000.

NILES—The French Paper Co. is planning for a number of extensions and improvements at its plant. A new power house will be erected.

ROCKWOOD—The Ford Motor Co. has commenced the installation of machinery at its new local plant, to be used for the manufacture of glass products for automobile service.

Montana

GREAT FALLS—The Anaconda Copper Mining Co., Anaconda, Mont., is considering the establishment of a new plant in the vicinity of Great Falls, for the manufacture of insulated copper wire products.

Nebraska

BURNHAM—The Burnham Brick Co. is considering the rebuilding of its local plant, partially destroyed by fire, May 16, with loss estimated at about \$100,000, including machinery.

New Jersey

MILLVILLE—The Millville Pulp and Pine Products Corp., 218-20 Walnut St., Philadelphia, Pa., E. H. Hulst, president, is completing plans for the erection of its proposed new 1- and 2-story plant at Millville and Cumberland Roads, Millville. Bids for erection will be asked at an early date.

New York

NEW YORK—The Atlantic Gulf Oil Corp., 11 B'way., is planning for the operation of its new oil refinery at Southampton, England, now nearing completion, during the present month. The plant will be operated in the name of its subsidiary organization, the Atlantic Gulf Petroleum Corp. It will have an initial daily capacity of 3,500 bbl., and this output will be increased later to about 5,000 bbl. per day maximum. The new plant will represent an investment in excess of \$3,000,000. Franklin D. Mooney is president of the parent corporation.

Oklahoma

PONCA CITY—W. K. Moore and D. J. Donahoe, Ponca City, are organizing a company to establish a local plant for the manufacture of bricks and other burned clay products.

ONETA—The Oneta Refining Co., recently organized with a capital of \$250,000, is considering plans for the construction of a new oil-refining plant in the vicinity of Pine Bluff, Ark. Henry Miers, Oneta, is one of the heads of the company.

Oregon

PORTLAND—The Portland Vegetable Oil Mills, Inc., has filed plans for the construction of the initial unit of its proposed new plant at North Portland, to cost about \$150,000, including machinery.

Pennsylvania

PHILADELPHIA—The General Smelting Co., Stock Exchange Bldg., is taking bids for the erection of a new chemical plant at Bath and Westmoreland Sts., Emile G. Perrot, 329 South Broad St., is architect.

Tennessee

CHATTANOOGA—The Signal Mountain Cement Co. has taken bids for the construction of a new cement manufacturing plant, estimated to cost about \$200,000, with machinery.

Texas

FORT WORTH—The Edmonds Oil & Refining Co. has plans under way for additions in its oil refinery at Riverside, near Fort Worth, to increase the daily capacity from 2,000 to 3,000 bbl.

SAN ANTONIO—The Gulf Portland Cement Assn., 812 Gibbs Bldg., recently organized with a capital of \$3,000,000, is perfecting plans for the construction of its proposed new plant in the vicinity of Castroville, Tex. The new plant is estimated to cost in excess of \$500,000. W. S. Campbell is president and general manager.

THREE RIVERS—The Three Rivers Glass Co., recently organized, will soon commence the construction of a new plant for the manufacture of glass products. It is proposed to have the plant ready for operation early in the fall.

TEXAS CITY—The Bennett Petroleum Co., Houston, Tex., is planning for the construction of a new petroleum plant in the vicinity of Texas City, to cost about \$100,000 with equipment. The company has a 12-acre site in this district.

BRECKENRIDGE—The Absorption Gas Products Co. has plans under way for the establishment of a chain of plants for gasoline absorption operations. The initial works will be located in the vicinity of Breckenridge, and will have a capacity of 7,000,000 cu.ft. C. C. McCandless is engineer.

West Virginia

WILLIAMSON—The Williamson Red Brick Co. has commenced the erection of

additions to its plant for increased production. New equipment will be installed.

PARKERSBURG—The Davis-Wolfe Oil Co., recently incorporated with a capital of \$100,000, has taken bids for the construction of a new local works, for the production of petroleum and petroleum byproducts. Robert E. Davis, Box 611, heads the company.

New Companies

THE SUPERIOR BRASS WORKS, INC., Detroit, Mich., has been incorporated with a capital of \$40,000 to manufacture brass and bronze castings and other kindred metal products. The incorporators are Frank M. Klump, Bedford, O.; Carl W. Thurmes and John M. Burke, 262 Chalmers Ave., Detroit.

H. C. BEBBINGTON & Co., INC., Trenton, N. J., has been incorporated with a capital of \$100,000 to manufacture steel products. The incorporators are Herbert W. Backes, C. T. and Harry C. Bebbington, 221 East Hanover St., Trenton.

THE CARBONIZED FIBER PRODUCTS CORP., New York City, has been incorporated with a capital of \$110,000 to manufacture fiber specialties. The incorporators are J. A. Boegman, W. R. Respass and L. F. Stumpf, 233 B'way.

F. P. LARMOYEAUX & SON, INC., Clarksburg, W. Va., has been incorporated with a capital of \$10,000 to manufacture glass products. The incorporators are Felix Larmoyeaux, Isa W. Monroe and G. H. Duthrie, Clarksburg.

THE J. A. C. PRODUCTION CO., 48½ North Vermilion St., Danville, Ill., has been incorporated with a capital of \$50,000 to manufacture refined oil products. The incorporators are C. W. Ames, G. H. Schultz and D. W. Osbern.

THE INTERNATIONAL MICA CO., Chicago, Ill., has been incorporated under Delaware laws with a capital of \$250,000 to manufacture mica products. The company is represented by William J. Dole, 140 North Dearborn St., Chicago.

THP PORTLAND MFG. CORP., New York City, has been incorporated with a capital of \$55,000 to manufacture paints, varnishes, etc. The incorporators are A. Oberbeck, C. Flathman and P. Gross, 302 B'way.

THE CHARLESTON EXTRACT CO., Charleston, W. Va., has been incorporated with a capital of \$200,000 to manufacture chemical products. The incorporators are E. B. Brown and O. P. Fitzgerald, Charleston.

THE ALBALOID NOVELTY CO., Newark, N. J., has been incorporated with a capital of \$100,000 to manufacture composition products. The incorporators are Henry Stuhler, Max M. Albach and Joseph Sobel, 55 New Jersey Railroad Ave.

THE WEISS OIL CORP., 220 South State St., Chicago, Ill., has been incorporated with a capital of 2,500 shares of stock, no par value, to manufacture oil products. The incorporators are Harry L. Meyers, H. Latzar and Edwin P. Swatek.

THE AMERICAN SOAP POWDER WORKS, Brooklyn, N. Y., has been incorporated with a capital of \$20,000, to manufacture soaps and kindred products. The incorporators are G. Silkworth, J. Leon and H. W. Van Alen, 215 Montague St., Brooklyn.

THE GULFTEX REFINING CO., Dallas, Tex., has been incorporated with a capital of \$100,000, to manufacture refined oil products. The incorporators are William White and Russell Reynolds, Dallas.

THE CLIMAX RUBBER CO. OF N. J., Newark, has been incorporated with a capital of \$1,000,000 to manufacture rubber goods. The incorporators are William J. Gilberts, Warner S. Rexford and J. Phillips Tarr, 120 Firemen's Bldg., Newark.

THE PERSSON LABORATORIES, Mount Clemens, Mich., has been incorporated with a capital of \$50,000, to manufacture chemicals and chemical byproducts. The incorporators are John H. Collins, Detroit; William T. Kelly and Gustaf A. Persson, Mount Clemens.

THE CHARLES MCADAM CO., Chicago, Ill., has been incorporated under Delaware laws with a capital of \$500,000 to manufacture paints, varnishes, etc. The company is represented by A. E. Manheimer, 10 South LaSalle St., Chicago.

THE C. E. ROGERS BRASS FOUNDRY CO., 64 Plympton St., Boston, Mass., has been organized by the estate of C. E. Rogers, to manufacture brass and bronze castings.

THE ELIZABETH DYE & CHEMICAL CORP., Elizabeth, N. J., has been incorporated with a capital of \$250,000, to manufacture chemicals, dyes and affiliated products. The

incorporators are James W. Roper, W. S. Knowlton and Dr. Paul Straus, Elizabeth.

THE MUTUAL PETROLEUM CORP., Adrian, Mich., has been incorporated with a capital of \$25,000, to manufacture refined mineral oil products. The incorporators are Charles A. Shierson, William E. Shierson and Rolland C. Rothfuss, Adrian.

THE GENERAL CHINAWARE CORP., New York City, has been incorporated with a capital of \$850,000, to manufacture china-ware products. The incorporators are Charles G. Atwood, William Hardman and Lewis H. Rogers, New York. The company is represented by Leonard E. Wales, Equitable Bldg., Wilmington, Del.

THE RESERVE PETROLEUM CO., Tulsa, Okla., has been incorporated with a capital of \$100,000, to manufacture petroleum products. The incorporators are J. R. Hill, Tulsa; and J. L. Kimmerl, Muskogee, Okla.

THE CONSOLIDATED PAPER CO., Monroe, Mich., has filed notice of organization to manufacture paper products. The company is headed by John C. Bulis, I. A. Newcomer and Albert H. Lockwood, Monroe.

THE PERRY & DERRICK CO., Dayton, Ky., has been incorporated with a capital of \$30,000, to manufacture paints, varnishes, etc. The incorporators are A. J. Grosser and F. J. Derrick, Dayton.

THE MAR-BELL PRODUCTS CO., Asbury Park, N. J., has been incorporated with a capital of \$100,000, to manufacture lime, cement and affiliated products. The incorporators are Ira A. Clayton, Joseph P. Watson and Joseph G. McDonough, 500 Main St., Asbury Park.

THE EL DORADO REFINING CO., El Dorado, Ark., has been incorporated with a capital of \$60,000, to manufacture refined oil products. The incorporators are W. J. Brown and William Wood, El Dorado.

THE AMERICAN LYSOFORM CO., New York City, has been incorporated with a capital of \$10,000, to manufacture chemicals, drugs and kindred products. The incorporators are C. H. Stange, H. W. Richter and J. M. Clark. The company is represented by Katz & Summerich, 120 B'way.

THE GLOBE MFG. CO., Worcester, Mass., has been incorporated with a capital of \$20,000, to manufacture celluloid and composition products. The incorporators are Henry and Simon Silverman and Samuel Wolfson, 54 Jackson St.

THE MACDOUGAL PROCESS CO., Niagara Falls, N. Y., has been incorporated with a capital of \$200,000, to manufacture electrochemical products. The incorporators are J. G. Rowe, R. H. Bennett and A. J. MacDougall. The company is represented by Kellogg, Babcock & Sullivan, Buffalo.

THE H. J. FLEMING PAPER CO., Philadelphia, Pa., has been organized by Harry J. Fleming, Frank C. Sayre and Harry R. Axelroth, 416 Walnut St., to manufacture paper products. H. J. Fleming, 1630 Pine St., is treasurer.

THE DUZ CO., New York City, has been incorporated with a capital of \$175,000 to manufacture washing and cleansing powders, and kindred chemical specialties. The incorporators are C. A. True, A. G. Thorne and M. E. Graef, 68 Winfield Ave., Jersey City, N. J.

THE UNION BRONZE CO., Reading, Pa., has been incorporated with a capital of \$50,000, to manufacture brass, bronze and kindred metal products. Robert P. Fritch, Reading, is treasurer.

THE EL DORADO OIL CORP., Paragould, Ark., has been incorporated with a capital of \$100,000, to manufacture oil products. The incorporators are H. S. Trice and W. G. Graves, Paragould.

THE CALIFORNIA GYPSUM CO., Los Angeles Cal., has been incorporated with a capital of \$1,500,000, to manufacture gypsum products. The incorporators are E. P. Wiley, Edwin K. Alpaugh, San Gabriel, Cal.; and C. H. S. Russell, Culver City, Cal.

THE DOMINO SHORTENING CO., 1615 First National Bank Bldg., Chicago, Ill., has been organized to manufacture oils, compounds and affiliated products. The company is headed by H. A. Timmins, E. S. Waterbury and M. E. Smith.

THE M. & M. OIL CO., Buffalo, N. Y., has been incorporated with a capital of \$30,000, to manufacture refined oil products. The incorporators are G. P. Manning and C. P. MacArthur, Jr. The company is represented by Penney, Killen & Nye, Ellicott Sq., Buffalo.

THE ROBINSON LIME CO., Winchester, Tenn., has been incorporated with a capital of \$250,000, to manufacture lime and kindred products. The incorporators are

Arthur J. Robinson, C. G. Ferris and W. S. Claiborne.

THE DERRICK OIL CORP., Jamestown, N. Y., has been incorporated with a capital of \$100,000, to manufacture petroleum products. The incorporators are W. J. Olson, H. S. Holmes and C. E. Nelson. The company is represented by R. H. Jackson, Jamaica, L. I.

Capital Increases, etc.

THE IMPERIAL PAINT CO., 80 Tenth St., Long Island City, N. Y., has filed notice of increase in capital from \$50,000 to \$100,000.

THE BOHEMIA BRICK & TILE CO., Houston, Tex., has filed notice of increase in capital from \$125,000 to \$250,000. A. T. Eddington is head.

THE PERFECTION TIRE & RUBBER CO., Marquette, Bldg., Chicago, Ill., operating a plant at Fort Madison, Ia., has filed notice of increase in capital from \$15,000,000 to \$20,000,000.

THE CARTERET OIL CO., Jersey City, N. J., has filed notice of increase in capital from \$1,500,000 to \$1,750,000.

THE BRADFORD-BROWN PAINT CO., Houston, Tex., has filed notice of increase in capital to \$40,000.

THE WORCESTER ABRASIVE CO., a Delaware corporation, has filed notice of organization to operate in New York, with a capital of \$300,000. H. S. Holmes, 1664 B'way., represents the company.

THE BROOKLYN FOUNDRY CO., INC., Orchard St., Brooklyn, N. Y., has filed notice of increase in capital from \$25,000 to \$100,000.

THE AMERICAN MALLEABLES CO., Lancaster, N. Y., has increased its capital from \$1,000,000 to \$2,000,000.

Coming Meetings and Events

AMERICAN CHEMICAL SOCIETY will hold a meeting at Rumford Hall, Chemists' Club, New York City, on June 10.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN LEATHER CHEMISTS ASSOCIATION will hold its eighteenth annual meeting at the Hotel Ambassador, Atlantic City, June 9, 10 and 11.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20. Technical sessions are scheduled as follows: Tuesday, on Preservative Coatings and Textiles; Wednesday, on Cement, Concrete and Road Materials; Thursday, on Ceramics, Lime and Gypsum, on Petroleum Products and on Testing Methods; Friday, on Metals.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-eighth annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., the week beginning June 20.

NATIONAL LIME ASSOCIATION will hold its annual convention in New York City June 15 to 17.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

CHEMICAL & METALLURGICAL ENGINEERING

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ELECTROCHEMICAL & METALLURGICAL INDUSTRY and IRON & STEEL MAGAZINE

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Volume 24

New York, June 15, 1921

Number 24

A New Explanation Of Hardening

IN VIEW of the importance of Messrs. JEFFRIES and ARCHER's contribution to the theory of hardening metals, it is not necessary to explain why so large a portion of this issue is devoted to it. Metallurgists interested in ferrous or in non-ferrous metals will find it explains a great many apparently unrelated facts concerning hardness; colloid chemists will be interested in the application of their science to metallurgy; and physicists will be pleased to know that some of the first results of X-ray analysis have been put to good use in this inquiry into the nature of hardening.

A generalized conception of hardness is presented, and it is then shown how various substances and practices increase this hardness in a number of different alloys by merely interfering with a perfectly normal property of ductile crystals; the ability to deform by development of transgranular slips.

Little of the material used by JEFFRIES and ARCHER is new—that is, presented for the first time. Nearly all the facts are old and undisputed; many of the explanations have been advanced before, but failed of acceptance because of a lack of supporting evidence. For instance, ten years ago, GRENET presented a paper before the British Iron and Steel Institute, in which he said that the hardness of chilled irons, steels, brasses and bronzes was due not so much to the prevention of the transformation from the "hot stable" to the "cold stable" state, which would occur on slow cooling, as to its partial completion. Consequently hardening by quenching is due "solely to the fineness of the structure." These ideas were given little more than a respectful hearing, but many of GRENET's critics have since come into camp with ROSENHAIN, who has exploited the properties of amorphous iron to account for the hardness of martensite. GRENET was on the right track, but he attempted no adequate explanation of why extremely fine grain causes hard metal.

BEILBY's amorphous theory has since then become generally accepted, so that few now dispute the fact that the aggregate of minute crystals just born from austenite would possess a relatively great amount of hard amorphous metal. By X-ray analysis JEFFRIES and BAIN in America, and WESTGREN in Sweden, have but recently and definitely proved the supposition that iron in martensite is in the alpha modification and the former agrees with MCCANCE that it contains (at least in its early history) carbon in solid solution—that is, in atomic dispersion. And now JEFFRIES and ARCHER call attention to the fact that fine grain is hard because the amorphous material and random orientation of grains interfere with slip. In this way they not only establish the nature of martensite but in addition they give a rational reason for its hardness. Almost since

the beginning of metallography, hardness of steels had been associated with martensite, and every effort has since been made to establish its nature, a step which SAUVEUR, twenty-five years ago, said was necessary before the riddle of quenching could be solved. If it were known just what martensite is, then one could proceed to explain why it should be hard.

But amorphous material does not grow in duralumin, for instance, on gentle annealing. Quite the opposite. Yet the hardness of the alloy is increased rather than decreased. No matter how adequately duralumin's quenched condition could be explained by amorphous boundaries surrounding fine grains, its hardening on aging must be due to another factor. MERICA and JEFFRIES were both working on this problem, but independently, and the two of them hit upon the germ of the general critical dispersion theory—that hardness is due to the dispersion of hard particles in the alloy, hard particles of sub-microscopic but correct size, neither too large nor too small. MERICA also pointed out that hardness in quenched and tempered steel could be ascribed to critically dispersed cementite.

Approaching the general theory of hardening by the "non-ferrous route" rather than from a consideration of the former theories of hardening steel, JEFFRIES and ARCHER now brilliantly show that a critical dispersion of hard particles causes maximum hardness, since it offers maximum interference to crystalline slip. And can we not agree with MERICA that such a dispersion offers as adequate a supplement to the effect of amorphous metal in hardened and tempered steel as it does in hardened and aged duralumin?

Disregarding the elegant way in which the theory covers numerous alloys by a simple conception, when applied to steel it has the virtue of ascribing hardness to the undoubted hardness of amorphous iron and cementite, rather than to the hypothetical hardness of beta iron. This undoubtedly makes for simplicity. It is to be expected that the many able men who support the claims of beta iron will not be converted overnight, and their criticisms will doubtless be forthcoming and properly welcomed. Yet no one would accuse the beta iron theory, in the full flush of HOWE's advocacy, of simplicity. Since the principal evidence that beta iron has existence is magnetic in nature, the beta iron theory must perforce explain hardness and magnetism at the same time. But when a steel is found in which the two do not vary in a proportional way, or another steel which has two or three magnetic susceptibilities for the same hardness, the beta theorists are in deep trouble. Their opponents are inclined to believe that such anomalies are best explained by the supposition that magnetism and hardness have no close relationship—in fact, are altogether different kinds of phenomena. Yet if they are discon-

nected phenomena, the beta iron theory loses its chief prop.

Perhaps, without knowing that hardness in steel could not be explained without simultaneously explaining the magnetic and electric properties, JEFFRIES and ARCHER have "gone ahead and done it"! If for nothing else, they have our congratulations for the magnetic-hardness divorce.

Tinkering With The Patent System

WHETHER said "Eternal vigilance is the price of liberty" probably had in mind the watchfulness necessary to guard what is essentially best in any of our human institutions. Certainly it applies to the patent system of the United States which our Congressmen and Senators are wont to improve from time to time by introducing so-called reforms. In 1912 it was the Oldfield bill; in 1915 the Paige bill, and in 1921 comes Senator STANLEY with a bill to amend the Revised Statutes relating to patents. The burden of reform which all of these volunteers would load upon our patent system is some variation of a scheme to compel patentees to work their patents. The Oldfield bill proposed compulsory licensing in case an inventor was unduly slow about putting his process into effect. The Paige bill was designed to force European dye-makers to operate in the United States by causing unworked patents to lapse within two years after they were issued. Senator STANLEY'S bill would amend the Revised Statutes relating to patents with a proviso to the effect that if a patent granted to a foreigner is "not worked or put in operation so as to result in actual production . . . in the continental limits of the United States within the period of two years from the date of its issue, the United States reserves the right to license any person or persons for purposes of manufacture in the United States." Prior to these three efforts toward compulsory working, two of which were unsuccessful and the third pending, the Congress did enact a compulsory working clause in 1832, but repealed it in 1836.

Compulsory working of patents, whether on pain of having the patent canceled or being compelled to grant a license to someone else, is a device that has always appealed to lay minds. It has never been approved by the best patent counsel, nor has it been acceptable to inventors at large. Legal opinion may be summed up in the remarks of Lord MOULTON, who, in discussing the British compulsory working act of 1907, said: "I think it is not only mischievous, it is also idiotic. It is one of those cases which are growing to be common, where the layman rushes into legislation with little or no acquaintance with the subject on which he is legislating. Knowledge has gone so far that the layman cannot keep up with the technical knowledge of a subject, even in politics. In my opinion, it would have been impossible for any man who understood this matter to devise the present legislation."

We respectfully commend Lord MOULTON'S opinion to Senator STANLEY and his colleagues and offer in addition a few arguments for defeat of the proposed legislation.

It is reported that Senator STANLEY'S avowed purpose in advocating this measure is to prevent a situation such as arose at the outbreak of the war when the

United States was cut off from supplies of German dyes. Presumably he believes that a compulsory licensing clause, which is in effect a compulsory working clause, would result in German manufacture in this country under German-owned United States patents. As Dr. B. C. HESSE pointed out in great detail in an address before the Rochester Section of the American Chemical Society in October, 1915, compulsory working would not create a dye industry. He showed also that compulsory working has been ineffective in the principal foreign countries and that some of those countries have entered into a mutual understanding whereby the clause is not enforced against their respective citizens. Further, Senator STANLEY'S plan would force German capital to manufacture in this country, thus promoting that "peaceful penetration" of industry which we found so objectionable when we went to war. It is true that the Stanley compulsory licensing clause applies only to foreign owners of United States patents; but to enforce it against them would encourage advocates of the idea to make it applicable to all United States patents, even though owned by American citizens. It requires no stretch of the imagination to see how surely such a measure would cause uncertainty on the protection afforded by a patent, and so weaken that protection that patents would have diminishing attraction for capital. The market for inventions would be decreased and the incentive of inventors proportionately reduced. And since the prime object of our patent system is to induce men to produce inventions, we should be exceedingly careful how we hedge them about with discouraging restrictions.

Those who have had experience with the development of patents will realize that two years is a comparatively short time in which to bring many processes and products to the stage of production contemplated in Senator STANLEY'S bill. This would deter inventors from perfecting their processes; and for the same reason it would probably deter licensees, because the first licensee would have to undergo the expense of development while others might come in and take licenses and manufacture without the handicap of initial development and expense. And as for the poor inventor who is now supposed to find it difficult to bring his patent to the production stage, would he not be worse off under a scheme of compulsory licensing? If manufacturers can now buy and suppress patents, as they are popularly supposed to do, how equally simple would it be for them to delay negotiations with an inventor for two years and then demand a license. We may also raise the question as to whether the license is to be exclusive or not. Presumably not, because "the United States reserves the right to license any person or persons" for the purpose of manufacture. And if licenses are not exclusive, how generally will they be taken, seeing the difficulties that will beset the licensee who takes upon himself the burden of initial development?

We have been able merely to touch upon the obvious features of the situation that would be created under Senator STANLEY'S bill and its logical development. The situation is fraught with danger to the patent system and to the inventive propensity of the American people. We understand that the bill has been reported favorably to the Senate by the Committee on Patents. Accordingly it will be necessary to take early action if the measure is to be defeated. We shall be glad to publish further discussion of the subject.

Labor Unions And Inefficiency

WHEN one discusses the single tax he discusses it on the basis of theory, since it is not operative. When one discusses the income tax he discusses it on the basis of practicality, because we have had it for several years and can observe its operation.

When we discuss labor unions and labor unionism we naturally discuss them on the basis of what we see. There is no occasion to consider theories or ideals regarding labor unionism because any theories entitled to consideration have had an opportunity to work out in practice. The labor union movement is not new. It is not because there has been insufficient time that only between 10 and 15 per cent of the workers are organized and between 85 and 90 per cent are left unorganized. If labor unionism as we see it involves inefficiency and injustice, it must bear the blame.

If we are investigating a species of plant, we observe where it grows, study its habitat and eventually determine the surroundings under which it will or will not grow. We can study mental inclinations in the same manner. In certain circumstances men tend to grow avaricious. In certain surroundings religious aspirations are aroused. Associated with certain persons one becomes ambitious to wear the most tasty neckties, while in association with a certain other kind of men thoughts about neckties do not thrive and the desire to be able to stick on a bronco's back has a vigorous growth.

The method is strictly applicable to a study of labor unionism. What is the favorite habitat of labor unions? Where do they thrive? Of the total enrollment in labor unions in the United States one finds that a very high percentage of the membership is included in three categories: (1) The United Mine Workers, whose members mine bituminous coal and anthracite; (2) the building trades; (3) the steam railroads and trolley lines. Outside of these three categories unionism is practically insignificant. The percentage of all unionism that is comprised in these three categories is very high, and the percentage of disturbance to the general industrial and economic situation caused by the unions in these particular lines is higher still.

Here, then, we have the favorite habitats discovered beyond peradventure of doubt. Whether studying a variety of plant or studying labor unionism, the investigator next proceeds to inquire whether there is anything peculiar about the discovered habitats that differentiate them from other places. No difficulty whatever is encountered in differentiating. Strikes in these lines of activity are in essence directed against the general public rather than against the proximate employer. In a trolley strike in a large town, which has the more patience, the public service corporation or the public that must foot it? In a six-day strike, who would suffer the more, the shareholders of the Pennsylvania Railroad Company or the patrons of the railroad? Or in an office building, the contractor whose margin is in a measure a percentage of the wages paid or the owner who has money tied up and wants to be ready for the office-leasing season? That is one kind of habitat where unionism thrives. The other is where a strike or wage disagreement is not disadvantageous to the employer. Time after time in the coal industry it has been found that consumers were stocked with coal in anticipation of a suspension of mining on the

biennial April 1 and the operators needed a suspension to permit the consumption of stocks so that damaging competition would be averted.

In all these cases we find inefficiency, the workman not doing the full amount of work he should do in a day, to do his share toward bearing the total burden of the work of society.

Promotion in Technical Positions

THE chemical profession generally will congratulate Dr. A. C. FIELDNER on his well-deserved appointment as director of the Pittsburgh Station of the Bureau of Mines. This is a recognition of Dr. FIELDNER's ability as an investigator and as a director of investigations. It is to be hoped that Dr. FIELDNER's new responsibilities will not weigh so heavily upon his hands as to prevent continuance of his work in the field of fuel investigations. The contributions which have come from his organization have been notable, and it would be a great loss if purely administrative and executive duties were permitted to interfere with his further active participation in this invaluable scientific work. Both in the Government and elsewhere there is too much of a tendency to place upon such men the burden of administrative responsibility which interferes with the work they are so well fitted by training and experience to carry through. It is often quite simple to secure for this administrative work much less experienced and less valuable men who, though capable in this particular, are not themselves investigators, either by temperament or training. It is very fortunate that the bureau recognizes this fact and plans to give Dr. FIELDNER such assistance as we hope will prevent unduly burdening him with correspondence and other details that always beset the chief of a large organization.

Our industrial organizations of technical sort, though striving for commercial efficiency, sometimes have not been as willing as they should to be efficient in such matters as this. If the only way in which the chief chemist, the chief metallurgist or other director of investigations can advance himself within a company is by assuming executive responsibilities, it is not strange that he seeks such position. Especially if the difference in salary between the purely executive position and the position in charge of research is large do we find this tendency to change from science into the commercial branches of the organization. It is certainly false economy to permit a man who has demonstrated his ability in research and development work to become a slave to routine. He may succeed at it, though this is by no means sure, but in any event the company will lose if such change is made. Even at the risk of paying the so-called subordinate men more than the executive head it may be worth while to keep successful research men in the field of their specialties. New developments which they produce may not save as much in a single year as would a valuable administrative decision or change in operating plan, but the improvements thus achieved are capitalized for all future time. In fact, without them the corporation may fall in the race for commercial supremacy distinctly behind its competitors in technical method or value of product. It is best by all means to keep each scientific man in the job for which his training and experience best fits him, even though the salary roll may look a bit unbalanced.

Readers' Views and Comments

Production of Pure Platinum

To the Editor of Chemical & Metallurgical Engineering

SIR:—I notice in the edition of your magazine dated April 20, 1921, on page 696, you mention that the Bureau of Standards has recently succeeded in producing platinum of higher purity than any obtainable from other platinum dealers, and also that Heræus' platinum has long been accepted as standard. It is also stated that this pure platinum has been melted in lime.

I would mention that the firm of Johnson, Matthey & Co., Ltd., of London, has for many years produced pure platinum, as I can attest from forty-seven years' experience with the firm. The platinum produced by it has passed all tests and is pure, but to produce it pure it is not necessary to melt it as you state, and the slightest trace of lime, if found, is not caused by melting in lime.

For your general information, I would say that G. Matthey, F.R.S., produced pure platinum by carefully refining metal, precipitating, washing in pure water free from Ca, pressing the powder into a solid ingot by hydraulic pressure, after which it was heated in a closed muffle, placed under a powerful drop hammer, and welded together. As is generally known, platinum is one of the easiest metals to weld. My experience is that if you want pure platinum do not melt it unless you are looking for trouble. Obviously if alloys of platinum are wanted, they must be melted, but the high temperature required causes (slight) contamination with the refractories used.

I may say that I am not depreciating the work of W. C. Heræus in the production of pure platinum.

Maidstone Road, Bound's Green,
London, N. 11.

H. A. KENT.

To the Editor of Chemical & Metallurgical Engineering

SIR:—I have read with interest the comments of H. A. Kent, of London, with reference to the brief press notice that appeared in your journal on the production of very pure platinum.

Mr. Wichers' paper is now in press and will appear shortly in the *Journal of the American Chemical Society*. In this paper there is given the experimental evidence in support of the statement that the platinum produced by the methods there described is of higher purity than any samples of Heræus platinum that we have been able to obtain or about which we have been able to find any published data. The platinum wire produced by Mr. Wichers was compared with a number of samples of Heræus platinum wire, selected from among the purest samples that we have been able to obtain from that maker during the past fifteen years.

I may add that Mr. Wichers did not compare the wire produced by his method of purification directly with a sample of Johnson, Matthey & Co. platinum wire, but no samples of wire that have thus far come into our possession from the latter source have quite equalled in purity the purest Heræus platinum wire. It has been found that the purer the platinum the higher its temperature coefficient of electrical resistance. For the purest Heræus platinum, the ratio of electrical resistance at 100 deg. to electrical resistance at 0 deg.—

i.e., $R_{100} \div R_0$ —is somewhat above 1.391. The samples of Johnson, Matthey & Co. platinum wire tested in the laboratories of the Bureau of Standards during the past fifteen years were found to give values of this ratio of about 1.386. Some specially pure samples of platinum wire furnished by Johnson, Matthey & Co. to a committee of the British Association were reported (B. A. Report 1901) to have a value equal to 1.3892. Dr. J. A. Harker in a report of the same committee (B. A. Report 1903) gives for the values of this ratio figures ranging from 1.387 to nearly 1.389. It seems very probable, therefore, that the Johnson, Matthey & Co. platinum is not quite so pure as is the Heræus platinum.

In another paper, now in preparation, it will be shown that Johnson, Matthey & Co. platinum, as furnished for high temperature thermocouples, contains *relatively* large amounts of calcium as compared with Heræus platinum and very much larger amounts than the platinum refined in the laboratory of the Bureau of Standards. The amount of calcium can be very greatly reduced by merely melting on lime under proper conditions.

I may add, in conclusion, that Mr. Wichers and his associates, C. O. Fairchild and W. F. Meggers, have also obtained thermoelectric and spectroscopic evidence that the wire which he has produced is purer than any of the samples with which it has been compared.

W. F. HILLEBRAND,

Chief Chemist, Bureau of Standards.

The Vapor Compression System of Evaporation

To the Editor of Chemical & Metallurgical Engineering

SIR:—May I offer the following information relative to Mr. Carlsson's article on "The Vapor Compression System of Evaporation" on pages 645-647 of your issue of April 13?

In introducing his subject, he suggests that multiple-effect evaporators have decided weak points both from an economical as well as a technical standpoint and throughout his article gives the impression that fuel must be primarily consumed to operate such equipment. As a chemical engineer, having had over ten years' experience in the design and operation of evaporators from the coil type to the film type, may I state that over 95 per cent of the multiple-effect evaporators operating today are using exhaust steam in whole or in part? It is first used in prime movers and fed to the vacuum plants at pressures up to 5 lb. per sq.in.

In actual practice with a film type of evaporator my own records over a long period show 2.8 lb. of water evaporated per lb. of exhaust steam used in a triple-effect machine having a capacity of 10,000 lb. per hour. This evaporation was obtained without the use of a preheater or utilizing hot outgoing condensate or vapors; with such arrangements the heat efficiency would have been increased.

Is it not rather a sweeping statement to say that "many suggestions of new evaporation methods made in recent years have failed until quite recently"? I can specifically state a number of cases where evaporation improvements have been carried out within the past ten years. For instance, the advent of the film evaporator resulted in such a compact design that it

was possible to superimpose three effects, thus making a self-contained triple-effect evaporator.

Mention that the Swiss firm began marketing the "Autovapor" evaporator only in 1918 places that firm far behind the pioneers in this system of evaporation utilizing vapor compression principles. As far back as 1906 experiments were made with a Simplex film evaporator in which live steam injector was embodied, which sucked back and compressed the vapor coming from the liquor. This compressed vapor and ingoing steam was then passed back to the calandria to perform further work. This in itself utilized the principle of vapor compression, although it was not carried to any elaborate conclusion. Prior to 1914 a technochemical concern built a vapor compression evaporator plant in London. This was known as the Söderlund-Boberg evaporator and has priority in development work over the "Autovapor," if it is not the same equipment.

I consider that the "Autovapor" efficiency figures quoted are on the high side, particularly if they were obtained with the design of equipment shown. It is well known in evaporator work that, consistent with the class of liquid being handled, the higher the temperature difference between the heating medium and liquid being heated the higher the transmission factor per square foot effective heating surface. For standard vacuum evaporator work, using exhaust steam, this temperature difference varies from 30 to 100 deg. F. Such a difference as 30 deg. F. would not be economically permissible with a vapor compression system, as the power and capital expended to produce this difference would overbalance any conservation of heat thereby gained. To make any vapor pressure system economically effective it is necessary to operate with low temperature differences, and this means increased heating surface. Using a coil type of pan, the heating surface would be so large for a normal commercial unit that the initial cost would be prohibitive.

Why distilled water (or condensed vapor) from the "Autovapor" is purer than that obtained from vacuum evaporators is not explained and is not perfectly clear.

I take exception to the balance sheets submitted, in that it is assumed the steam used is primarily produced for this purpose, where, as before mentioned, the majority of plants use exhaust steam. Again, the figure of 2 lb. of water evaporated per pound of steam for a triple effect is too low, and should be 2.8 for a film type of plant, which is the most modern type of vacuum evaporator. The figure of 8 hp. for a condensate pump designed for a triple-effect evaporator of 2,200 lb. capacity has evidently been taken from a textbook. The actual practice figure is nearer 2 hp.

I am glad the writer indicates the shortcomings of this system, in that "when dealing with concentrated solutions, the conditions are not so favorable, because the boiling points of the solutions are higher than those of solvents." This means that it is too costly to compress the vapor to a point where the temperature difference would produce a concentrated solution.

A triple-effect film evaporator will treat any and all solutions, concentrating up to 30 deg. Bé. continuously, evaporating 2.8 lb. of water for 1 lb. of exhaust steam and with a mechanical expenditure of 1.7 hp. per 2,000 lb. evaporated, with no high-speed or complicated mechanism requiring skilled supervision.

It will be many years before a compression system of evaporation will be able to compete with the film

evaporator in the average industry, and electrical or water power will have to be at low cost, with a perfected fool-proof compressor, made sufficiently rugged to warrant unskilled attention. The capital cost and overhead, involving skilled attention for compressor and evaporator, is not included in Mr. Carlsson's balance sheet.

BURTON DUNGLINSON.

Chicago, Ill.

To the Editor of Chemical & Metallurgical Engineering

SIR:—My statement, in my article on "The Vapor Compression System of Evaporation" in your issue of April 13, that the multiple-effect system has weak points from economical and technical points of view, refers to the fact that condensers in general have to be installed with the result that a certain amount of latent heat is wasted. Furthermore, having rather small quantities of water to evaporate, it is very expensive to install such a huge aggregate to get the desired efficiency, the Autovapor having only one container with its compressor and motor with which a good efficiency is obtained. The latter installation does not require more labor than the multiple-effect system. With larger apparatus using exhaust steam in evaporation, the calculation on page 647, second column, shows that the compression system is able to compete favorably with a multiple-effect system. Throughout the article the calculations are based upon installations having a capacity of 2,200 lb. A triple effect under those conditions does not have greater efficiency. For larger capacities both of the methods have greater efficiency factors and results of a comparison will still hold.

In regard to my "sweeping statement" I might say that it referred to different compression methods tried in the past and Mr. Dunglinson has mentioned two which he knows have been a failure or at least had but a very limited application. As far as my experience goes, this is true. This pioneer work, however, I am certain the manufacturers of the Autovapor appreciate and I don't think they claim to be the first ones.

As a matter of fact the Söderlund-Boberg people confine in their English patent the use of the machines to solutions similar to sulphite cellulose waste liquor.

The Autovapor in its perfection now accomplished is running with quite different heat head than the Söderlund-Boberg, in fact it is similar to that of multiple-effect evaporators due to the development of the high-speed turbine compressor. This machine is able to handle the vapor in a very satisfactory manner. As a matter of fact, the point in this system is the compressor and its accomplishment has been such that the vapor compression system is economically effective without operating with low temperature difference and too much increased heat surfaces.

The efficiency figures are not on the high side. They are obtained in real practice and with a small installation. In this connection I would like to correct the figure 19.3 on page 647, line 48, which ought to be 42.7. With greater units higher results are obtained.

I have a list of twenty-five installations of this apparatus in Europe showing that the Autovapor has passed its "childhood." I think this fact is the best answer to Mr. Dunglinson's statement of the probable shortcoming on the part of the Autovapor system.

That the compressor really is fool-proof and that the expenses for capital cost and overhead are not prohibitive do not require discussion. GUSTAV CARLSSON.

Niagara Falls, N. Y.

Italian Chemical Industries

FROM OUR SPECIAL CORRESPONDENT

GENOA, Italy, May 20, 1921.

DURING the last few weeks the crisis in the Italian chemical industries has been aggravated by the elections just finished, by the shortage of American and English coal, and by the upset conditions of labor. Only a few works, especially those producing the common acids, alkalis and fertilizers, can continue their work as usual, whereas all those producing the finer chemicals have either closed or continue under great difficulty, working only for four days a week with reduced hours. In the metallurgical and engineering industries only those concerns which have to supply materials to the Italian state railways, to the shipyards and to the hydro-electric plants can be kept in running condition.

FOREIGN EXCHANGE SINKS FURTHER

The foreign exchange, especially in the cases of the United States dollar, of the English pound and of the Swiss and French franc, has sunk considerably during the past month, while no change followed through a renewed business intensity with German-speaking countries and some of the new Balkan states. These conditions and the absence of demand brought a further reduction in prices for most chemicals, metals, drugs, essences and other products, causing great losses to the producers and merchants. The exportation of Sicilian products has come to a sudden standstill owing to the rise in price when sold for foreign currencies. A new law authorizing the exportation against payments in Italian lire was issued, and this, it is expected, will facilitate a resumption of foreign traffic.

ITALIAN INDUSTRIALS MEET

With the view of helping the future of the chemical industries and other Italian industries the principal Italian industrials met at Rome under the auspices of the Minister of Finances to discuss the difficulties through which the said industries are passing, and demonstrate the utter impossibility of continuing with the present fiscal taxes, which are gradually ruining all industrial enterprise.

WAGE IMPROVEMENT IN THE CHEMICAL INDUSTRY

After several sittings and discussions, the troubles between the Italian chemical workmen and their employers were finally settled. Through the accord reached the wages will be increased 0.50 lire for the men, and 0.40 lire for the women, boys and girls, dating back to Feb. 1, 1921. From this arrangement are excluded the dye works of Cengio, Rho, Cesano Maderno and Turro, and companies that have national agreements.

ITALIAN FERTILIZERS

The demand for immediate delivery of fertilizers is nearly stopped, owing to the advanced season. Contracts for July, August and September delivery of important amounts of superphosphate were concluded recently, but the prices made in this instance are much below those of the market quotations.

A NEW INDUSTRIAL FAIR

A new industrial fair, occupying an area of 25,000 sq.m. and arranged for accommodating over three thousand exhibitors, was inaugurated in the City of Milan.

The leading concerns manufacturing drugs, essences and metallurgical products in Italy and other countries were represented. Besides the usual world-known products, new raw materials for producing refreshing drinks, pharmaceutical products and essences were noted. German-speaking countries have taken advantage of this exhibition to advertise their produce in all branches and to open new business relations not only in Italy but also elsewhere.

NEW WATER-POWER AND HYDRO-ELECTRIC DEVELOPMENTS IN ITALY

Further developments took place during the last five weeks in Italian hydro-electric plants. The erection of an important plant at Mazé has just been started. The waters of the River Dora with 60-m. head will be diverted, through special canals, to a series of turbines. The electric power is to be utilized in the neighborhood. The Italian Council of Ministers has approved special arrangements to guarantee the financing of the erection of new hydro-electric plants. A law was published constituting the Autonomous Association for the Development of Hydraulic Power and New Waterway along the River Adige to the Lake of Garda. This would prove greatly beneficial to the provinces of Verona, Mantova, Modena, Bologna and Trento. The new concern will have an unlimited capital, being financed by some of the most important banks, and will use the hydraulic power for light, for electrification of the railways and for motive power in the industries of these provinces. The construction of the second largest hydro-electric plant in the world (the Niagara Falls plant being the largest) not far from the City of Venice has already been started. Two thousand five hundred workpeople are now employed on the work of building canals by which a great portion of the waters of the River Piave will be caused to run into a huge distribution basin leading to the power plant. This work is pushed simultaneously with that of the enlargement of the port of Venice.

COAL SCARCITY IN ITALY

A great famine of American and English coal is being experienced, owing to the suspension of all deliveries from England and to the fact that few ships have reached Italy from the United States. This has brought up the prices very strongly for the rare lots of the coal still available. To help matters as much as possible the Italian state railways have further lowered the prices of the German war reparation coal which they offer for industrial purposes and for consumption in the ports. Not all the consumers of coal could take advantage of such offer owing to their plants requiring better qualities of coal, such as that which can only be obtained from the United States and from England.

ITALIAN ARTIFICIAL DYE INDUSTRY

The Italian Minister of Industry is studying the application of customs tariffs for favoring the Italian artificial dye industry. This industry, born principally during the war, has now four large works in Lombardy and Liguria, and employs thousands of workmen. The Italian customs, up to the moment of writing, did not place any importation duty on dyestuffs, nor are these considered among the products of prohibited importation. This tariff encounters resistance on the part of producers of colored fabrics and yarns, who wish to get the products they use at as low a price as possible.

Survey of Chemical Engineering Education

Summary of Questionnaire Showing Curriculum of 78 Institutions—Courses Taught Include 49 in Chemistry, 15 in Physics, 10 in Mathematics, 9 in Mechanics, 6 in Engineering Elements, 31 in Mechanical, 6 in Civil, 8 in Electrical, 6 in Mining, 14 in Sanitary, 3 in Safety, 14 in Industrial, 11 in English, 6 in Languages and 23 Miscellaneous

THE committee on chemical engineering education of the American Institute of Chemical Engineers, composed of Joseph H. James, Ralph H. McKee, Charles L. Reese, Albert W. Smith and James R. Withrow, with Arthur D. Little as chairman, has initiated a survey of chemical engineering courses in seventy-eight institutions in the United States, this being the entire number known to the committee as offering such courses. Through the co-operation of the presidents and heads of departments in these institutions it has been possible to tabulate in a comparative way the apportionment of time and credit to the several subjects included in these courses, and this tabulation is here presented, primarily as a report of progress and for the purpose of precipitating the discussion which the extraordinary variation in such weighting would seem to justify.

MULTIPLICITY OF SUBJECTS INCLUDED

The first feature of outstanding significance is, of course, the remarkable multiplicity of subjects that have come to be included in these courses. The next of important interest is perhaps the widely divergent views as to the relative values assigned to the same subjects in the different institutions. There appears also to be a tendency to multiply courses by the subdivision of fundamental subjects into minor courses that might conceivably to better advantage be tied together into a major course.

NEED OF STANDARDIZATION

All this would seem to point quite clearly to an imperative need of standardization of courses of chemical engineering as taught in our American institutions. To what extent, however, this may be desirable, how it may best be accomplished, or whether a complete recasting of courses along the lines suggested by the case system or the School of Chemical Engineering Practice of the Massachusetts Institute of Technology is the indicated remedy, the committee at this time expresses no opinion, preferring to have the benefit of the views and discussion which it is hoped the publication of this tabulation may provoke.

Any communications relative to the subject will be especially welcomed and will receive careful consideration if addressed to Dr. Arthur D. Little, chairman of the committee, at 30 Charles River Road, Cambridge 39, Mass.

The table is being published in advance of the committee report to the society at the Detroit meeting next week to enable proper study prior to discussion there. The views presented at the meeting will be published in connection with the report of the meeting or separately in a subsequent number. Those who wish to forward written communications to the meeting expressing their views should send them to Dr. John C.

Olsen, secretary, Statler Hotel, Detroit, in time for presentation on Monday.

EXPLANATION OF THE TABLES

Where the parenthetical numbers (5) and (6) are used in connection with the hours devoted to a subject, five- and six-year curriculums are indicated. The footnotes indicated by single, double, triple and quadruple crosses are to be found under Remarks, lines 222-226 in the respective columns in which they occur.

The forty-nine headings under chemistry show a tendency for a few institutions to offer a specialty such as sugar at Louisiana and paper at Maine. It is also an indication of the limit of possibilities of chemical instruction and how much must be left for the student to dig out for himself after graduation. Irish history seems to be the joker, no institutions giving credits or devoting hours to it, but the committee must have included it with full knowledge that no chemical engineer can get along in a manufacturing plant without knowing the ways of the Irish foremen.

CHEMICAL ENGINEERING LABORATORY FACILITIES MEAGER

Only twenty-seven out of the seventy-eight institutions included in the report offer any chemical engineering laboratory facilities or instruction. In any other field of engineering education this would be inconceivable. However, the types of equipment that are available for student work are so very limited in variety and size that it is an open question whether equipment operation can be studied anywhere except in a manufacturing plant. The large-scale evaporator station at the University of Michigan shows the possibilities for engineering research and design data determinations within the province of the university. Other fields of activity such as distillation, reduction and grading of solids might be similarly intensively developed on a large scale, if the commercial interests involved could be persuaded to co-operate with the institution having the best fitted staff to take up the work.

The large number of white spaces under Industrial Engineering again emphasizes the fact that the student going into a plant organization has to realize that he has just graduated into being his own teacher. He must be able to create a course for his own study on production engineering, costs, operation planning, industrial relations, commercial specifications, estimates and contracts whenever there is a demand, if he is ever to quit the drawing board and be an executive.

Undoubtedly there are errors, some even so colossal as omitting the name of some very important institution such as the University of Illinois or physical chemistry from the curriculum of Boston Tech. We shall be glad to publish all corrections received and forward them to the committee.

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Specifications for the Color of Gypsum Plasters

BY WARREN E. EMLEY AND CHARLOTTE G. FAXON*

IN THE Tentative Specification for Gypsum Plasters, published by the American Society for Testing Materials, in 1920, the following paragraph occurs:

"Calcined gypsum for finishing coat may or may not contain retarder. It may be sold in two grades—viz., 'white' and 'gray.'"

Numerous cases are on record where dealers have ordered gypsum plaster of such a color that it will match a previous shipment. If the second lot is to be used to patch a wall which has been plastered with the first lot, obviously the colors must match pretty closely.

For white coat work it is customary to mix calcined gypsum with lime putty. Unless the mixing is done with unusual care, there will be spots of lime visible in the finished wall. Just how plainly visible these spots are will depend upon the relative colors of the lime and the gypsum. If they are both the same color, the spots will be invisible; if one is nearly white and the other dark, the effect may be so bad as to condemn the plaster.

INVESTIGATIONS FOR MEASURING THE COLOR OF GYPSUM PLASTERS

The above citations illustrate the need for some method of measuring the color of gypsum plasters and of specifying any color which may be desired. In order to meet this need an investigation was undertaken at the Bureau of Standards, and this paper is intended to present the results so far obtained.

Fortunately, the method had already been established, and the equipment was available. These are described in detail in Bureau of Standards Technologic Papers 92 and 167. Irwin G. Priest, chief of the color section of the bureau and senior author of both of the above papers, has co-operated with us not only by giving personal supervision to the experimental work, but also by assisting in the interpretation of the data.

A careful study of the subject can be made only by reference to the two papers cited above. For this reason, only a brief description of the method used will be given here.

A small block of the plaster to be examined was molded and allowed to become thoroughly dry and hard. It was mounted for spectrophotometric examination beside a standard block of magnesium carbonate in a box so that the sample and standard were diffusely and equally illuminated, and so placed that one half of the spectrophotometer field was illuminated by light reflected by the sample, while the other half was illuminated by light reflected by the standard. By rotating a Nicol prism, the brightness of one half the field may be made to increase, while that of the other half simultaneously decreases. When the two halves match, the position of the prism indicates the relative quantities of light reflected from the sample and the standard. By rotating a glass prism in the path of the reflected light any desired wave-length may be selected, light of every other wave-length being simultaneously cut off. It is thus possible to measure the ability of the sample to reflect light of any wave-length and to compare this ability with that of the standard

magnesium carbonate which reflects nearly 100 per cent of the light falling on it. The ratio between the intensities of the light of any given wave-length reflected by the sample and by the standard may be expressed as a percentage, and may be plotted against the wave-length. This method of expressing the results is shown in Fig. 1, which is drawn from actual data obtained by measurements of the reflecting powers of a gypsum plaster for lights of different wave-lengths.

A careful study of this curve is worth while, as it illustrates several points pertinent to the problem in hand. If the curve is a straight, horizontal line, the color which it represents will be neutral—white, gray, or black. Whether the color is white or black will be indicated by the position of the line. If the line shows 100 per cent reflection for all wave-lengths, the sample is as nearly white as the standard. A perfect black would show zero per cent reflection for all wave-lengths; intermediate positions of the line indicate varying shades of gray, but the grays are purely neutral only when the line is straight and horizontal. In the case illustrated, the line is neither straight nor horizontal. It shows that the reflecting power of the sample for blue light was deficient, which is another way of saying that the sample has a yellow or red tint, and the sample varies from neutral gray to that extent. Since the reflecting power runs from about 50 per cent of that of the standard in the blue to about 70 per cent in the red, it is evident that the neutral gray to which the color of this sample approaches is not very nearly white.

Fig. 2 shows the approximate average spectral distribution of light from the noon sun at Washington. If the ordinate of this curve corresponding to each wave-length is multiplied by the per cent reflection for that wave-length as shown in Fig. 1, the results may be plotted to give the curve in Fig. 3. This curve represents the spectral distribution of sunlight after reflection from the sample. The area under this curve is proportional to the total reflection of the sample for sunlight. This area may be expressed as a fraction of the area under the standard curve, Fig. 2. The relative brilliance of the sample is then directly proportional to the logarithm of this fraction.

Measurements were made on thirteen samples of gypsum plasters, to determine their ability to reflect lights of different wave-lengths. The results were plotted in curve form, of which Fig. 1 is typical. All of the curves were of the same general shape—that is, all of the plasters had a yellow or red tint. The curves differed in their positions, however, which shows that some of the samples approached the whiteness of the standard more closely than others did.

REQUIREMENTS FOR SPECIFYING THE COLOR OF A PLASTER

Inasmuch as the samples examined were selected as being representative of the entire field and the curves were all found to be similar in shape and without pronounced breaks, it may be assumed that gypsum plasters will not show any pronounced color unless some pigment has been intentionally added. The color of a plaster may therefore be specified by stating how much it varies from gray (that is, how red or yellow it is), and how far this gray departs from the standard white. The former requirement may be expressed numerically as the ratio of the per cent reflection of blue light (compared with the standard) to the per cent reflection of

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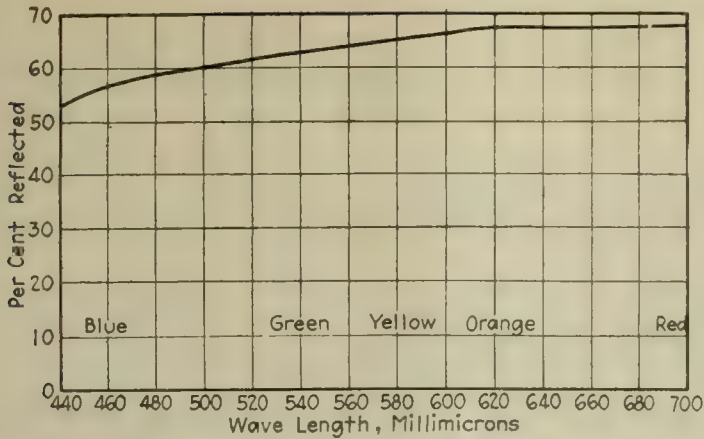


FIG. 1 - Amount of Light of Different Colors Reflected by Sample No. 9 Expressed as Per Cent of the Amount Reflected by a Standard White Surface.

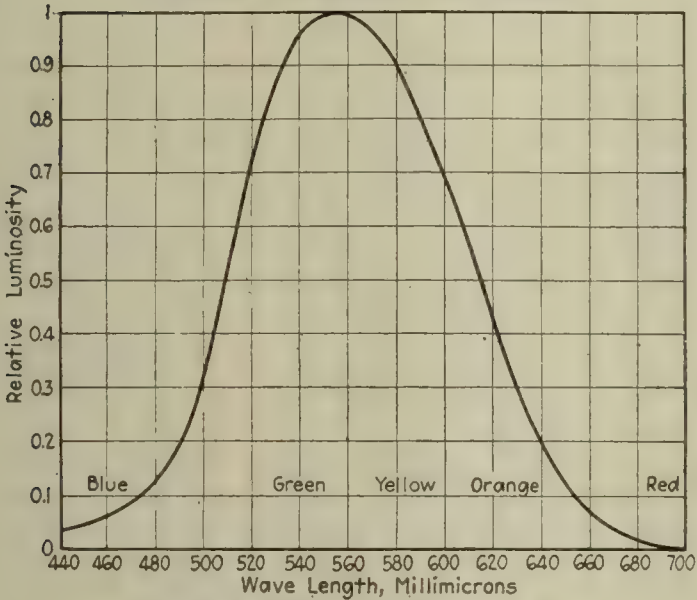


FIG. 2 - Spectral Distribution of Average noon Sunlight at Washington D.C.

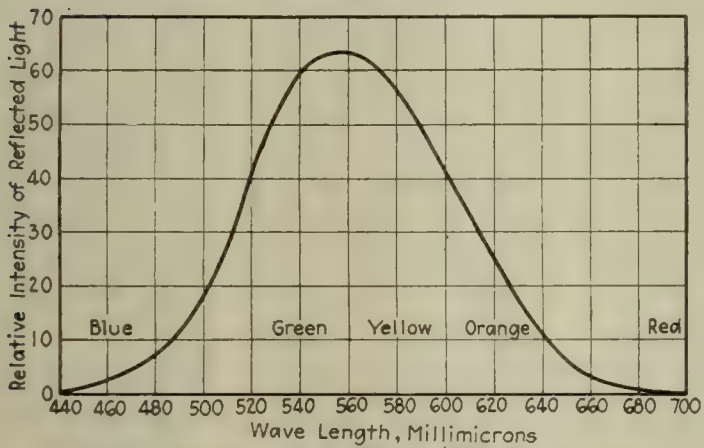


FIG. 3 - Spectral Distribution of Sunlight as Reflected from Sample No. 9. Each Ordinate is the Product of the Correspondent Ordinates of Figs 1 and 2

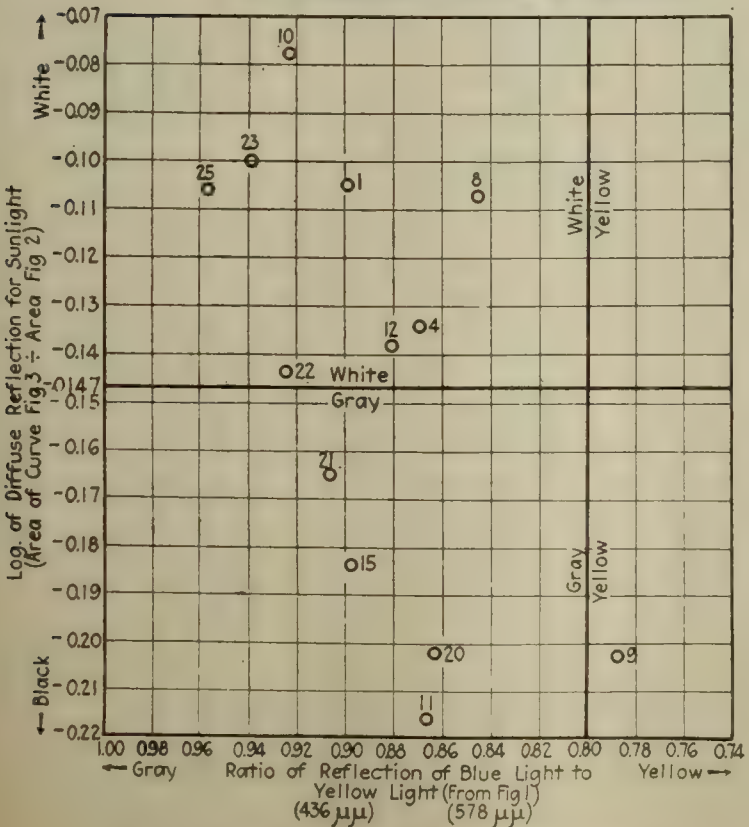


FIG. 4 - Comparative Colors of Samples Examined

yellow light. Blue light has a wave-length of 436 millimicrons; yellow light, 578 millimicrons. If this ratio is 1, the sample is gray; if greater than 1, it has a blue tint; if less than 1, a yellow tint. The second requirement has already been defined as being numerically expressed by the logarithm of the ratio between the area of the curve shown in Fig. 3 to the area of the sunlight curve shown in Fig. 2.

The results obtained from the thirteen samples examined are listed in the following table, and are shown in the form of a diagram in Fig. 4.

Sample No.	Description of Sample	Ratio of Reflection Blue:Yellow	Log. of Ratio Total Reflection of Sample: Total Reflection of Standard
1.	Plaster of paris F (Nova Scotia gypsum)	0.900	0.105
4.	Windsor FFF plaster (Nova Scotia gypsum)	0.870	0.134
8.	Superfine Windsor cement (Nova Scotia gypsum)	0.846	0.107
9.	Wood fibered plaster (Nova Scotia gypsum)	0.787	0.203
10.	Potters' plaster (Nova Scotia gypsum)	0.923	0.078
11.	Retarded gaging plaster, Oklahoma	0.866	0.216
12.	Unfibered cement plaster, Oklahoma	0.881	0.138
15.	Molding plaster, Oklahoma	0.898	0.184
20.	Molding plaster, Ohio	0.863	0.202
21.	Stucco, Iowa	0.907	0.165
22.	Retarded stucco, Iowa	0.925	0.144
23.	Molding plaster, New York	0.939	0.100
25.	Stucco, New York	0.957	0.106

In the last column a small number indicates a close approach to the whiteness of the standard. The smaller the number in the next to the last column the more yellow is the sample. If this figure were 1, the sample would be gray.

In Fig. 4 a horizontal line has been drawn midway between the extreme values of samples 10 and 11. It is proposed that all samples falling above this line may be called white, and all samples falling below it gray. A careful visual examination of the samples indicates that this classification is satisfactory.

The position of the vertical line has been arbitrarily fixed. Sample 9 is apparently the only one which might be condemned as being too yellow, and the line has been placed accordingly. Samples falling to the right of this line should not be designated as either white or gray; they are yellow.

The requirements suggested for a "white" plaster are therefore: (1) The logarithm of the diffused reflection for average sunlight shall be numerically less than 0.147, and (2) the ratio of the reflection of blue light (wave-length = 436 millimicrons) to the reflection for yellow light (wave-length = 578 millimicrons) shall be not less than 0.8.

For a "gray" plaster, requirement 1 as changed to read "more than" instead of "less than." Requirement 2 is the same for both white and gray plasters.

While it is believed that a "white" plaster meeting the requirements given above will be nearly enough white to be satisfactory for all commercial purposes, it must be remembered that the requirements are rather lenient. Therefore, white plasters may differ noticeably among themselves. If it is necessary that two white plasters shall match each other, much more rigid requirements must be specified.

In case a plaster of perfectly definite color is desired, an individual specification must be written, for it is obvious that there can be as many such specifications as there are colors. It is suggested that in writing such a specification a curve similar to Fig. 1 be drawn, indicating the desired color by the shape and position of the curve. A deviation from the curve of 5 per cent either way at any wave-length should be permitted.

Byproduct Coke Plants in the United States

The following list of manufacturers of byproduct coke in the United States May 1, 1921, has been compiled by the United States Geological Survey:

Operator	Address	Name or Location of Works	Number and Kind of Ovens
Alabama			
Alabama By-Products Corp.	American Trust Bldg., Birmingham.	Birmingham.	50 Koppers
Gulf States Steel Co.	Brown-Marx Bldg., Birmingham.	Alabama City.	37 Koppers
Semet-Solvay Co.	Syracuse, N. Y.		
Also in Ill., Ky., Mich., N. Y., Ohio, Pa., W. Va.			
(Tenn. C. I. & R.R. Co.)	(Birmingham)	Ensley.	240 Semet-Solvay
(Central Iron & Coal Co.)	(Holt)	Tuscaloosa.	60 Semet-Solvay
Sloss-Sheffield Steel & Iron Co.	American Trust Bldg., Birmingham.	Birmingham.	120 Semet-Solvay
Tennessee Coal, Iron & R.R. Co.	Birmingham.	Fairfield.	434 Koppers
Woodward Iron Co.	Woodward.	Woodward.	80 Koppers 60 Wilputte 90 Koppers being rebuilt 120 Koppers
Colorado			
Colorado Fuel & Iron Co.	Boston Bldg., Denver.	Minnequa.	
Illinois			
Chicago By-Product Coke Co.	Peoples Gas Bldg., Chicago.	Chicago.	100 Koppers building
Coal Products Mfg. Co.	Aurora.	Joliet.	35 Koppers 18 Wilputte
Illinois Steel Co. (Also in Ind.)	208 South La Salle St., Chicago.	Joliet.	280 Koppers
International Harvester Co.	606 South Michigan Ave., Chicago.	South Chicago.	88 Wilputte
North Shore Gas Co.	Waukegan.	Waukegan.	13 Semet-Solvay
St. Louis Coke & Chemical Co.	208 South La Salle St., Chicago.	Granite City.	80 Roberts 240 Roberts building
Semet-Solvay Co. (Also in Ala., etc.)	Syracuse, N. Y.		
(By-Products Coke Corp.)	(Chicago)	South Chicago.	280 Semet-Solvay
Indiana			
Central Indiana Gas Co.	Muncie.	Muncie.	22 Klonne
Citizens Gas Co.	Majestic Bldg., Indianapolis.	Langsdale.	41 Semet-Solvay
		Prospect.	100 United-Otto 40 Wilputte
Illinois Steel Co. (Also in Ill.)	208 South La Salle St., Chicago, Ill.	Gary.	700 Koppers
Indiana Coke & Gas Co.	Terre Haute.	Terre Haute.	30 Gas Machinery 30 Koppers
Inland Steel Co.	South Dearborn St., Chicago, Ill.	Indiana Harbor.	130 Koppers
Linton Gas Co.	Linton.	Linton.	3 Gas Machinery
Steel & Tube Co. of American (Also in Wis.)	111 W. Washington St., Chicago, Ill.	Indiana Harbor.	120 Semet-Solvay
Kentucky			
Semet-Solvay Co. (Also in Ala., etc.)	Syracuse, N. Y.		
(Kentucky Solvay Coke Co.)	(Ashland)	Ashland.	108 Semet-Solvay
Maryland			
Bethlehem Steel Co. (Also in Pa.)	Bethlehem, Pa.	Sparrows Point.	300 Koppers
Massachusetts			
New England Fuel & Trans. Co.	111 Devonshire St., Boston.	Everett.	400 United-Otto
Michigan			
Ford Motor Co.	Dearborn.	Dearborn.	120 Semet-Solvay
Michigan Alkali Co.	Wyandotte.	Wyandotte.	54 United-Otto
Semet-Solvay Co. (Also in Ala., etc.)	Syracuse, N. Y.	Detroit.	215 Semet-Solvay
Minnesota			
Minnesota By-Product Coke Co.	1000 Hamline Ave., St. Paul.	St. Paul.	65 Koppers
Minnesota Steel Co.	Morgan Park Station, Duluth.	Duluth.	90 Koppers
Zenith Furnace Co.	West Duluth.	West Duluth.	65 United-Otto
Missouri			
Laclede Gas Light Co.	1017 Olive St., St. Louis.	St. Louis.	56 Koppers 8 Piette building
New Jersey			
Camden Coke Co.	80 Park Place, Newark.	Camden.	150 United-Otto
Seaboard By-Product Coke Co.	Box 267, Jersey City.	Kearny.	165 Koppers
New York			
Donner-Union Coke Corp.	Box 193, Buffalo.	Buffalo.	150 Koppers
Empire Coke Co.	Geneva.	Geneva.	46 Semet-Solvay 94 United-Otto
			282 Rothberg
Lackawanna Steel Co.	Buffalo.	Lackawanna.	60 Semet-Solvay 40 Semet-Solvay 60 Semet-Solvay
Semet-Solvay Co. (Also in Ala., etc.)	Syracuse.	Solvay.	
(Wickwire Steel Co.)	(Buffalo)	Buffalo.	
Ohio			
American Steel & Wire Co.	Western Reserve Bldg., Cleveland.	Cleveland.	180 Koppers
Brier Hill Steel Co.	Youngstown.	Youngstown.	84 Koppers
Hamilton-Otto Coke Co.	Hamilton.	Kokotto.	100 United-Otto
McKinney Steel Co.	Perry-Payne Bldg., Cleveland.	River Furnaces.	204 Koppers
National Tube Co.	Frick Bldg., Pittsburgh, Pa.	Lorain.	208 Koppers
Penn Iron & Coal Co.	Leader-News Bldg., Cleveland.	Canal Dover.	24 Roberts
Republic Iron & Steel Co.	Republic Bldg., Youngstown.	Youngstown.	143 Koppers
Semet-Solvay Co. (Also in Ala., etc.)	Syracuse, N. Y.		
(Otis Steel Co.)	(Cleveland)	Cleveland.	100 Semet-Solvay
(Ironton Solvay Coke Co.)	(Ironton)	Ironton.	60 Semet-Solvay
(Portsmouth-Solvay Coke Co.)	(Portsmouth)	Portsmouth.	108 Semet-Solvay
Toledo Furnace Co.	Western Reserve Bldg., Cleveland.	Toledo.	94 Koppers
United Furnace Co.	Western Reserve Bldg., Cleveland.	Canton.	47 Koppers
The Youngstown Sheet & Tube Co.	Stambaugh Bldg., Youngstown.	Youngstown.	306 Koppers
Pennsylvania			
Allegheny By-Product Coke Co.	McKeesport.	Glassport.	120 United-Otto
Bethlehem Steel Co. (Also in Md.)	Bethlehem.	Bethlehem.	424 Koppers
		Lebanon.	90 Semet-Solvay
		Steelton.	120 Semet-Solvay 60 Koppers
			210 United-Otto
Cambria Steel Co.	Widener Bldg., Philadelphia.	Franklin.	92 Koppers 190 Cambria-Belgian 60 Camb.-Belg. bldg 60 Cambria-Belgian 88 Semet-Solvay bldg.
		Rosedale.	
Carnegie Steel Co.	Carnegie Bldg., Pittsburgh.	Clairton.	768 Koppers
Jones & Laughlin Steel Co.	Pittsburgh.	Farrell.	212 United-Otto
Philadelphia Suburban Gas & Electric Co.	Chester.	Pittsburgh.	300 Koppers
Pittsburgh Crucible Steel Co.	Pittsburgh.	Chester.	40 Semet-Solvay
Rainey-Wood Coke Co.	52 Vanderbilt Ave., N. Y. City.	Midland.	100 Koppers
Semet-Solvay Co. (Also in Ala., etc.)	Syracuse, N. Y.	Swedeland.	110 Koppers
(American Manganese Mfg. Co.)	(Philadelphia)	Dunbar.	110 Semet-Solvay
Rhode Island			
Providence Gas Co.	Turks Head Bldg., Providence.	Sassafras Point.	40 Koppers
Tennessee			
Chattanooga Coke & Gas Co.	James Bldg., Chattanooga.	Alton Park.	24 Semet-Solvay
Washington			
Seattle Lighting Co.	Stuart Bldg., Seattle.	Seattle.	20 Klonne
West Virginia			
Domestic Coke Corp.	Drawer 436, Cleveland, O.	Fairmont.	60 Koppers
La Belle Iron Works.	Steubenville, O.	Follansbee.	94 Koppers
Semet-Solvay Co. (Also in Ala., etc.)	Syracuse, N. Y.		
(National Tube Co.)	(Pittsburgh, Pa.)	Benwood.	120 Semet-Solvay
Wisconsin			
Milwaukee Coke & Gas Co.	Milwaukee.	Milwaukee.	120 Semet-Solvay
Steel & Tube Co. of America	First Nat'l Bank Bldg., Milwaukee.	Mayville.	108 United-Otto

The Slip Interference Theory of the Hardening of Metals

A Mechanical Conception of Hardening of Pure Metals, Allotropic and Non-Allotropic, of Solid Solutions of Constant or Variable Solubility, and of Metallic Aggregates—In General, Hardness Is Due to Interference With Slip, a Characteristic Property of Ductile Crystals

By ZAY JEFFRIES AND R. S. ARCHER

IN GENERAL, pure metals in their normal condition are relatively soft and weak. They can be usefully hardened and strengthened by mechanical work and by alloying, and their alloys can often be further hardened by heat-treatment. The methods of hardening the different metals vary so much in detail, and the phenomena which accompany hardening are so unique, that there has arisen a variety of special theories to account for the mechanism of hardening. It is our purpose to present a more general theory applicable to all cases.

DEFINITION OF HARDNESS AND ABSOLUTE COHESION

The general terms "hardness" and "strength" connote a number of more specific physical properties. The most definite of these is the proportional limit or, what is practically the same thing, the elastic limit. The common measure of the strength of a material is its "tensile strength," or the maximum intensity of tensile stress endured before rupture, calculated on the original cross-sectional area of the test-piece. This is obviously a more complex property than the elastic limit. Hardness may mean resistance to indentation, as measured by the Brinell test; resilience, as measured by the Shore scleroscope; scratch hardness, cutting hardness, resistance to machining, or some other special kind of hardness. All of these properties may be embraced in the general definition: *Hardness is resistance to permanent deformation.*

Metals owe their hardness and strength to the attractive forces between their atoms. Any permanent deformation of a metal involves changes in the relative positions of some of the atoms, and therefore the breaking, temporarily at least, of some interatomic "bonds." The rupture of any material, whether with or without permanent deformation, also involves the breaking of interatomic bonds. The greatest possible resistance that a material can offer to deformation or rupture is the summation of all the interatomic bonds on a plane through the specimen normal to the stress, a summation which may for convenience be termed the "absolute cohesion" of the material. Actually such a summation of forces never is realized, and its total is more than sufficient to account for the strength of the strongest alloys. Rupture always takes place by degrees, and the breaking of atomic bonds is not simultaneous. The tensile strength of a material therefore represents the maximum number of atomic bonds that come into play simultaneously during the test, and since the elastic limit usually comes at a lower stress, it represents a still smaller percentage of the absolute cohesion.

Absolute cohesions of metals are far in excess of the values obtained for tensile strength. A qualitative illustration of this fact may be found in a consideration of some properties of pure iron. The tensile strength, in the hot-rolled condition, is about 40,000 lb. per sq.in., a value representing as usual the maximum load divided by original cross-section. If the actual reduced area of the test-piece

is measured throughout the progress of the test and the stress computed on this basis, a value will be found for the maximum stress which is much higher than the tensile strength. The maximum stress will then be about 80,000 lb. per sq.in. Severely cold-worked iron may show a tensile strength of 150,000 lb. per sq.in. The maximum actual stress is again somewhat higher (165,000), but not in so large a ratio as in the case of the hot-rolled iron.

Even in the cold-worked iron, rupture still takes place by degrees—that is, by a kind of tearing action—so that the highest of these figures still does not represent the inherent absolute cohesion. The significant thing is that the inherent cohesion of the pure metals is more than sufficient to account for the strength of their strongest alloys. The strengthening of a metal by cold-work can only be due to some mechanism by which the interatomic bonds are brought more effectively into play, so that more of them have to be broken simultaneously. When a metal is strengthened by alloying, the interatomic forces due to the presence of unlike atoms may enter as an additional factor, but the main factor in the hardening and strengthening consists in taking better advantage of the great inherent cohesion of the principal metal.

Metals are crystalline and are built up of atoms arranged in definite and repeating patterns. The regularity of atomic arrangement gives rise to certain planes of weakness, or low resistance to shearing stress. When an external load produces a shearing stress on such a plane which exceeds the resistance of the crystal to shear on that particular plane, fracture of the crystal takes place. The fragments formed may or may not adhere to each other. If they do not, the failure of the crystal is complete, and it is said to be brittle. The plane of weakness is then known as a cleavage plane. More generally, in the useful metals, the crystal fragments adhere and merely glide or "slip" over each other. The result of such slip, repeated on many planes, is a measurable permanent deformation; the crystal is ductile, and the planes of weakness are called "slip planes."

The first appreciable formation of slip planes marks the beginning of plastic deformation and therefore the passing of the elastic limit. The resistance to permanent deformation, which is a general measure of hardness and strength, represents resistance to the beginning and propagation of slip. Anything that serves to hinder slip is a source of strength and hardness. *The hardening and strengthening of metals by any of the known methods may be considered as due principally to interference with slip.*

FRACTURE IN A SINGLE DUCTILE CRYSTAL

Fig. 1-A represents a test-bar of square cross-section, which is supposed to consist entirely of a single grain of a ductile metal. It is further supposed that this grain has such an orientation that planes of easy slip are perpendicular to the plane of the paper and make angles of about 45 deg. with the axis of the test-piece. Now if the piece is subjected to tension, shearing stresses are developed which reach a maximum value at 45 deg. to the tensile load and hence parallel to the planes of easy slip. As these stresses increase, failure of the crystal will take place in the form of slip, or block movement, along one of these

planes, *ab*, the location of which will generally be determined by some local weakness. (Fig. 1-B.)

Ductile metals possess the property of automatically limiting the extent of the movement on any particular slip plane. Instead of slip continuing on the first plane until complete rupture of the piece occurs, the movement comes to a stop after a displacement which is very small as compared with the dimensions of the test-piece. The actual displacement may be something on the order of one twenty-thousandth of an inch, or about 5,000 atom diameters. The resistance to movement along the first slip plane increases so that slip is forced to take place on new planes.

The amorphous metal theory of Beilby offers what appears to the present authors to be the only completely satisfactory explanation of this phenomenon. The rubbing together of the crystal fragments on the plane of slip is supposed to tear some of the surface atoms loose from their regular crystalline arrangement, thus forming a layer of amorphous metal. The friction generates heat rapidly so that a high

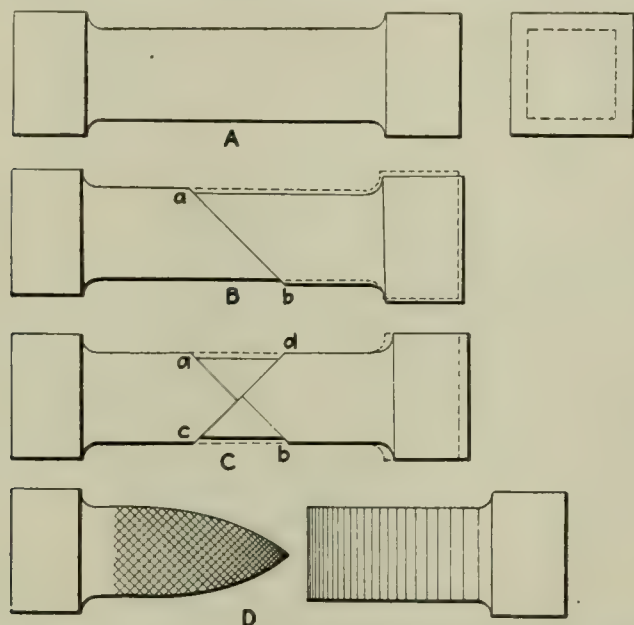


FIG. 1. A TO D. PLASTIC DEFORMATION OF TEST-BAR COMPOSED OF A SINGLE DUCTILE CRYSTAL

temperature is reached locally. This high local temperature softens the amorphous metal, which is essentially merely an undercooled liquid. With the softening of the amorphous metal layer the resistance to slip diminishes and there is less frictional heat developed. The high local temperature is then quickly dissipated by conduction to the surrounding metal, whereupon the amorphous metal hardens and offers a resistance to further slip which is greater than that on planes on which slip has not yet occurred.

To return to our single crystal test-bar, let us suppose that the second slip is on a conjugate plane *cd*, making an angle of about 90 deg. with the planes of the first set. (Fig. 1-C.) It is readily seen how repeated slips of this character result in a general increase in the length of the test-bar, and a decrease in its diameter.

Fig. 1-D represents the test-bar after rupture. The view on the left shows the same surface of the bar as in the three views above, and illustrates the multiplication of intersecting slip planes, especially near the fracture. The view on the right shows a face of the test-bar at 90 deg. to that on the left. It will be noted that there has been no reduction in diameter on this face at the fracture. The test-piece has drawn out into the shape of a wedge. This result has actually been obtained by Sykes¹ on single-crystal wires of molybdenum, and similar results have been obtained by the authors with aluminum.

RELATION BETWEEN GRAIN SIZE AND STRENGTH

In the single-crystal test-piece with its planes of easy slip parallel to the maximum shearing stress we have the worst possible condition for resisting an applied load. The resistance to the beginning of slip is limited to the shearing strength of the crystal, since the exterior surfaces of the crystal are free and are not supported in any way. After slip has occurred on a number of planes additional resistance to slip is created, as will be explained later, and the maximum load sustained

may be well above the load required to produce the first slip.

Ordinary pieces of metal are aggregates of many crystalline grains of different orientations. Between the grains there must exist metal of disordered atomic arrangement. Whether or not this boundary metal possesses the perfectly random arrangement of atoms demanded for the "vitreous amorphous" cement of Beilby, it appears to possess the fluid characteristics of amorphous substances. At low temperatures it furthermore possesses great hardness and strength, doubtless because of the absence of potential slip planes.

In an aggregate of many grains of different orientation, there cannot be any continuous plane of weakness. The application of a load cannot produce any slip planes extending entirely across the section, as in the case of the single grain just considered. When slip takes place in any one grain it cannot continue without change of direction into adjacent grains because, except in very rare instances, the potential slip planes of adjacent grains do not register. The permanent deformation of the metal is thus resisted at the grain boundaries by the disregistry of the planes of low cohesion, and especially in fine-grained metals, by the specific hardness of the amorphous cement, which itself is due to the absence of planes of weakness. The result is an increase in elastic limit, hardness, and strength.

Sykes' tests on molybdenum wire are of particular interest in this connection, since we have single-grain wire as a starting point. The following figures are a striking illustration of the strengthening effect of grain refinement:

Grain Size	Tensile Strength Lb. per Sq.In.
Single grain ²	32,000
Average grain diameter of 0.0011 in.....	51,000
Average grain diameter of 0.0002 in.....	96,000

All these wires had a diameter of 0.025 in., and were tested at 300 deg. C., far below the lowest annealing temperature of molybdenum, which is about 900 deg. C. At this temperature (300) the results are properly comparable, since all specimens possessed considerable ductility.

The effect of grain size on the hardness of alpha brass has been carefully worked out by Bassett and Davis³. Fig. 2 shows their results obtained on a 68-32 brass. The specimens having a Brinell hardness of 80 or less are stated to be completely recrystallized. A change in hardness from 42 to 80 is therefore attributable entirely to grain refinement. From these results and his own observations, Prof. C. H. Mathewson of Yale has deduced an equation connecting hardness and grain size, as follows:

$$\text{Brinell Hardness} = \frac{K}{\sqrt[4]{D}}$$

where *D* is the diameter of average grain in millimeters, and the constant *K* has a value of about 30.

It is evident that twinning planes as well as grain boundaries represent discontinuity of the planes of weakness and hence interference with slip. The change in orientation at a twinning plane, however, is much less complete than at a grain boundary, and the strengthening effect is therefore less. While it is not possible for slip to take place through twin crystals on a continuous plane, it is possible and probably usual for slip to follow a continuous surface, which has the form of a "broken plane." The intersection of such a surface with the plane of a polished specimen is a broken line. Slip bands through twins are accordingly continuous but change direction at each twinning plane. (See Figs. 9 and 10, page 1063.)

¹The molybdenum wire tested by Sykes was made up of large grains which occupied the entire cross-section of the wire, but did not extend the full length of the pieces tested. Since each test-piece contained several grains of varying orientation, failure would be most apt to occur in that grain which happened to have planes of easy slip most nearly in the direction of maximum shear stress. Furthermore, it is probable that out of the number of grains involved some one grain was oriented very nearly in this direction of greatest weakness. The results therefore represent the lowest strength of molybdenum of the size tested. If the elastic limit had been determined we would have a value very close to the resistance to shear on the planes of easiest slip.

³"A Comparison of Grain Size Measurements and Brinell Hardness of Cartridge Brass," W. H. Bassett and C. H. Davis, *Trans.*

²"Effect of Temperature, Deformation, Grain Size and Rate of Loading on the Mechanical Properties of Metals," W. P. Sykes, A.I.M.E., February, 1921, meeting. A.I.M.E., vol. 60, p. 428.

The permanent deformation of a metal by cold-work involves the breaking of the grains into fragments along intersecting systems of slip planes, and movement of these fragments with respect to each other. In the first stages of deformation the crystalline fragments within any one grain undoubtedly retain considerable uniformity of orientation. As the deformation proceeds, there must be some rotational movement of the fragments, this being especially true near the old grain boundaries. In so far as new orientations are created, the effect is equivalent to grain refinement. It is probable that even after severe cold-working there is still general uniformity of orientation in the fragments of any particular grain. The slip interference at the surfaces between such fragments of somewhat similar orientation is therefore more on the order of the interference at twinning planes than of the interference at grain boundaries. Additional interference is offered by such amorphous metal layers as may be formed at the slip planes.

The degree of hardening and strengthening by cold-work may be very great, especially when it is possible to carry the working to extremes without causing spontaneous annealing. The following values illustrate the degree of strengthening for various metals. The term "normal" refers to a structure of equiaxed grains of average size:

Metal	Tensile Strength, Lb. per Sq.in.	
	Normal	Severely Cold-Worked
Aluminum	12,000	35,000
Copper	30,000	70,000
Iron	40,000	150,000
Nickel	60,000	250,000 (2 mil. wire)
Molybdenum	85,000	385,000 (2 mil. wire)
Tungsten	Brittle	550,000 (2 mil. wire)
Tungsten	Brittle	700,000 ($\frac{1}{2}$ mil. wire)

The great increase in strength by cold-working can be due to only one cause—the more effective utilization of the inherent cohesion of the metal. This is accomplished by minimizing the effect of the planes of weakness resulting from the normal crystalline structure.

HARDNESS OF SOLID SOLUTIONS

It is a general rule that metals are hardened and strengthened by the addition of elements which dissolve in them to form solid solutions. Our knowledge of the structure of solid solutions is quite limited, but from the results so far obtained it seems that the atoms of the solute replace those of the solvent without substantial change in the space lattice of the latter, up to the limit of the first or "alpha" solution in case of limited solubility, or the first of a series of solid solutions. This conclusion is based upon studies of alloy series in which the components have similar atomic volumes, and somewhat different conditions may obtain when this criterion is violated. There is good reason to believe, however, that in all cases solid solutions are characterized by the *atomic* dispersion of their components.

When an intermetallic compound forms and dissolves in one of the component metals, it is commonly considered to go into solution "as such." For example, austenite is generally held to be a solution in gamma iron of iron carbide rather than of elementary carbon. This implies that distinct molecules of iron carbide are dispersed in the gamma iron.

From the evidence available, and particularly from a consideration of the phenomena of diffusion, the authors have reached the conclusion that this is not the case, but that the carbon in austenite is present as individual atoms of carbon. These atoms are undoubtedly held strongly to the neighboring iron atoms, but the union

is not permanent. Diffusion must consist in a migration of carbon atoms and not of groups or "molecules" containing several iron atoms. Such groups could not, on account of their size, diffuse through solid iron.

According to this view cementite has no existence except as a crystalline substance, which is not merely precipitated but *formed* on the decomposition of austenite. An entirely similar conception is held of other

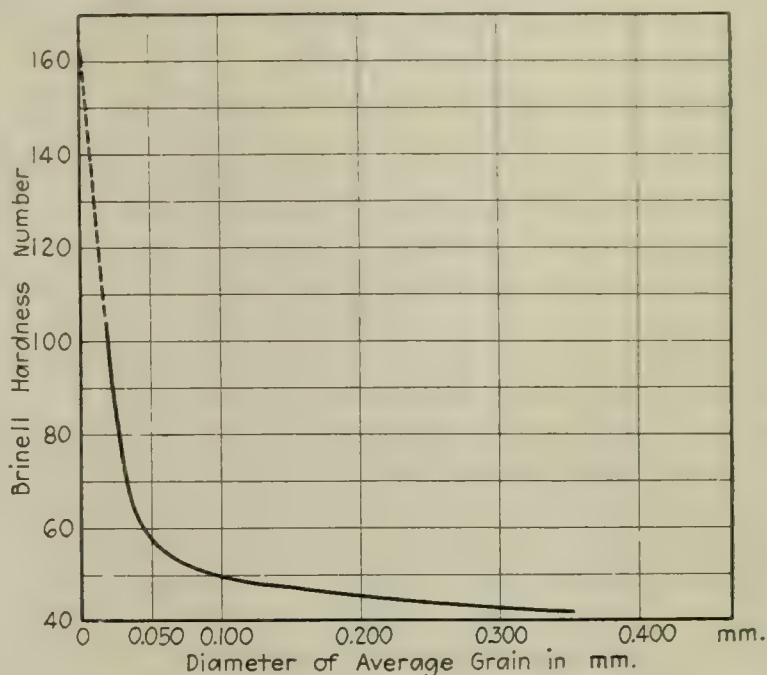


FIG. 2. GRAIN SIZE VERSUS HARDNESS IN ALPHA BRASS, ACCORDING TO BASSETT AND DAVIS

cases involving the solubility of an intermetallic compound, in particular of the case of aluminum and the compound CuAl_2 , discussed later in some detail.

For the present the essential point is that the dispersion of the components in a solid solution is certainly atomic in many cases and probably atomic in all cases. The increased hardness and strength are therefore traceable directly to increased interatomic forces, the attraction between unlike atoms being in general greater than between like atoms. We may conceive an additional mechanical factor in the form of a roughening of the slip planes due to the presence of atoms of unlike size, or, as Bridgman puts it, a staggered arrangement of the atoms.

Because of the atomic dispersion of the components and the interchangeability of the atoms, it is quite natural that solid solutions should, in general, possess ductility comparable with that of pure metals. They can be deformed plastically by the process of gliding on slip planes and are thereby hardened by the breaking up of their planes of weakness. The hardening and strengthening effects of grain refinement and cold-working apply to solid solutions as well as to pure metals, and are superimposed upon the hardening effect of the solute.

The structural constituents in alloys which possess the greatest specific hardness and strength are the intermetallic compounds and non-metallic compounds such as oxides. The structure of intermetallic compounds is less known than that of solid solutions, inasmuch as the atomic arrangement has not been worked out, to the authors' knowledge, for a single compound of this type. In general, these compounds are of a low order of symmetry, which, together with the large interatomic forces involved, accounts for their great hardness. The atoms are probably arranged in such a way that those of one element are not interchangeable with those of another element. This would account for their lack of plasticity.

One of the most important considerations in the loading

of any brittle material is eccentrically distributed stress. A ductile material subjected to eccentric loading quickly adjusts itself by permanent deformation at any points where the stress exceeds the elastic limit, with comparatively little damage. This is not possible in a brittle substance, and if the stress at any point in a piece subjected to load exceeds the elastic limit, rupture results. It is obviously easier to avoid local overstressing in small pieces than in large pieces. This accounts for the fact that many materials, which are commonly thought of as very fragile, show remarkably high strength when tested in small sections. Vitreous silica, for example, is quite easily broken when in fairly large pieces, although it shows a tensile strength as high as 160,000 lb. per sq.in. in the form of fibers.

This point is important in the present discussion in connection with intermetallic compounds. These substances are as a rule hard and brittle, and are too commonly considered to be weak. Their true strength when properly protected against eccentric loading by their small size and by imbedding in a ductile matrix is undoubtedly very high. We may safely assume that cementite, for example, has a strength of several hundred thousand pounds per square inch.

It has long been recognized that the presence of a hard and strong constituent in an alloy may strengthen it by opposing the "flow," or slip, of the weaker constituent. Just as slip is opposed at the grain boundaries of a pure metal by the change in orientation, it may be opposed to a still greater extent if the material at the grain boundary possesses in addition to its different orientation a specifically greater hardness. The most familiar example of this is the reinforcing effect of the pearlite constituent in hypoeutectoid steels.⁴ While pearlite is not a single constituent, it may well be imagined to have an effect like that exerted by hypothetical similar grains of a strong solid solution. The structurally free ferrite is the continuous phase, in which the pearlite is scattered as disconnected islands. If the free ferrite were a structureless amorphous substance, the pearlite could produce only a mild strengthening effect, by a sort of frictional resistance to flow, but the ferrite is crystalline and yields only by slipping on its crystallographic planes of weakness, and such slip is opposed by the rigidity of the pearlite.

This mechanism of hardening, which has been described as the "obstruction principle," refers particularly to reinforcement of a continuous ductile matrix by grains of a stronger constituent which are similar in size to the grains of the matrix. The grains of the matrix are strengthened by *external* support. It has recently become evident that metals can be hardened to a still greater degree by a hard substance dispersed as fine particles *within* the grains.

AGING OF DURALUMIN

A very important incident in the development of the theory of hardening by hard substances highly dispersed is the study of the light aluminum alloys of the "duralumin" type, by Merica, Waltenberg and Scott.⁵ The following is typical of the composition of these alloys: Copper, 4.0 per cent; magnesium, 0.5; manganese, 0.5; aluminum (commercially pure), remainder.

These alloys in the rolled or forged condition can be very materially hardened by a heat-treatment consisting of quenching from about 500 deg. C., followed by aging for several days at ordinary temperatures. The hardness and strength immediately after quenching are

about the same as in the "annealed" condition, but on aging increase spontaneously about 40 per cent.

Merica, Waltenberg and Scott base their explanation of this hardening on the variation of the solubility of the compound CuAl_2 in aluminum with temperature. In Fig. 3 is reproduced a portion of the equilibrium diagram of the aluminum-copper system, showing the solubility curve of CuAl_2 in aluminum. It will be noted that the solubility of the compound decreases from about 4 per cent (copper) at 500 deg. C. to probably less than 1 per cent at room temperature. A piece of duralumin examined microscopically immediately after quenching shows a "solid solution" structure—that is, a structure free from visible particles of CuAl_2 . After the alloy has aged so that the hardness and strength have greatly increased, the structure is apparently unchanged. There is reason to believe, however, that there has occurred

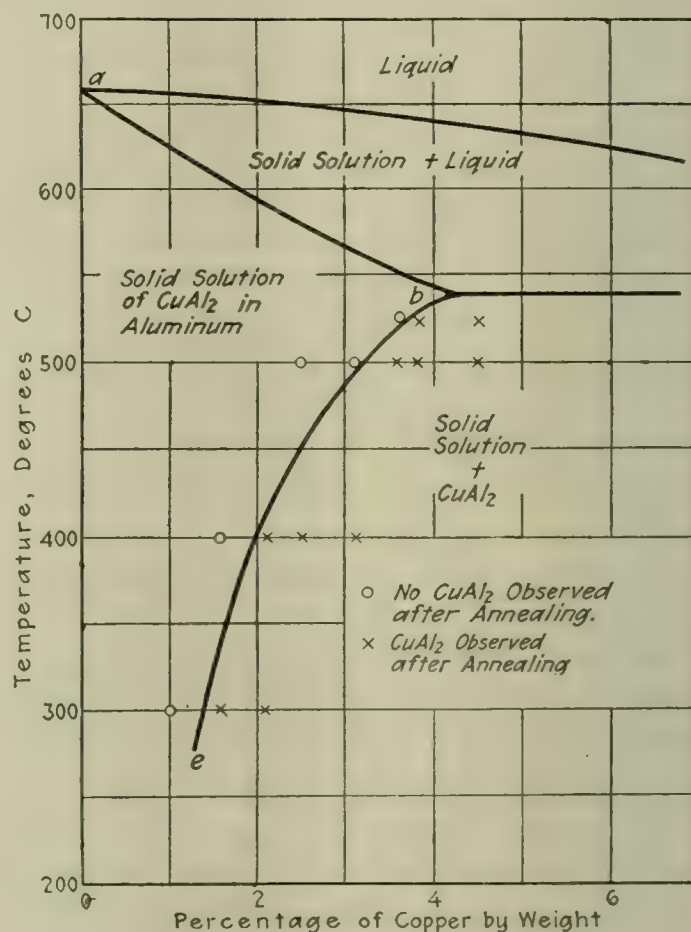


FIG. 3. PORTION OF THE EQUILIBRIUM DIAGRAM OF THE Cu: Al SERIES SHOWING THE SOLUBILITY CURVE OF CuAl_2 IN ALUMINUM, ACCORDING TO MERICA, WALTENBERG AND SCOTT

during aging a precipitation of CuAl_2 in the form of particles of submicroscopic size, to correspond to the diminished solubility of the compound at the lower temperatures. Quoting from the paper referred to:

"Upon heating a specimen of duralumin that has been quenched from 500 deg. C., but not aged, an evolution of heat occurs at from 250 to 275 deg. C. . . .

"No thermal change takes place upon cooling the same specimen, provided it has not been heated beyond 520 deg. C. Upon reheating the same slowly cooled specimen, no evolution of heat is found corresponding to that upon the first heating. Without doubt, therefore, a chemical reaction takes place at 250 to 275 deg. C. upon heating the quenched sample with evolution of heat—i.e., indicating the formation of stable from unstable phases, not a transformation of stable to other stable phases, the two systems being in equilibrium during the transformation. Such a transformation must take place with heat absorption upon raising the temperature.

"A specimen that has been quenched and aged at from 100 deg. to 150 deg. C. to secure maximum hardness shows little or no evolution of heat upon heating. Whatever may be the chemical reaction that is indicated on the first heating curve of a quenched specimen, it has taken place during

⁴See discussion of the "obstruction theory" in "Metallography of Steel and Cast Iron," H. M. Howe.

⁵"Heat-Treatment of Duralumin," P. D. Merica, R. G. Wattenberg and H. Scott, *Bulletin A.I.M.E.*, June 1919, p. 913. *CHEM. & MET. ENG.*, vol. 21, p. 551 et seq.

the aging of the specimen, during which the hardening also occurs; stable phases have formed and the subsequent heating curve shows no arrest corresponding to that of the quenched specimen.

"This chemical reaction can hardly be other than the precipitation of CuAl_2 from its supersaturated solution in aluminum, although direct visual evidence bearing on this question is also lacking. . . .

"Although it cannot be directly proved that the thermal arrest at about 250 deg. C. noticed upon heating a quenched unaged specimen of duralumin is due to the precipitation of CuAl_2 , no evidence directly contradicts this assumption, which is in entire accord with our knowledge of the equilibrium within the alloy, and this arrest cannot be assigned to any other phase change.

"It has been shown by many previous investigations and confirmed by the authors that aluminum undergoes no transformation in the solid state between ordinary temperatures and its melting point. No other phase changes could occur in the main mass of duralumin, the grains of solid solution, therefore, except those of solution or precipitation of FeAl_3 , of the X compound, of CuAl_2 , of Mg_2Al_3 , or of Mg_2Si , within the grains. Aluminum, which contains the same amounts of FeAl_3 and of the X compound as does duralumin, is not altered by heat-treatment as is duralumin, nor does it show a reverse heat effect upon heating as does the latter. This heat effect must, therefore, be due to the precipitation either of CuAl_2 , Mg_2Al_3 or Mg_2Si . But the alloys containing only magnesium in amounts up to 3 per cent also do not harden upon aging. There remains only the precipitation of CuAl_2 with which to explain this heat effect.

"The theory outlined above of the mechanism of the hardening of duralumin during aging most readily explains the interesting fact discovered by Mr. Blough and confirmed by the authors that the amount of hardening during aging increases as the temperature of quenching increases. At higher quenching temperatures more and more CuAl_2 is dissolved in solid solution. After quenching, the CuAl_2 is in excess of its solubility; the higher the quenching temperature the greater is the excess, and this is precipitated during aging. The hardening is in proportion to the amount of the highly dispersed CuAl_2 formed.

"If this theory is accepted for the moment, it is interesting to consider the effect of degree of dispersion upon hardness in the case of a solid solution, in this case of CuAl_2 in aluminum. Duralumin immediately after quenching is generally softer than it is in the annealed condition. Thus alloy C-11, in the form of sheet, gave the following values of hardness:

	Annealed at 300°	Quenched, but not aged	Quenched, and aged 8 days
Scleroscope hardness, magnifying hammer..	17	16	35

"This is probably due to the fact that a specimen, as ordinarily cooled after annealing, still contains some dissolved CuAl_2 in excess of its solubility; the material hardens slightly during cooling. Specimens cooled extremely slowly give a scleroscope hardness of from 7 to 10, much lower than that of the quenched, unaged ones.

"Upon aging a quenched specimen at 200 deg. C., for example, the hardness first increases to a maximum and afterward decreases. During that aging there has been first a formation of fine nuclei of CuAl_2 followed by coalescence of these particles into ones of larger size. There is, therefore, a certain average size of particle of CuAl_2 for which the hardness of the material is a maximum; atomic dispersion of the solute, CuAl_2 , is not the dispersion that produces the maximum hardness, but some intermediate one between it and that at which the particles become visible by ordinary means."

An important point in this theory of the hardening of duralumin is the conclusion that there is a certain average size of particle which produces maximum hardness, any size either larger or smaller causing less hardness. This is opposed to the generally held idea that a given amount of a substance added to a metal produces the greatest possible hardening effect when it is in *solution*—that is, when it is in the highest possible state of dispersion. The degree of dispersion conducive to maximum hardness may conveniently be designated by the term "critical dispersion." Dispersions finer than this may be called "sub-critical," and those coarser "super-critical."

It is also important to note the magnitude of the hardening effect in duralumin. It is possible to increase the hardness of pure aluminum approximately tenfold by producing within grains of an aluminum-copper solid solution a critical dispersion of hard particles. This hardening cannot be referred to any of the mystic causes sometimes assigned in the case of steel. The only conceivable explanation is that it is due to the presence of a vast number of very small, hard particles dispersed throughout the grains of aluminum (which probably retain a little copper in true solid solution).

These conclusions regarding the hardening of duralumin naturally suggest seeking analogies in other alloy systems. Merica and his co-authors called attention to the case of steel, pointing out a similarity to duralumin in that the decomposition of a solid solution into particles of sub-microscopic size (ferrite and cementite) is involved and also in that some steels (very high-carbon steels and high-speed steels) shown on tempering an *increase* in hardness, followed by the usual decrease. The theory advanced for the hardening of duralumin did not include any explanation of the mechanism by which the particles of CuAl_2 cause hardness. Some conception of this mechanism is necessary to any extension of the theory.

The present authors have attempted to analyze the mechanism of this hardening effect, so that the necessary conditions could be defined for all cases. Such analysis involves the explanation, first, of how one constituent dispersed within another produces such great hardness, and second, of why there is a critical dispersion or size of particle which produces maximum hardness.

EASY SLIP IN MAGNETIZED PLATES

In duralumin we are dealing with an aggregate composed of a ductile, relatively weak matrix—aluminum—greatly strengthened by the presence of small hard *disconnected* particles of CuAl_2 . The strength attained in the duralumin must be derived from the inherent cohesion of the continuous aluminum matrix. There is no conceivable way in which a few per cent by volume of a strong constituent in disconnected particles could impart a new element of cohesion of the magnitude actually obtained. Their action must consist in rendering more effective the cohesion latent in the aluminum. The logical inference is that this is accomplished by the elimination of extended planes of weakness—that is, by slip interference.

In Fig. 4 is represented a section through a crystal, the fine parallel lines representing a set of planes of easy slip. It may assist in obtaining a concrete conception of the mechanical conditions to consider a stack of iron plates placed in a strong magnetic field at right angles to their surfaces. It would be very difficult to pull these plates apart by a straight tensile effort, but comparatively easy to separate them by sliding them over each other. This stack of plates presents a rather close analogy to the conditions obtaining in a ductile crystal, especially in that the forces which hold the atoms of a crystal together are probably electro-magnetic in character.

In separating the magnetized plates by a straight pull it is necessary to overcome the entire magnetic attraction at once, whereas in sliding the plates the magnetic force is overcome only at the edges and then gradually by small increments. The principal resistance due to sliding is the frictional resistance of the plates due to the pressure. In order completely to separate the portions of a crystal on opposite sides of a plane of slip by a direct tensile pull it would be necessary to break simultaneously all the atomic

bonds on the plane. This would require a force equal to the absolute cohesion of the metal. The two portions can move with respect to each other on the slip plane without permanent rupture of any considerable proportion of the atomic bonds. Of course, extended slip separates the atoms from their old neighbors, but cohesion bonds are established with their new neighbors. The separation of the magnetized plates by a direct pull results in a "brittle" fracture with a minimum work of rupture. When the plates are separated by sliding, the work of rupture is increased by an amount equal to the frictional losses. Similarly when a crystal is fractured in a brittle manner the work of rupture is a minimum, whereas in a ductile fracture the work of rupture is markedly increased due to the friction at planes of slip.

SMALL HARD PARTICLES ACT AS KEYS

Fig. 5 shows an ideal section through a crystal in which it is supposed that a hard, strong substance is dispersed in the form of substantially spherical particles. These particles are supposed to be about equal in size, but of course the circles cut by the plane of the section should be of different sizes according to the distance of this plane from the centers of the spheres. It will be noted that there is not a single plane of easy slip which does not encounter at least one of these hard particles. Under the action of an external load tending to produce slip along these planes, the hard particles must act as *keys*, mechanically obstructing any motion along the planes as a whole. The result is increased elastic limit, hardness and strength.

Now suppose all the hard particles to be gathered into a single large particle, as shown in Fig. 6. Although the size and strength of the "key" are greatly increased, there are many planes of weakness left without any reinforcement. The single large particle does not interfere with slip on these planes. It is easily seen that the strengthening effect of the hard particles increases with their *number* and not with their size. Even in case all possible planes of slip are keyed at some points, more effective slip interference must result from diminishing the size and increasing the number of the particles. We thus have the rule that the hardening effect of a given amount of hard dispersed substance is greater the smaller the particles. This rule must reach a limit as the particles approach atomic dimensions. We do not know how small a crystal may be and still possess the characteristic hardness and strength of the substance.

Let us consider the strength of true solid solutions or atomic dispersions from the point of view of the slip interference theory. Planes of weakness are present just as in the pure metal or solvent. At intervals the succession of atoms of solvent is interrupted by an atom of the solute. At each point where an atom of the solute occurs there is an increased bond, or, we might say, pressure, on the plane of

potential slip, due to the greater force of attraction between the unlike atoms. This constitutes in effect a key, very much as to do the crystalline particles of CuAl_2 in aluminum. The planes are seemingly "spot welded" together by the atoms of the solute.

The experimental evidence indicates that the formation of crystalline nuclei of CuAl_2 in duralumin, from the solid solution of copper in aluminum, causes an increase in hardness and strength. If the key action of the atomically dispersed copper were equivalent to that of the crystalline particles of CuAl_2 , we should not expect this to be the case, since the hardness should increase as the *number* of keys increases. It is quite natural to suppose that the attractive forces of the copper and aluminum atoms for each other are not brought fully into play until the atoms are arranged in their most stable arrangement—that of the compound. The key formed by the little group of aluminum atoms surrounding the copper atoms in the solid solution is more easily sheared through than is a particle of crystalline CuAl_2 . The critical dispersion for maximum hardness should therefore consist of the smallest possible particles having the characteristic crystallinity of the compound. If we classify particles according to their diameters in terms of atoms, the following probably represents approximately the sizes involved:

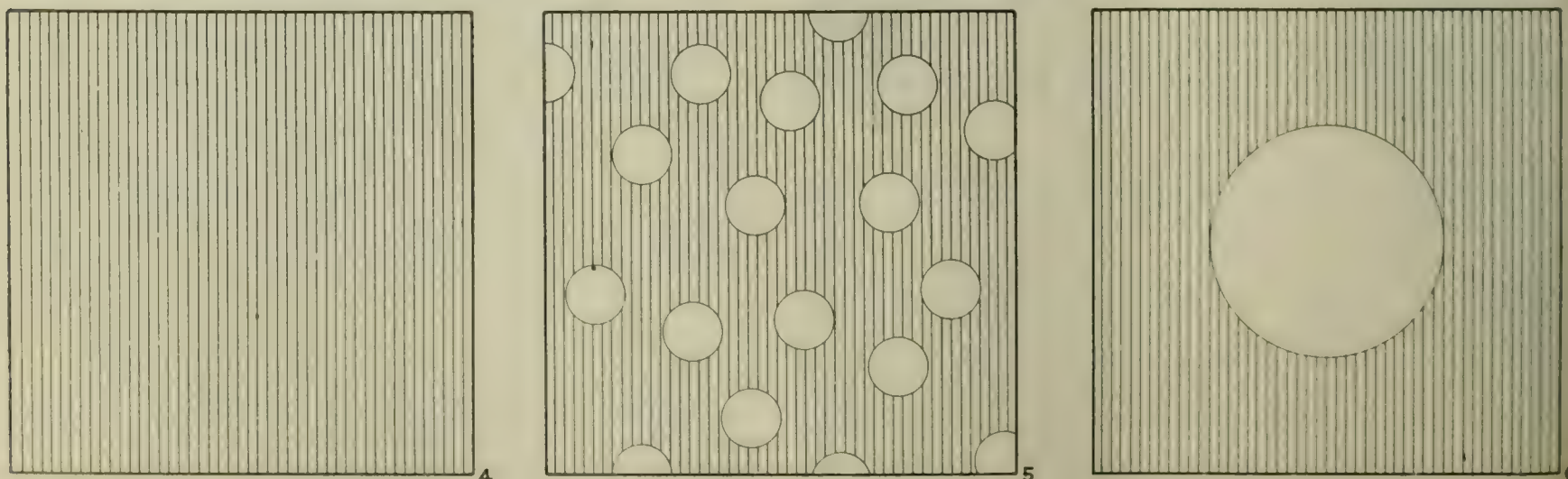
1 atom diameter	solid solution	somewhat hard
10 atom diameters	critical dispersion	hardest
1,000 atom diameters	smallest visible particles	somewhat soft

NUMBER OF KEYS IN A DURALUMIN CRYSTAL

Let us take for an example the hardness changes in a duralumin alloy containing 4.5 per cent Cu. This alloy would contain 2 atoms per cent of copper or 8.33 weight per cent of CuAl_2 assuming that all of the copper is present as that compound. This would be at most 5.4 per cent CuAl_2 by volume; actually it is less than that amount, inasmuch as some of the copper will always be in solution. When the worked alloy is heated to a temperature at which all of the copper is in solution and then quenched, the hardness will be about 80 Brinell. The copper is probably in atomic dispersion. On aging, the hardness can be increased to about 140 Brinell as the CuAl_2 precipitates and the particles reach critical size. By very slow cooling from high temperatures the hardness can then be reduced to about 50 Brinell. Such a hardness is produced only after the CuAl_2 particles have reached relatively large sizes.

Tensile strength varies with the hardness. The plasticity is the greatest in the freshly quenched condition and the least when the CuAl_2 particles are present in critical size. The high plasticity accompanying atomic dispersion of copper would be expected, because the areas of potential slip planes will depend on grain size only. The interference to slip is greater than in pure aluminum; it resides in the nature of greater pressure between the two slip surfaces, but the planes are relatively smooth.

An average sized grain of duralumin would have about 2,000,000,000 atoms of copper on each potential slip plane. Although we do not know exactly the percentage of the



FIGS. 4 TO 6

Fig. 4. Set of planes of easy slip in a crystal having no internal slip interference. Fig. 5. Slip planes "keyed" by hard particles. Fig. 6. Hard constituent gathered into a single large particle, leaving many planes, without reinforcement.

copper precipitating as CuAl_2 during aging, we can for convenience consider it as 75 per cent of that present. Assuming now that the CuAl_2 particles have reached an average size of one ten-millionth inch diameter there will still be 500,000,000 copper atoms on each of the above planes and in addition each plane will be keyed with the relatively hard CuAl_2 particles at 35,000,000 to 40,000,000 places. This condition corresponds nearly to critical dispersion. By the time the CuAl_2 particles have reached an average diameter of a hundred-thousandth of an inch, each of the above planes will be keyed in about 3,500 to 4,000 places; if the diameter were further increased one hundred times only about three planes cut of eight would be keyed at all!

The presence of a given amount of hard substance in large particles produces excess slip interference locally, but leaves portions of the metal in a weak condition. Cohesion of the mass as a whole is therefore gained by subdivision of the key material into many particles distributed as uniformly as possible. The weak links of the chain of slip planes are thus strengthened at the expense of the strong ones. Plastic deformation in such a material produces an intricate system of slip planes determined by the number and size of the particles. In many places the slip cannot follow the easy crystallographic planes, but is forced to take place in unfavorable directions. The quantity of dispersed substance may be so great that the resistance to slip becomes equal to or greater than the direct rupturing strength of the atomic bonds, and brittleness accompanied by relatively great hardness will result.

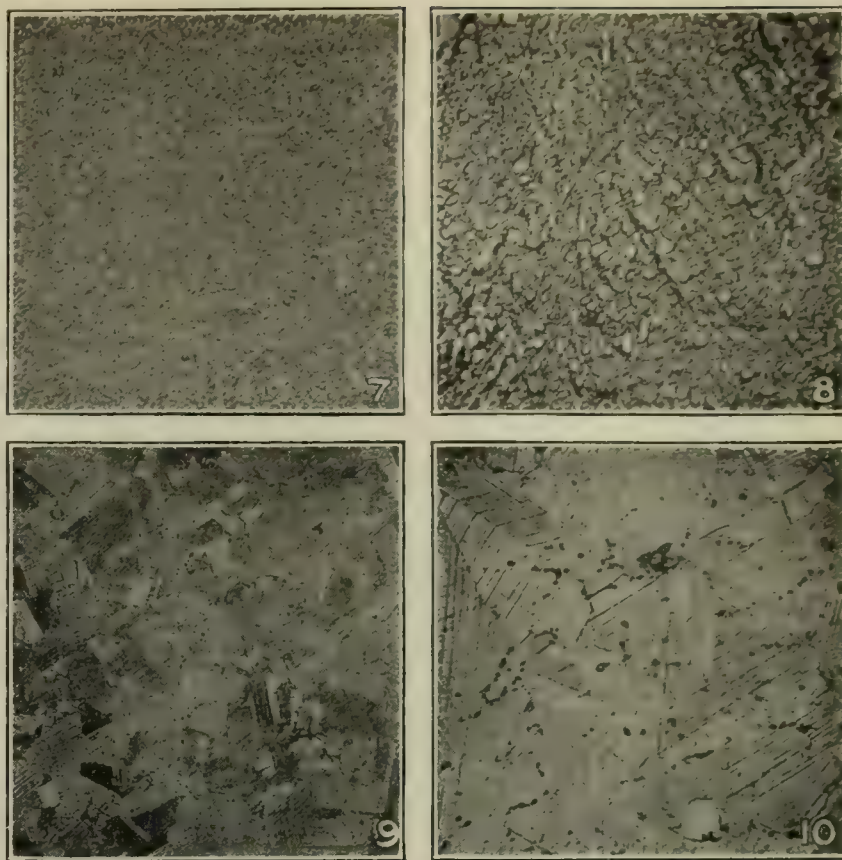
Fig. 7 is a micrograph of a high-carbon steel in which the cementite has been coarsely spheroidized. One can readily see what an intricate system of slip planes or flow surfaces must be produced in this structure by plastic deformation. Fig. 8 shows this structure at higher magnification (650 diameters) after plastic deformation. It will be noted that the slip avoids the cementite and that the surfaces of slip are rough. The appearance is intricate as opposed to the systems of regular slip planes in nearly pure metals shown below in Figs. 9 and 10. As compared to critical size, the particles of cementite shown in Figs. 7 and 8 are very coarse. Each of the larger particles of cementite shown in these micrographs would have to be subdivided into about 1,000,000,000 particles to reach critical dispersion. The intricacy of the system of slip planes would correspondingly increase.

ADHESION BETWEEN CONSTITUENTS

While the CuAl_2 and Fe_3C particles probably have rather strong adhesion for the aluminum and iron respectively, such adhesion need not obtain in order to produce hardening. Copper oxide often present in copper should have very little adhesion for the metal, but when it is present in the form of globules within the copper grains it produces a strengthening effect. Antisell⁶ states that 0.2 per cent (1.8 per cent Cu_2O) oxygen increases the tensile strength of annealed copper over 10 per cent. Figs. 9 and 10 show a small quantity of Cu_2O . The particle size is large as compared to critical dispersion. In fact there is no way known to produce a very fine dispersion of the Cu_2O , and hence we cannot greatly harden copper by its presence in relatively small quantities. It will be noted that the slip planes in Fig. 10 have a tendency to extend completely across the grains. Yet slip planes in general avoid the Cu_2O particles or are faulted or stopped by them.

This represents the first stages of slip interference.

Thorium dioxide probably has little adhesion for tungsten, but when 1.5 per cent by volume is present as particles within the grains the tensile strength is increased in the temperature regions within which the metal is ductile. The presence of the thoria also has



FIGS. 7 TO 10

Fig. 7. High-carbon steel. Cementite coarsely spheroidized. $\times 150$. Fig. 8. Showing plastic deformation in high-carbon steel with spheroidized carbide. $\times 650$. Fig. 9. Slip bands in copper. $\times 30$. Fig. 10. Slip bands in copper. $\times 150$.

the effect of increasing the tensile strength more for a given amount of working below the annealing temperature than in pure tungsten. The cases of Cu_2O in copper and ThO_2 in tungsten are important, because they give positive evidence of the strengthening effect of these mixtures in which a weakening might be expected due to decrease of the effective cross-sections of the metals.

In all of the cases mentioned above the hardness has been produced by dispersing *hard* particles within relatively large grains of metal. We should not expect *soft* particles to produce hardening, because the "keys" of soft substance would shear and thus assist rather than oppose slip. The term *soft* is used here in the relative sense only.

SIMILARITY OF MANGANESE STEEL AND DURALUMIN

The explanations of the hardening of duralumin and of hardening by grain refinement are so simple and logical that we should examine the phenomena of the hardening of steel from the same viewpoint. The fact that iron is capable of existing in at least two crystal-line forms makes it difficult to differentiate between cause and effect and to appraise the true significance of the "critical" changes. The case of duralumin might be equally difficult to understand if hardening by heat-treatment were accompanied by allotropic and visible structural changes. Hardening of duralumin does not involve an allotropic change, twinning, or even a refinement of grain.

Its study teaches us that a soft crystal of aluminum can be hardened by dissolving copper in it; that the aluminum-copper solid solution can be further hardened by the precipitation of some of the copper into minute particles of CuAl_2 ; that maximum hardness is produced when the precipitated compound is present in particles of a small (critical) size, certainly much less in diameter than 1,000 atoms; that when the particles become larger than the critical size the hardness decreases as the particle size increases. The percentage increase in the hardness of aluminum by proper alloying and heat-treatment is comparable to that obtained in iron by alloying with carbon and heat-treatment.

If manganese steel containing from 1.0 to 1.5 per cent C and 13 per cent Mn is quenched from a high temperature, the structure existing at the high tem-

⁶"Relationship of Physical and Chemical Properties of Copper," Frank L. Antisell, A.I.M.E., Bull. 157.

perature is preserved at room temperature. The result is an aggregate of grains of austenite, which is in this case gamma iron with the carbon and manganese dissolved in it. The hardness is about 160 Brinell, a very substantial increase over pure alpha iron (75). The austenitic structure is stable unless the manganese steel is cold-worked or heated. The hardness increases on tempering and may reach about 500 Brinell after suitable heat-treatment. As the steel hardens it becomes magnetic, but not in proportion to the increase in hardness—in fact most of the hardening occurs before the steel has reached 2 per cent specific magnetism⁷ and before there is much visible change in the structure of the austenite.⁸

If a piece of this steel be heated to 1,100 deg. C. and cooled slowly, a network of carbide, presumably a mixture or solution of cementite and manganese carbide, is formed. Austenite at temperatures around 400 to 600 deg. C. is supersaturated with carbon, since the carbides precipitate around 500 deg. C. into particles large enough to be seen with a microscope.

Since the dispersion of the carbon is atomic in the austenite, it does not offer maximum interference to slip. The austenitic manganese steel is therefore relatively soft and ductile: the carbon dispersion is subcritical. The formation and precipitation of carbides into particles of visible size show that every size between molecular and visible must have obtained at some previous stage. The critical size or dispersion must have been reached prior to the appearance of the visible particles. Carbide of iron is magnetic and hence slight magnetism might appear on annealing, accompanied by a considerable increase in hardness, without producing a transformation of any appreciable amount of austenite into alpha iron. This latter transformation proceeds slowly, however, and its effect is superimposed on that resulting from the carbide precipitation.

Transformation into alpha iron produces an entire change in structure and a decided increase in magnetism, but the hardness may increase or decrease. Extended exposure to temperatures around 650 deg. C. eventually produces softening.

It is thus seen that in the early stages of hardening manganese steel the changes are strikingly similar to those found in the hardening of duralumin.

GRAIN REFINEMENT IN QUENCHING STEEL

There is an important factor accompanying the changes from austenite to granular pearlite which is absent in duralumin—namely, change in grain size of the matrix. When pure iron is quenched from above 900 deg. C., the ferrite grain size is smaller than that produced by slow cooling. As the carbon content is increased the ferrite grain size produced by quenching from above the upper critical progressively decreases. When the carbon content exceeds about 0.2 per cent the structure may all be martensite, in which the iron exists in the crystalline magnetic (alpha) state, but in most cases no definite grains of ferrite can be detected under the microscope.

As pointed out previously, reduction of grain size is itself an important factor in hardening. The quantitative significance of sub-microscopic grain size has been no better understood or appreciated than that of reducing dispersed particle size to approach atomic dimensions. By extrapolation in Mathewson's⁹ formula it is found that the hardness of alpha brass could be increased to 300 Brinell (nearly twice the hardness of cold-worked alpha brass), if

a grain size of about $\frac{1}{250,000}$ in. diameter could be produced. Each grain would then comprise about 100,000,000 atoms. There is no way known to produce such fine grain size in alpha brass and consequently we cannot develop such hardness. The results given above on tungsten, molybdenum and nickel indicate, however, that this figure is probably not higher than the absolute cohesion of the alloy. According to the general proposition that the absolute cohesion of a pure metal is sufficient to account for the hardening produced in alloys of that metal, it should be possible to produce hardening by reduction of grain size alone to an extent comparable to that produced by the critical dispersion of hard particles in relatively large crystals.

The change of properties of the nickel-iron alloys by heat-treatment is of especial importance in connection with the effect of change of grain size alone. An iron-nickel alloy containing 7.54 per cent Ni, 0.09 per cent C and 0.04 per cent Mn had its strength more than doubled by quenching from a dull red heat.⁹ Edwards concludes from a general review of the work on iron-nickel alloys that the presence of carbon is not necessary in order for such hardening to take place on quenching. Nickel lowers the transformation temperature of iron to such an extent that the quenching of a 7.5 per cent nickel alloy produces great grain refinement. The quenched product might be termed a carbonless martensite. Thus we have in certain iron-nickel alloys without carbon marked hardening accompanied by a great reduction in grain size. This is a simple case where the hardening is due to one factor—namely, reduction of grain size—whereas in duralumin and probably in the first stages of the hardening of manganese steel this factor does not enter, the hardening being attributable to a fine dispersion of hard particles within ductile crystals. These two factors may occur simultaneously in ordinary steels, making possible the many variations in their properties by heat-treatment.

MARTENSITE IS ALPHA IRON

In austenite we assume that the carbon is quite uniformly distributed in atomic dispersion. When austenite is quenched to form martensite, the short time and low temperature of transformation favor the retention of a large amount of the carbon in atomic dispersion in the ferrite. The transformation of austenite at A_1 under equilibrium conditions involves a change of the gamma iron to alpha iron and the combination of the carbon with iron to form cementite (Fe_3C). The latter would not form unless the iron changed its crystal structure. Therefore the allotropic transformation of the iron is the cause and the formation of cementite is the result. The change in iron involves no substantial migration of atoms, while the formation of cementite does. The logical order for the transformation to take place in eutectoid and hypo-eutectoid steel is first the iron transformation and then the cementite formation. When austenite is slowly cooled through A_1 , the two changes occur so close one after another as to be called simultaneous. When the cooling rate is proper to form troostite, physico-chemical equilibrium but not structural equilibrium results—that is, the ferrite and cementite both form but in such small particles that heating to temperatures slightly under A_1 (500 to 700 deg. C.) causes marked structural change.

When the cooling rate of the austenite is sufficiently rapid to form martensite, the transformation of the gamma iron to alpha is substantially complete, whereas the formation of cementite is not complete.

⁷Iron equals 100 per cent.

⁸"Metals and the Common Alloys," S. L. Hoyt, pp. 347-349.

⁹"Physicochemical Properties of Steel," C. A. Edwards, p. 164.

Martensite should therefore consist principally of sub-microscopic ferrite grains containing carbon in solution. The carbon content of the mother austenite will strive to precipitate as particles of Fe_3C , and the extent of this reaction will depend on the temperature-time conditions during quenching, aging and tempering.

The following are the reasons for concluding that the formation of martensite from austenite represents a change from gamma to alpha iron:

1. The complete change in microstructure of martensite, as compared to that observed when austenite is preserved on quenching, indicates a transformation of gamma iron.

2. The magnetism of martensite suggests the presence of crystalline magnetic (alpha) iron.

3. The X-ray spectrometer proves that alpha iron is the chief constituent of martensite. Steels which are non-magnetic show face-centered cubic lattices with the X-ray spectrometer, whereas martensite, which is magnetic, shows a body-centered cubic lattice. A 1.5 per cent C steel quenched from above the critical in iced brine showed both martensite and austenite under the microscope, and the X-ray spectrometer pattern showed both face- and body-centered lattices. A 0.35 per cent C steel quenched from above A_c showed only martensite under the microscope and only a body-centered lattice with the X-ray spectrometer.¹⁰

There are other considerations which suggest that the transformation from austenite to martensite represents a substantially complete change from gamma to alpha iron, but in view of the definiteness and finality of the results of the X-ray spectrometer, no other evidence need be considered.

MARTENSITE CRYSTALS ARE SUBMICROSCOPIC

Having established the fact that martensite consists chiefly of crystalline iron of the alpha modification, we conclude that the ferrite is present in grains of sub-microscopic size for the following reasons:

1. The conditions obtaining at the time of the formation of martensite are conducive to the production of small grains.

2. In low-carbon martensite formed from coarse grained austenite, ferrite can often be seen under the microscope in the form of very small plates.

3. In higher carbon steels which are conducive to the formation of finer grains on quenching, no ferrite can be resolved under the microscope.

4. In order to obtain a good Hull pattern¹¹ with the X-ray spectrometer it is necessary that the specimen be fine grained. In a 0.35 per cent C martensite, formed by quenching from 1,300 deg. C., the alpha iron pattern was typical of that obtained from fine-grained metals, even though the austenite grains from which the martensite was formed were large enough to be seen with the unaided eye.

It is not to be understood that the ferrite grains in martensite are necessarily equiaxed. The conditions obtaining during their formation are conducive to the production of very small plates of ferrite running parallel to the cleavage planes of the austenite. Whether the grains are substantially equiaxed or in plates, the precipitation along the austenite cleavage planes gives rise to the acicular structure of martensite. The tendency for this cleavage precipitation is so marked that martensite formed by quenching large grains of austenite appears under low magnifications to have a grain structure similar to that of the austenite. Detailed examination, however, reveals the fact that the

austenite grain structure is entirely replaced by a structure so fine that it is often impossible to find a single crystalline particle large enough to see with a high-powered microscope. The apparent crystalline masses observed after light etching are seen to be, after deep etching, complexes of very fine structure.

NO CEMENTITE IN MARTENSITE

The reasons for concluding that the austenite-martensite transformation does not represent a complete formation of the cementite are: (1) The heat evolved when martensite changes to troostite. (2) The failure to detect the presence of cementite in untempered martensite by magnetic analysis.¹² (3) The etching characteristics of martensite as compared to troostite suggest that the carbon is in solution in the former and is largely present as cementite in the latter.

The authors believe that it is the carbon rather than the carbide in solution in the ferrite of the martensite for the same reason that they believe that it is the carbon and not the carbide which is in solution in austenite. Cementite can form in martensite only by the migration of carbon atoms. In order for these to migrate freely they cannot maintain contact with any particular iron atoms. In freshly formed martensite therefore most of the carbon should be atomically dispersed, but a small amount may actually be in the form of particles of cementite. The presence of the carbon assists in the hardening indirectly by helping to produce a very fine ferrite grain size and directly by strengthening the ferrite grains.

Although the ferrite of the martensite is held to contain carbon in solution, it is considered that the fineness of grain is chiefly responsible for the hardness.

Great hardening can be produced with 0.40 per cent C, which is 1.9 atoms per cent. No case is known with large-grained metals where 1.9 atoms per cent of one element dissolved in a metal produces hardening at all comparable with that of a 0.40 per cent C martensite. In austenitic manganese steel there may be as much as 7 atoms per cent of carbon and 13 per cent manganese (by weight) dissolved in gamma iron without producing marked hardness. The structure in this case is coarse grained. It may be argued that 0.40 per cent carbon produces 6 per cent of cementite and that it is this compound which is in solid solution in the ferrite. The same argument applies to manganese steel which would have over 20 per cent of cementite in solid solution. If, therefore, we assume solution of the carbon in the ferrite of the martensite it follows that the grain refinement must be the principal cause of the hardness. Experimental evidence points conclusively to a super-refinement of the ferrite grains and favors the conclusion that the greater part of the carbon has not formed into carbide.

The hardness of martensite may therefore be attributed chiefly to a combination of two factors—namely: (1) The super-refinement of the ferrite grains, and (2) the strengthening of the ferrite by carbon.

Too little is known regarding the exact sequence of hardness changes on tempering quenched carbon steels. The most marked effect is one of softening, and the opinion is fairly general that softening is progressive throughout the whole range of tempering temperatures. It is certain that the tempering of hardened tool steel at temperatures above 200 deg. C. reduces its cutting hardness and probably also its Brinell hardness. The Shore scleroscope hardness of tool steel seems to be less affected by tempering at low temperatures. It is likewise quite certain that steels of medium carbon content which have been hardened are softened by tempering at temperatures above 350 deg. C., as proved by thou-

¹⁰Preliminary results of work done by Jeffries and Bain.

¹¹"The Crystalline Structure of Metals" by Jeffries and Archer, CHEM. & MET. ENG., vol. 24, p. 776 (May 4, 1921).

¹²K. Honda, "On Magnetic Analysis as a Means of Studying the Structure of Iron Alloys," *J. Iron & Steel Inst.*, No. 2, 1918, pp. 375-419.

sands of tests on hardness and tensile strength. The hardness of low-carbon steels is known to be not greatly changed by tempering, and the changes brought about by tempering above 500 deg. C. are certainly in the direction of softening. Steels of the various carbon contents are seldom tempered commercially at temperatures below those which produce easily measureable softening. There is, therefore, a lack of results of commercial practice in the tempering of hardened steels at very low temperatures.

It is stated by Heyn and again by Boynton that tempering, even in its early stages, gradually reduces the hardness of martensite. Heyn's conclusions are drawn from scratch hardness tests on high-carbon steel. Among the few published contributions on this subject is a paper by C. Grard¹³ in which it is reported that the first effect of tempering is to *increase* the hardness.

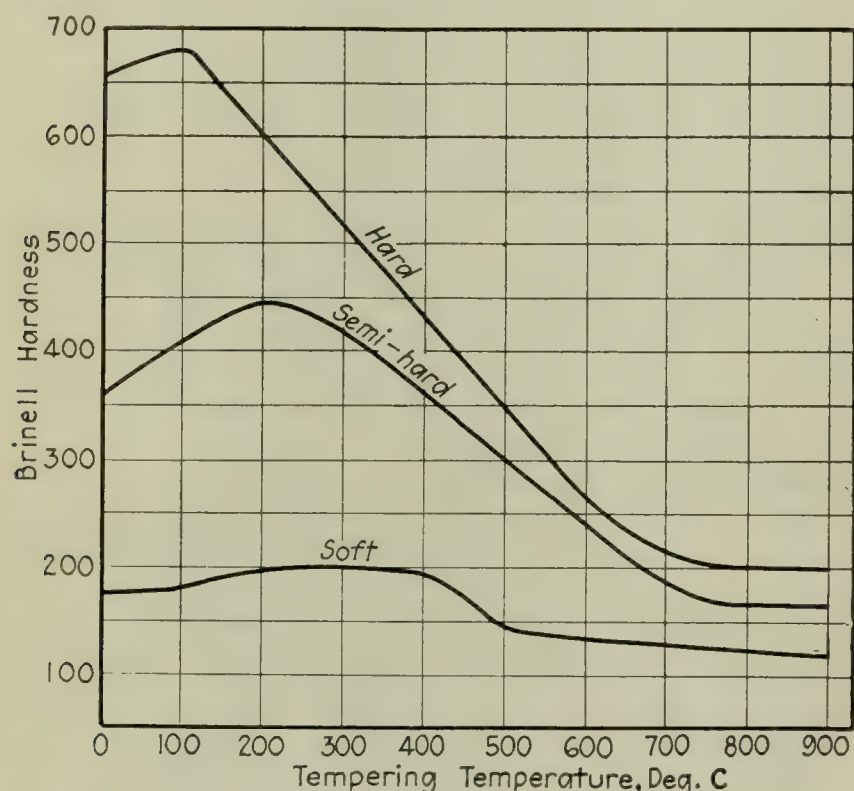


FIG. 11. EFFECT OF TEMPERING ON THE HARDNESS OF HARDENED STEEL (GRARD)

His results are plotted in Fig. 11. They are described as typical of the steels of the classes named. No analyses are given.

While Grard's curves are opposed to general opinion, it is believed that they merit serious consideration as representing perhaps an overlooked phenomenon in the tempering of steel. He appears to have made a particular point of the accuracy of his hardness determinations. These were also confirmed, in the case of the soft and semi-hard steels, by tensile strength results which parallel the hardness results closely; hard steels were too brittle for satisfactory tensile tests after low tempering temperatures. It is to be noted that the maximum hardness attained on tempering occurs at a lower temperature the higher the initial hardness. Marked softening also begins at lower temperatures the higher the initial hardness.

According to the critical dispersion ideas the precipitation of cementite in martensite should produce an increase in hardness. Cementite meets all of the requirements of a good "key" material.

At some stage in the formation and growth of cementite particles, conditions would be proper to produce maximum hardness. It is not probable that all of the cementite particles have critical size at the same time. At any given time in the first stages of tempering, some particles should be super-critical, some critical and some sub-critical. It must be considered also that alpha iron

has some solvent power for carbon under equilibrium conditions; all of the carbon therefore cannot form into cementite.

After the cementite formation has progressed nearly to completion the larger particles grow by absorbing carbon in solution in the ferrite. The ferrite will be supersaturated in carbon with respect to large particles and saturated with respect to small particles of cementite. The precipitation of the carbide on the larger particles produces a condition of undersaturation with respect to the smaller particles which then are dissolved. The carbon atoms diffuse toward regions of low concentration, which is toward the larger particles.

Growth of cementite crystals during tempering is favored by long time and high temperature. The successive stages of troostite, sorbite and granular pearlite represent in part progressive increase in size and decrease in number of the cementite particles.

CHANGES IN FERRITE ON TEMPERING

As the carbon changes noted above are progressing there must be some change in the ferrite. In the case of a steel containing 1 per cent carbon the formation of cementite will require about 15 per cent of the iron. This iron must be supplied from the ferrite or from any amorphous iron which may be present. Such a change would tend toward a more perfect equilibrium in the ferrite which would tend toward softening. It seems certain that the growth of the ferrite into larger particles at temperatures from 350 to 550 deg. C. is an important factor in the decrease of hardness. The effect of changes in the ferrite caused by low-temperature tempering (below 300 deg.) is small, but even this becomes appreciable in the harder martensites.

Martensite cannot be hard without being fine grained and in general the greater hardness will be produced by the greatest grain refinement. The finer the grains the lower should be the temperature at which structural changes begin on tempering, and hence this factor should cause martensite to soften considerably by prolonged heating at temperatures well below 300 deg. C.

The first stages of the tempering of martensite therefore involve two opposing factors; the changes in the ferrite tend to produce softening while the first precipitation of the cementite tends to harden. We might expect an increase or decrease in hardness according to the rapidity and extent of these opposing changes.

If low-temperature tempering does not produce a change in hardness, it should not be prematurely concluded that no internal changes had taken place. It is quite conceivable that in Prof. Campbell's¹⁴ steels heated twelve hours at 100 to 108 deg. C. the hardness changes were insignificant, yet the electrical resistivity had decreased 25 per cent. Such a change is consistent with the breaking down of a solid solution into two constituents. The extensive work of Barus and Strouhal¹⁵ also shows that even heating for an hour at 66 deg. C. produces internal changes in hardened steel. A structural change and change in electrical resistivity might obtain and the hardness might increase, remain constant or decrease in accordance with the relative magnitude of these opposing factors.

Any austenite which may be present in a quenched steel will further complicate the results produced on tempering. The transformation of austenite on heating is always accompanied with hardening. As a rule the lower the temperature at which the transformation will take place the harder will be the transition product. Mauer¹⁶ found, for example, that austenite containing 1.94 per cent C and 2.24

¹³"Research on the Hardness of Steel," Captain C. Grard. *Proc. 6th Congress Inst. Assoc. for Test. Mat.* III₂.

¹⁴E. D. Campbell, "On the Rate of Change at 100 Deg. C. and at Ordinary Temperatures in the Electrical Resistance of Hardened Steel," *J. Iron & Steel Inst.*, No. 2, 1918, pp. 421-428.

¹⁵*Bull.* 14, U. S. Geologic Survey (1885).

¹⁶"Investigations on the Hardening and Annealing of Iron and Steel," *Metallurgie*, vol. 6, 1909, pp. 33-52. Ed. Mauer.

Mn transformed at 400 deg. C., while a steel containing 1.66 per cent C and having a structure of two-thirds austenite and one-third martensite showed the transformation at 250 deg. C. The latter had very much higher maximum hardness. This accords with the observation that austenitic manganese steel transforms only at a relatively high temperature and never attains extreme hardness.

NATURE OF TROOSTITE AND SORBITE

The constituents troostite, sorbite and granular pearlite represent different degrees of subdivision of the ferrite grains and the cementite particles. As the tempering temperature is increased up to A_1 and as the time of exposure at temperature increases the ferrite grains and the cementite particles become larger. These two factors now combine to soften and weaken the steel. The slip interference theory discussed above explains nicely the decrease in hardness as the constituents become coarser. The hardness of a tempered martensite will be affected indirectly by the quantity of carbon, because cementite opposes ferrite grain growth, and directly by the slip interference caused by the cementite. It is because the presence of carbon has this double (direct and indirect) hardening effect that the physical properties of heat-treated steel vary so much with change in carbon content and with change in heat-treatment. For example, pure iron has a hardness of about 75 Brinell, whereas troostite containing about 0.9 per cent C may have a hardness of 500. The hardness of the troostite is due partly to the mere presence of cementite and partly to the ferrite grain refinement caused by the cementite.

Obviously the alloy steels are more complex than the carbon steels. In general the hardening alloy ingredients help to produce martensite at slower rates of cooling than would be possible in carbon steels. They also strengthen the ferrite by their presence in solid solution and may change the nature and degree of dispersion of the hard particles that are produced on tempering.

RESTATEMENT OF THEORY

Although there is substantial agreement among metallographists regarding the nature of troostite, sorbite and granular pearlite, there has been a constant controversy for the last thirty-five years regarding the nature of martensite. Many theories have been put forward and volumes have been written on this subject.

No attempt will be made here to discuss these various theories. It may be mentioned that the authors made their analysis of this problem without consideration of any of the current theories. While the conclusions reached regarding the nature of martensite do not correspond completely to any current conception, they correspond in the main to a combination and extension of the ideas of Grenet¹⁷ and M'Cance.¹⁸

Owing to the X-ray spectrometer results the conclusions regarding the allotropic changes can now be considered as established. It is obvious that the "beta iron" theory has little foundation. Even if beta iron is a true allotrope there is no evidence that it is hard or that it is present in martensite. The theory advanced by Edwards and Carpenter¹⁹ that martensite represents

twinning in gamma iron is also untenable, for the reason that martensite consists chiefly of alpha iron. The "solid solution" and "carbon" theories are unsatisfactory, because they are indefinite and incomplete.

The ideas regarding the nature of martensite presented in this article not only accord with observations of fact and fulfill the requirements of logic and simplicity, but a concrete mechanism is put forward showing how the structures postulated are able to account for the hardness of quenched steel and the changes in properties on tempering.

SUMMARY

A complete theory of hardening must explain hardness in non-allotropic metals, a task which has been attempted in the preceding pages, and is summarized below:

1. The inherent cohesion of the pure metals is far in excess of values obtained for tensile strength.
2. Mechanical failure under stress is ordinarily premature because of the presence of crystallographic planes of weakness, or potential slip planes.
3. Any structural condition which interferes with slip on these planes of weakness increases the strength and hardness of the metal. Furthermore, every known method of hardening metals can be referred to this principle of "slip interference."
4. In a pure metal the most simple source of increased hardness is grain refinement, which introduces slip interference at the grain boundaries due to the different orientations of the adjacent grains, and, especially in fine grained metals, to the disorganized or amorphous metal between the grains.
5. Cold-working introduces slip interference by the fragmentation of the grains and the production of amorphous metal.
6. The hardness and strength of amorphous metal itself is due to the absence of the planes of weakness characteristic of crystals.
7. Slip within grains is opposed by the presence of a strong constituent at the grain boundary, providing that if the strong constituent is brittle, its shape and size are not such as to lead to effective weakness due to eccentricity of loading.
8. Effective hardening is obtained by slip interference within the grains, due to the presence of hard constituents uniformly distributed in the form of very fine particles.
9. It is not necessary that the hard constituent possess great adhesion for the matrix.
10. The effect of a given amount of hard constituent increases with the fineness of subdivision, reaching a maximum at an average particle size denoted by the term "critical dispersion." The critical dispersion probably consists of the smallest particles having the characteristic properties of the crystalline substance. The order of magnitude of the diameter of such particles is probably about 10^{-7} cm. A higher degree of dispersion, particularly the atomic dispersion of solid solutions, is less conducive to hardness.
11. Corresponding to the maximum hardness at critical dispersion, there is a minimum in ductility.
12. Increase in the amount of dispersed substance produces increased hardness, but the brittleness also increases, so that there is a limit to the useful hardness and strength that can be obtained.
13. The amount of hard dispersed substance which produces the greatest useful strength increases as the size of particle increases.
14. The actual amounts of hard dispersed substances which produce useful results are from about 2 to 15 per cent by volume.
15. The only manner in which the high degrees of dispersion desired are produced consists in the limited decomposition of solutions, and in particular of solid solutions.
16. Martensite consists of a solid solution of carbon in very fine-grained alpha iron. The hardness is due chiefly to the grain refinement of the ferrite, but partly to the carbon in solution.
17. The tempering of martensite involves two changes: ferrite grain growth and the precipitation and growth of cementite particles. Ferrite grain growth causes progressive softening. The precipitation of cementite causes hardening, but the growth of the particles above the critical size produces softening.

¹⁷Grenet, "The Transformations of Steel Within the Limits of the Temperatures Employed in Heat-Treating," *J. Iron & Steel Inst.*, No. 2, 1911, pp. 13-75.

¹⁸A. M'Cance, "A Contribution to the Theory of Hardening," *J. Iron & Steel Inst.*, No. 1, 1914, pp. 192-265.

¹⁹C. A. Edwards and H. C. H. Carpenter, "The Hardening of Metals, With Special Reference to Iron and Its Alloys," *J. Iron & Steel Inst.*, No. 1, 1914, pp. 138-191.

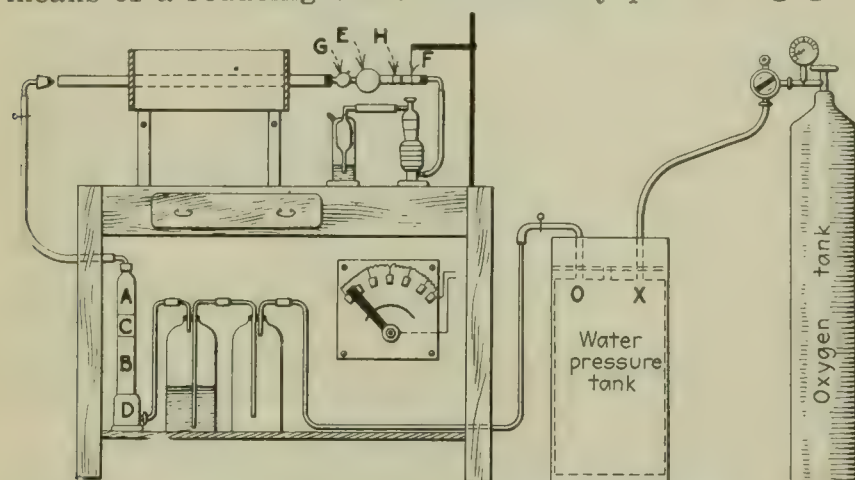
A Simplified Carbon Combustion Train

BY W. W. BOONE*

THE estimation of carbon in steel has probably attracted more attention than that of any other element, due to its far-reaching influence upon the properties of the steel. At present the three most general methods used are: (1) Color comparison; (2) direct combustion; (3) wet combustion. For all ordinary steels the direct combustion of the steel in a current of oxygen is the most rapid and accurate method known. The color comparison method is very inaccurate in many cases, and the wet method entails the use of bulbs and apparatus too fragile and delicate for technical purposes.

In designing a simplified combustion train the writer has endeavored to eliminate all non-essentials for ordinary steel analysis, and at the same time make the train as nearly foolproof as possible. The apparatus is shown in the accompanying figure.

In most trains the flow of oxygen is regulated by means of a reducing valve and mercury pressure gages.



SIMPLIFIED CARBON COMBUSTION TRAIN

This scheme, however, requires frequent juggling of the reducing valve during the same determination, especially during the period of combustion, and hence the pressure and flow vary considerably.

By the insertion of a water-pressure tank a practically uniform pressure is maintained throughout the combustion. This tank is of galvanized iron 12 in. in diameter and 36 in. in height, with an open top. Another shell 30 in. in height telescopes into the first tank and is fastened securely in position by means of a rod imbedded in the larger tank. When water is poured into this tank so that it is approximately half full an airtight seal is produced. The idea for this tank originated from an ordinary acetylene generator.

Oxygen is admitted through the inlet *X*, thus causing the water to rise around the inner shell. When *X* is closed and *O* is opened, the oxygen in the tank flows out under the pressure of the column of water. One filling of the tank provides enough gas for four or five six-minute combustions. From the water tank the oxygen passes through two bottles, one acting as a safeguard against possible sucking back in the system, and the other containing a saturated solution of potassium hydroxide, which filters and dries the gas bubbling through it. The oxygen is subjected to final drying in a tower containing 20-mesh calcium chloride (*A* and *B*), 20-mesh sodium calcium hydrate (*C*) and concentrated sulphuric acid (*D*). After leaving the combustion tube (silicon) the gas passes through tubes containing: granulated zinc (*G*), 20-mesh calcium chloride (*E*),

phosphoric anhydride (*H*) and 20-mesh calcium chloride (*F*). The zinc takes care of any sulphur gases which might have been formed in the evolution, the calcium chloride and phosphoric anhydride acting as drying agents before the gas enters the absorption bulb. Usually three special tubes are placed between the absorption bulb and the combustion tube; one for the calcium chloride, one for the zinc, and one for the phosphoric anhydride. This entails more costly and elaborate apparatus and requires more time for packing. The one simple tube containing all the necessary purifying agents in the minimum of space works excellently under heavy working conditions. Flemming or similar absorption bulbs packed in the usual way may be used as absorption media.

MANIPULATION OF THE METHOD

A factor or a half factor weight (usually half factor is sufficient) of fine steel drillings is placed in a Johnson clay boat lined with RR alundum. These factor weights for carbon may be purchased, respectively, 2.7273 g. and 1.3636 g. and were used in order to eliminate reference to tables or calculation for the carbon percentage present. Gas is allowed to flow through the hot furnace for some time, to insure the removal of all CO_2 before the combustion is begun. A weighed absorption bulb is now fitted into place and the upper stopcock opened. The boat containing the sample is pushed into the middle of the combustion tube, the entrance stopper replaced and oxygen admitted. The lower stopcock of the bulb is now opened and the combustion is run for six minutes. At the end of this period the upper stopcock of the bulb is closed, then the lower stopcock, and the bulb is disconnected for weighing. The lower stopcock is momentarily opened to release the pressure in the bulb before weighing, the oxygen is now shut off and the boat containing the burned sample removed from the furnace. Any moisture or dust adhering to the bulb is carefully removed with a silk handkerchief and the bulb is weighed against a tared bulb. The gain in weight is the percentage of carbon, since a factor weight was used. It is merely necessary to place the decimal point two places to the left in the case of a four-place weight.

With two furnaces in use, one balance for weighing samples and one for weighing the absorption bulbs, the writer frequently carried out seventy to seventy-five determinations in eight hours.

With low-carbon steels it is sometimes necessary to preheat the sample in order to obtain a perfect fusion. Two minutes' preheating is usually enough, and in such case the entire combustion should still occupy but the six minutes with a full factor weight and the five minutes with a half factor weight. This method gives accuracy to 0.01 per cent.

Artificial Iron Ore for Hydrogen Generation

An artificial iron ore has been developed by the Bureau of Standards for use in the steam-iron process of hydrogen generation. This material is made by impregnating a porous earthenware supporting body of approximate shape with iron nitrate and decomposing it to the oxide. Laboratory experiments on a limited scale indicate that this material is far superior to a natural iron ore for the purpose of producing hydrogen. The bureau is about to undertake the production of a sufficient amount of this material to permit of extensive tests in the hydrogen plant at Langley Field.

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Injuries Caused by Emergencies

BY CHESLA C. SHERLOCK

MOST employers are familiar enough with the workmen's compensation laws to know that they are liable for the payment of compensation to injured workmen who receive their injuries through accidents arising "out of and in the course of" the employment.

Those employers who are operating under the common law theory of damages, and there are thousands of them, even in the states having compensation laws, know that they are not liable for accidental injuries caused to their workmen, unless the fault for the accident rests in the negligence of the employer in some particular. In spite of these provisions, there is one exception to the two rules mentioned above, which apply in all cases of accidental injury, whether the employer be operating under the compensation system or under the common law theory, and that is where emergencies arise which cause the injury to the workman.

A CONCRETE ILLUSTRATION

Suppose, for the purposes of clearly illustrating this rule of law, that we take a concrete illustration embodying the essential features of the rule, which is common to the experience of employers generally. Let us suppose that the case arises in the factory of a chemical company, and that it arises through the agency of an explosion of chemicals.

A workman, John Doe by name, has been asked by his foreman to repair a leak in the gas tank of one of the company's automobiles. John removes the tank from the car, and carefully empties it of all the gasoline which it contains. He then takes the tank to a bench in one corner of the packing room and commences to heat a bit of solder with a blow torch.

In the office is one of his pals, a buddy he had known overseas, whose avowed duty it is, under the terms of his contract of employment, to take care of the office force. This man, Fred Jones by name, is not engaged in a hazardous occupation and is not covered under the terms of the workmen's compensation acts as they are generally understood. The employer does not even pay a premium on his risk.

As soon as John Doe, out in the packing room, applies his torch to the solder and moves it in close proximity to the hole in the gas tank, there is a terrific explosion, which not only kills John Doe, but scatters flames in every direction and severely burns another employee.

Fred Jones, who is working in the office, hears the explosion and sees his pal topple over. In his excitement he rushes through the office door in an effort to rescue him. But he is met by a scorching sheet of flame which drives him back. In his terror he realizes that the fire department must be summoned immediately or the entire plant will shortly be destroyed by the possible explosion of other chemicals stored in the packing room awaiting shipment.

RUN DOWN RUSHING TO FIRE ALARM BOX

He turns and dashes into the office and out the front door. He does not summon the fire department by stopping in the office and calling Central as he might do, and probably should do. Instead, he remembers in that brief moment of terror that there is a fire-box alarm on the corner across the street, and he makes for that place.

Impelled by the sudden emergency which looms all-

terrible in his mind, he does not look this way or that and before he reaches his destination he is struck by a delivery truck and seriously maimed and injured.

The cooler heads in the packing room, in the meantime, through the use of fire extinguishers close at hand, have put out the blaze and forestalled the threatened conflagration. John Doe's body is removed to an undertaking establishment and Fred Jones and the other employees are taken to the company hospital.

In the course of time, the employer sends in a claim for compensation not only for the workman who was injured through burns, but for Fred Jones as well. "I realize," he said, in making the claim to his insurance carrier, "that I have not paid a premium on the risk for Fred Jones, but I feel that he has a right to compensation under the law, and since by the terms of your policy you agree to hold me blameless for any and all claims of such nature and should have anticipated such a case, I have no hesitancy in claiming relief for Jones."

INSURANCE COMPANY DENIES LIABILITY

A few days later an adjuster for the insurance company stepped off the train and made his way quietly to the chemical factory. He talked to a few workmen on the premises before he went to the office of the employer.

"I am authorized to make settlement in the cases caused by your recent explosion," he said, "but I am not prepared to accept liability in the case of Fred Jones. I have carefully investigated the circumstances surrounding his injury and I do not feel that he has a compensable claim."

"But," interrupted the employer, "how do you reach such a conclusion? His injury was clearly caused by the explosion. If he had not rushed across the street to turn in a fire alarm, he would never have been injured."

"That is true," replied the adjuster, "but when he went across the street he was outside the scope of his employment. His injury arose absolutely from causes entirely foreign to the duties of his employment, which were to manage this office force. And, besides, clerks and office people are not entitled to coverage under the terms of the workmen's compensation acts."

"Yes," agreed the employer, "but one of his duties was to do all that he could to preserve this business against loss. He was clearly acting for my welfare when he attempted to turn in a fire alarm and was clearly acting for my best interests. Technically, of course, he was not managing my office force then, but do you mean to say that the law is as narrow as all this? I thought that the compensation system prided itself on being free from technicalities."

The adjuster was firm in his position. "I can do nothing but refuse to pay compensation to Jones, until the Industrial Commission orders me to do so. Of course, if Jones wants to go to bat on this, he has the right and we will get the benefit of an official ruling on the case."

The employer's jaw snapped. "All right, I shall advise Jones to do that very thing, as soon as he is able, and I am going to give him all the legal assistance I have at my command!"

JUDGMENT AGAINST INSURANCE COMPANY

In the course of time Fred Jones did bring an action against the insurance company for compensation and it was tried before an arbitration committee composed

of one Industrial Commissioner and two other arbitrators selected by the parties. The Commissioner wrote the following opinion, which was the unanimous decision of the committee:

"It is true that Fred Jones was technically outside the scope of his employment when he rushed across the street to send in a fire alarm. He was not even on the employer's premises and the accident that caused his injury did not arise out of the duties he was required by his employment to perform. But in this case a sudden emergency was presented upon which he acted, presumably with the idea of best promoting his employer's interests. And while in the course of that intention he suffered his loss and the impairment of his earning capacity.

"The emergency rule of law holds that an employee may be even guilty of an error of judgment, and still be entitled to relief from his employer for injuries sustained. Jones, it might properly be urged, should have used the telephone in his office to summon the aid of the fire department. He was, perhaps guilty, of an error of judgment in dashing into the street, and thereby receiving injury to himself, but the law throws the mantle of protection over him in such circumstances, and this is true, whether we view the matter from the common law standpoint or from the compensation angle.

"As to the question of whether Jones should be denied compensation because he was technically not covered under the employer's policy of insurance, it is well settled that mere failure to include all risks in a policy does not absolve the parties from liability. Such a construction might properly be urged to defeat the whole system of compensation liability, and we feel that the best interests of the parties are promoted by awarding the claimant the relief he seeks."

It is not necessary to elaborate further, except to state that the emergency rule of law is a general rule and that it will apply to all employers, regardless of whether they are operating under one system or the other. It is one of the very few rules of law approved by the common law system which has been preserved in the compensation system of compensating injured workmen.

Wooden Posts for Plant Inclosures*

With the increasing necessity for proper protection of chemical and industrial plants by inclosing the property with wire or board fences the question frequently arises as to the right type of wooden posts in fence construction. The fact is, there is no choice between round or split posts if the amount of heartwood is the same in both. But if the percentage of sapwood is increased by splitting, the split posts will be less durable, and if the percentage of heartwood is increased, it will be more durable than a round one. Posts of spruce, hemlock or any of the true firs are exceptions to this rule, because their heartwood and sapwood are equally durable.

When posts are to be treated with creosote or other preservative, a round post is preferable to a split post, because of the comparative ease with which the sapwood can be treated. The heart faces on split posts do not, as a rule, absorb preservative well. Split red-oak posts will take treatment, because the wood is very porous, but the heart faces of split posts of many other species, notably white oak, red gum and Douglas fir, resist the penetration of preservative, even under heavy pressure.

*Forest Products Laboratory Technical Notes.

Progress of Belgian Chemical Industry

The Belgian chemical industry is composed of a Federation des Industries Chimiques de Belgique, which is subdivided into a series of fifteen associations, says a recent consular report. The information for certain associations is missing or incomplete, but the following figures relate to the production of those for which figures could be obtained by the Ministry of Economic Affairs:

Products	Metric Tons	
	1913	1920
Soda, potash and derivatives:		
Carbonate of soda.....	31,234	31,000
Caustic soda.....	3,261	2,418
Chloride of lime.....	7,444	3,970
Chloride of calcium.....	6,025	2,850
Potash and derivatives.....	47,964	40,229
Acids, minerals and derivatives:		
Sulphuric acid.....	600,000	400,000
Nitric acid.....	10,000	7,500
Hydrochloric acid.....	22,500	27,000
Sulphate of soda.....	25,000	40,000
Superphosphate of lime.....	465,000	220,000
Wood products for distillation, cubic meters	46,000	21,000
Products of coal distillation:		
Alkali.....	1,500	894
Anhydrous ammonia.....	40	62
Sulphate of ammonia.....	22,696	9,048
Benzene, 90 per cent.....	5,216	4,194
Coal tar.....	37,337	25,872
Naphthalene.....	5,593	4,702
Creosote oil.....	8,705	5,543
Tar.....	47,106	28,304
Light oils.....	6,277	1,785
Powders and explosives.....	3,500	2,200

The present production of artificial silk is about 70 per cent of what it was before the war.

Gas-Fired Crucible Furnaces

Before the Sheffield Society of Metallurgists and Metallurgical Chemists, on April 19, F. M. Parkin, of Hobson, Houghton & Co., advocated the use of gas-fired furnaces for melting crucible steel as being superior in all respects to the coke-fired furnaces which have been employed ever since the crucible process was invented by Huntsman. There are a number of gas-fired crucible furnaces in Sheffield, but the newer method is in its infancy. Mr. Parkin said that gas-melting was cheaper than coke fuel, the operation was less arduous for the workmen, and the product—at any rate as regards composition—was superior to the material made with coke. Speaking from an experience of a considerable number of years with the Harvey-Siemens regenerative furnace, he stated that he had produced hundreds of tons of steel every year, which was sold in competition with coke-made steel, and the results had been highly satisfactory. The steel was better than the steel which was made by the older fuel.

New German Refractory Product

A new method of converting ordinary bricks into refractory firebrick has been perfected in Germany, consisting of a coating comprising a mixture of 75 per cent carborundum and 25 per cent sodium silicate. The mixture is applied to the bricks when they are thoroughly dried, and the coating sets and thoroughly dries in twenty-four hours, being slowly heated and burned in. This coating averages about one-fiftieth of an inch in thickness, and the adherent glassy veneer of carborundum gives remarkable resistance to any mechanical injury; it has the ability to withstand very high temperatures and affords complete protection against the chemical action of flames. It is said that sudden changes of temperature do not have any effect upon it. This coating has been used successfully as a lining for gas retorts as well as for the outside surface, and a paste of equal parts of carborundum and clay is used for repairs when cracks occur.

Suggestions for Calibrating Base Metal Thermocouples by the Freezing Point Method

BY KIRTLAND MARSH*

When calibrating thermocouples by the freezing point method, it is essential that the metals used be pure and maintained pure. Pure tin, zinc, aluminum and copper can be readily obtained from the Bureau of Standards for this purpose, but care must be exercised in using them to guard against contamination. This is realized by inclosing the thermocouple to be calibrated in a sheath to protect it from the molten metal. The sheath also prevents short-circuiting the couple at the surface of the metal. Hard glass tubes can be used for tin and zinc, but in aluminum these are unsatisfactory, and they cannot be used in copper. An iron tube can be used in any of these metals satisfactorily if steps are taken to prevent the contamination of the metal by the iron. This can be prevented in the following manner:

Prepare a mixture of one part by volume of graphite and two parts water; flake graphite will not mix readily with the water, but finely powdered graphite or ordinary plumbago, such as is used in foundries for facing, is satisfactory. Heat the sheath to about 900 deg. F., dip in the above mixture and withdraw quickly in order that there will be enough heat left in the sheath to dry the coating of graphite. The mixture should be thoroughly stirred before being used, because the graphite or plumbago will settle to the bottom of the container. A suitable container can be made of a piece of 4-in. iron pipe capped on one end and long enough to extend about 12 in. above the surface of the mixture to prevent spattering.

The sheath, after having been dipped and a smooth dry coating of graphite obtained, can be immersed in the molten metal without fear of contaminating it. After the sheath has been removed, any clinging metal and dross can be readily removed and the same sheath safely used in some other metal.

The only precaution necessary is to remove any loose oxide scale from the sheath before it is dipped and immersed in the metal; if this is not done, some of the scale may chip off and fall into the metal and thus render it impure and alter the freezing point.

When copper is used the furnace temperature is high enough to burn off the coating of graphite and in this case a second coating of lime can be used to protect the graphite. A suitable lime wash can be made of one part by volume of slaked lime and one part water. Heat the sheath to 900-1,000 deg. F., dip in the graphite wash, quickly remove and allow to dry thoroughly and then repeat in the lime wash. Both coatings will generally dry thoroughly without reheating.

Thermocouples of the pencil type, consisting of an insulated wire element welded at one end to a tubular element inclosing it, can be calibrated without a sheath if they are given a protective coating of graphite.

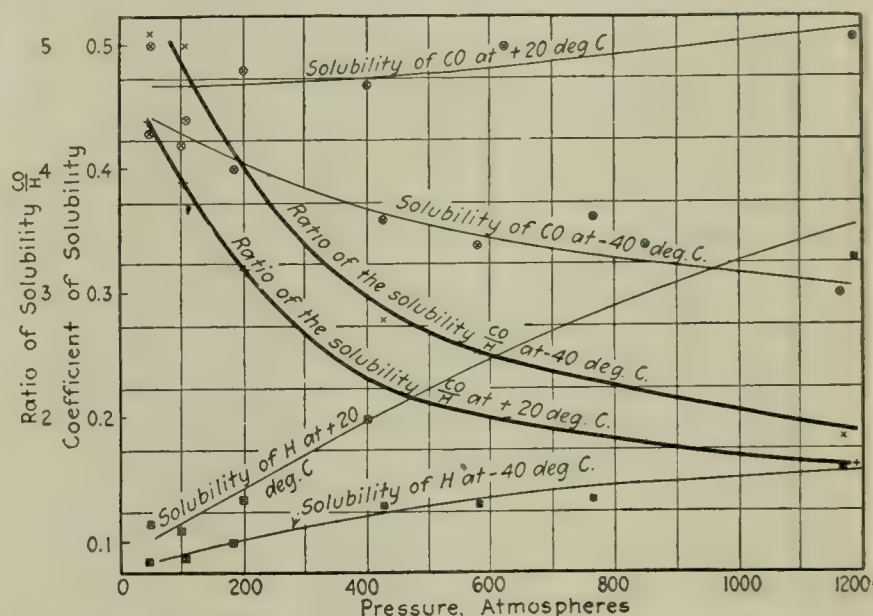
The chief advantages of these washes in calibrating thermocouples are as follows: metal sheaths which are much stronger and more rugged than refractory sheaths can be used; the molten metal is protected from contamination; one sheath can be used in all the metals because it can be thoroughly cleaned, and couples of the pencil type can be calibrated without any sheath, under which conditions the couple is much more sensitive to temperature changes and the calibration rendered more reliable, particularly when only a little metal is used.

*Aluminum Company of America, New Kensington, Pa.

Synopsis of Recent Chemical & Metallurgical Literature

Production of Hydrogen for the Manufacture of Synthetic Ammonia by the Hyperpressure Process.—In a note presented before the French Academy of Sciences, Feb. 21, 1921, Georges Claude stated that the commercial success of the hyperpressure process for the manufacture of synthetic ammonia depends on the economical production of hydrogen.* In another note of April 4, 1921 (*Comptes rendus*, April 18, 1921, pp. 974-977), he describes his experimental work for the production of practically pure hydrogen by separating it from its mixtures, such as water gas and coal gas. This separation is easily realized by the application of the principle of the insolubility of hydrogen and the solubility of the other gases of the mixture in ordinary ether.

The mixture, compressed to a given pressure, is passed through the solvent at a very low temperature when all the



SOLUBILITY OF HYDROGEN AND CARBON MONOXIDE IN ORDINARY ETHER

gases but hydrogen are dissolved in the ether. The solvent with the gases in solution is drained off, and when expanding to atmospheric pressures the dissolved gases escape, leaving the solvent ready for re-use.

The difficulty encountered in the use of this process is that the hydrogen obtained is somewhat contaminated with carbon monoxide; but a series of tests has led to the practical means of how to reduce the CO content to a minimum. This is best shown in the accompanying figure giving the solubilities of hydrogen and the carbon monoxide in ordinary ether at +20 and -40 deg. C. for pressures up to 1,600 atmospheres. By working at a low temperature, -40 deg. C., and at a pressure of about 100 atmospheres it is possible to obtain hydrogen containing less than 0.002 part CO.

Predicting Strength of Rolled Steel.—William R. Webster is to read a paper before the Wilkes-Barré meeting of the American Institute of Mining and Metallurgical Engineers, reopening a subject which was much discussed during the early '90s. Since then Campbell,¹ Cunningham,² Stead³ and McWilliam⁴ have proposed formulas for the relation between chemical composition and strength. It was early recognized that differences in amount of reduction during rolling would account for 6,000 to 10,000 lb. per sq.in. tensile strength.

*See CHEM. & MET. ENG., April 20, 1921, p. 706.

¹"Manufacture and Properties of Iron and Steel."

²Trans., Am. Soc. Civil Eng., vol. 38, p. 78 (1897).

³J. Iron and Steel Inst., vol. 44, p. 5 (1916).

⁴J. Iron and Steel Inst., 1918, II, McWilliam's formula for ultimate strength normalized 1 in. bars of basic open-hearth steel is $38,000 + [800 + 4(C - 20)]C + 120Si + [100 + 2(C - 20)]Mn + 1,000P$.

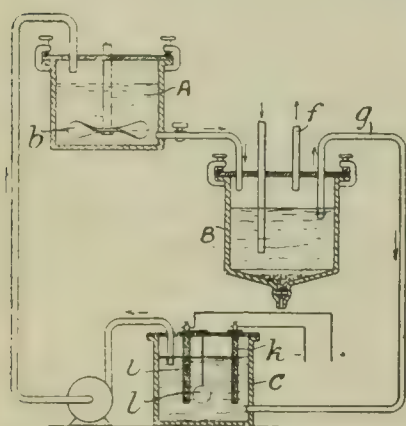
Finishing temperature also had an important influence; in fact, several steel works have found it useful to construct tables of their own to include the effects of all the conditions existing at that particular place. One such table for basic open-hearth steel is quoted, and Mr. Webster finds that by starting with 50,145 lb. per sq.in. for a 0.10 per cent C, 0.34 per cent Mn steel, the results would be closely approximated by giving an increase of 830 lb. for each point carbon and 170 lb. for each point manganese. "When phosphorus is greater than 0.02 the figures should be increased at the rate of 1,000 lb. for each 0.02 per cent that the phosphorus exceeds 0.01 per cent."

Recent Chemical & Metallurgical Patents

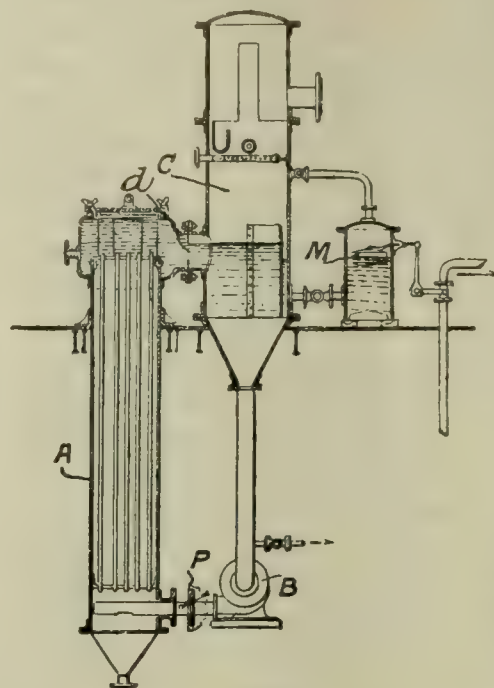
British Patents

For complete specifications of any British patent apply to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Refining Platinum.—In the separation of platinum from other metals, there is obtained a solution containing gold and palladium, which are then precipitated, leaving a pure platinum solution from which the metal is electrodeposited. The precipitation of gold and palladium may be effected by means of hydrogen previously treated with ultra-violet light, for instance by passing the gas through a helical silica tube surrounding a silica mercury-vapor lamp. If a plate of gold or palladium is placed in the solution, a voltaic couple is stated to be formed with the hydrogen. In obtaining the solution of platinum, gold and palladium there may be employed broken ingots of impure platinum or sludges resulting from electrolytic treatment of impure gold anodes in nitric acid solution, the silver being deposited on the cathode and platinum, iridium, palladium, gold and lead precipitated. The impure metal or sludge may be treated with diluted aqua regia at 70 deg. C. in a closed vessel A provided with a stirrer b. Only the platinum, palladium and gold dissolve. An alternative method of obtaining such a solution consists in treating an impure gold anode in acid auric chloride solution or aqua regia, silver, iridium, rhodium, ruthenium, etc., remaining undissolved. A part of the gold may then be deposited electrolytically, say in the same cell, but the solution must be removed from the cell when it contains 3 per cent of gold, 6 per cent of platinum and 0.5 per cent of palladium. Treatment with the hydrogen is effected in a closed vessel B, excess of gas escaping by a pipe f, and the solution being removed by a pipe g extending downward through one-third of the height of the vessel. The electrolytic vat C for the deposition of platinum is provided with a tight cover and with electrodes k, i of pure retort carbon. A current density of 4.8-9 amperes per sq.dm. is suitable. Removal of the spongy platinum may be facilitated by slightly paraffining the cathode. If the anode is exposed to ultra-violet light, the chlorine is enabled to act on water, regenerating hydrochloric acid and producing oxygen, which either acts on nitrogen oxides present in the electrolyte to regenerate most of the nitric acid for re-use, or escapes with the hydrochloric acid to the first electrolytic cell where it assists dissolution of the gold anode. The source of ultra-violet light may be a silica mercury-vapor lamp l, placed either between the electrodes and near the anode, or outside a window in the wall of the cell. (Br. Pat. 157,785; not yet accepted; F. SLATINEANU, Cressy-Onex, near Geneva. April 6, 1921.)



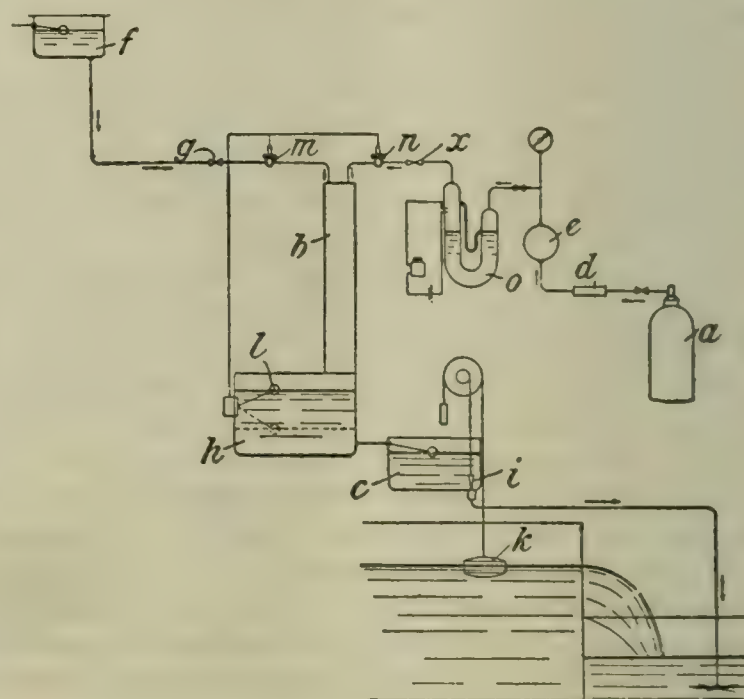
Evaporating Liquids.—In an evaporating apparatus in which liquid is heated by circulation through a tubular heating apparatus A and is evaporated in a separate chamber C from which the unevaporated liquid is returned to



the heater, the formation of vapor in the heater is prevented by increasing the pressure therein by providing a restricted outlet d between the heater A and the vessel C and by inserting a pump B in the pipe which returns the liquid to the heater. The pressure is regulated by a valve P. A float regulator M serves to regulate the feed of liquid to the evaporator. To increase the transmission of heat in the heater A, the speed of flow of the liquid in the tubes is increased by the pump B, the tubes are placed closer together, and the steam

is circulated repeatedly over the tubes. In evaporating salt solution, the conical base of the chamber C is connected to a vessel adapted to receive the deposited crystals and to discharge them by admission of compressed air. In evaporating liquids such as milk, fruit juice, gelatine solution, etc., the heater A is heated by circulation of hot water which is heated in a second tubular heat-exchanger heated by steam. (Br. Pat. 158,569; BARBET ET FILS ET CIE., Paris. April 20, 1921.)

Sterilizing Liquids.—In sterilizing water or other liquid by addition of chlorine or other gas, water and chlorine are passed in regulated streams to an absorber b, and the chlorinated water which collects in a vessel h is supplied



to the main flow of water in proportionate quantities. Chlorine is passed from a reservoir a through a filter d, a reducing valve e, a metering device o and a regulating valve x to the absorber b, and water is passed from a tank f through a valve g. The chlorinated water passes from the vessel h to a vessel c through a float valve and is fed through a tapered valve i controlled by a float k immersed in the main flow of water passing over a weir. The flow of chlorine and water to the absorber may be regulated by diaphragm valves m, n operated by a float l in the vessel h. The metering device o may be arranged to record the amount of chlorine that passes through it. (Br. Pat. 158,578; W. PATERSON, London. April 20, 1921.)

Current Events

in the Chemical and Metallurgical Industries

American Engineering Council Receives Report on Waste Elimination

At the regular bimonthly meeting of the executive committee of American Engineering Council in St. Louis on June 3, the Committee on Elimination of Waste in Industry made a report of the investigations which it has been conducting for the past six months. The outstanding feature of the report was the responsibility placed upon management for 50 per cent of the wastes of industry, while less than 25 per cent was laid at the door of labor. The investigation revealed a margin of unemployment of more than a million men, idle equipment valued at billions of dollars, and a waste of time, energy and money in other ways amounting to millions annually.

The full report of the committee, which was not adopted by Council, but which is to be published under its authority as a committee report and signed by the committee, comprises 125,000 words and deals with the deep-seated causes of waste apart from the world-wide waste and extravagance caused by the war. It discloses loss and waste from interruption of production, low production, restriction of production, and lost production.

Wastes attributable to faulty management are characterized as follows:

"The average method of management is far behind standards which have demonstrated their practical value; billions of dollars are tied up in idle equipment, and there is a large additional waste through maintenance and depreciation charges; manipulations in raw material result in serious losses; an evil in some instances is the practice of cancellations and returns; high labor turnover is a rough index of one of the commonest wastes in industry; the waste of time and energy and money through duplication of estimates and bids in the building trade runs into millions every year; quantity figuring by all bidders is a duplication of effort and a source of waste in construction work."

Both employer and employee are charged with restricting production, the former by limiting the total output of an industry and the latter by limiting the rate of production of the individual. Preventable diseases and industrial accidents account for an economic loss of over three billion dollars per annum.

In order to eliminate much of the waste the committee recommends a program of governmental assistance involving the establishment of a national industrial information service, a national statistical service, a national health policy, a nation-wide program of industrial standardization and a revision of such federal laws as interfere with stabilization of industry through trade associations and similar organizations.

Numerous other committees made reports at this meeting of Council, but no important action was taken. The next meeting probably will be held in September, at which time it is likely that a president will be elected to succeed Mr. Hoover. The Council voted to send out nomination blanks.

Three new organizations were elected to membership in the Federated American Engineering Societies. These are: Jamestown Engineering Society, Vermont Society of Engineers and Technology Club of Syracuse.

Exercises at Edgewood Arsenal

Special exercises were held at Edgewood Arsenal on June 4 in commemoration of the anniversary of the establishment of the Chemical Warfare Service as an integral subdivision of the Army. In addition to addresses in which the accomplishments of the year were reviewed, there was a minstrel show, moving pictures and a dance.

A. C. Fieldner Becomes Superintendent of Pittsburgh Station, Bureau of Mines

The important post of superintendent of the Pittsburgh station of the Bureau of Mines has been filled by the appointment of Arno C. Fieldner. Mr. Fieldner has been the acting superintendent of the station since June, 1920. An administrative assistant will be employed, so that Mr. Fieldner may carry on the greater part of his research work. He will continue to discharge the duties of supervising chemist. As superintendent, Mr. Fieldner will receive a salary of \$5,000.

While Mr. Fieldner has demonstrated that he has unusual executive ability, he has been disinclined to accept an administrative position. Former Director Cottrell, of the Bureau of Mines, and Director Bain each has been anxious that Mr. Fieldner continue uninterruptedly on his research work. A determined effort has been made to secure a properly qualified person, other than Mr. Fieldner, for the position. The difficulty is, however, that such engineers are unwilling, or are not in a position, to make the financial sacrifice necessary with the Government's scale of salaries.

Experimental work calling for nearly \$400,000 a year is being conducted at the Pittsburgh station.

Mr. Fieldner formerly was a member of the U. S. Geological Survey. He went with the Bureau of Mines at the time its work was separated from that of the Geological Survey. During the war he was transferred to the Chemical Warfare Service, where he attained the rank of major. On June 13, 1919, he was re-transferred to the bureau and was made supervising chemist at Pittsburgh. Since the promotion of E. A. Holbrook to be assistant director of the bureau Mr. Fieldner has acted as superintendent.

Patent Amendment Proposed

In the interest of the national defense and to prevent unwarranted advantages to foreign inventors, Senator Stanley of Kentucky has proposed an amendment to the Revised Statutes providing that any patents issued to foreigners must be put in operation and production in reasonable quantities begun within the continental limits of the United States within two years. Failure to comply with that provision entitles the United States to issue a license which will permit use of the patent.

The legislation, Senator Stanley states, is intended to prevent such a situation as arose at the outbreak of the war when the United States was cut off from supplies of dyes which were made only in Germany. German interests had American patents covering more than 1,000 coal-tar products. Had these interests been required to manufacture their products in the United States American industries depending on them would not have been paralyzed. Senator Stanley points out that practically every other nation has a law requiring compulsory production, within the country, of patented articles taken out by foreigners.

American Ceramic Society Announces Summer Meeting

The American Ceramic Society's summer meeting will be held at Canton, Alliance, Sebring and East Liverpool, Ohio, July 25 to 27 inclusive, with headquarters at the Hotel Courtland, Canton, Ohio.

Among the plants visited in Canton will be the Deuber Watch Case Co. On the evening of July 25 a banquet will be held at the Canton Country Club. On Tuesday the members will visit ceramic plants in Alliance, closing the day with a dinner party and smoker at Myers Lake. Wednesday, the 27th, will be devoted to visiting plants in the East Liverpool district.

Research Council Chemical Division Officers Elected

Dr. F. G. Cottrell has been re-elected chairman of the Division of Chemistry and Chemical Technology of the National Research Council for the year beginning July 1. Julius Stieglitz was elected vice-chairman. The executive committee, in addition to Drs. Cottrell and Stieglitz, will be composed of W. D. Bancroft, R. B. Moore, W. F. Hillebrand and C. G. Fink.

Members at large of the Division of Chemistry and Chemical Technology, elected for three years, are Treat B. Johnson, New Haven, Conn., and R. B. Moore, Washington, D. C.

Representatives of constituent societies have been selected as follows:

American Chemical Society—C. E. Franklin, Stanford University, California; John Johnston, Yale University, New Haven, and J. E. Teeple, New York City.

American Ceramic Society—Albert V. Bleininger, Bureau of Standards, Washington.

Dr. Cottrell Goes to Europe

Dr. F. G. Cottrell, chairman of the division of chemistry and chemical technology of the National Research Council, sailed June 11 for Europe to make a survey of the applications being made of helium in European countries. He also will make a special study of oxygen separation and concentration. In this work he is representing the U. S. Bureau of Mines as well as the Research Council.

While in Europe Dr. Cottrell will attend the meeting of the International Union of Pure and Applied Chemistry, which is to be held in Brussels June 27. Other delegates selected by the National Research Council to attend the Brussels meeting are E. S. Chapin, Frederick G. Keyes, Collin McCall, H. S. Taylor and James B. Conant.

Chicago Meeting of the Refrigerating Engineers

The American Society of Refrigerating Engineers held its eighth Western meeting at the Hotel Drake, Chicago, May 25 to 27.

BUSINESS SESSION

One of the most important items that this association has under advisement is the preparation of a mechanical refrigeration code, a committee of the society working in co-operation with the American Engineering Standards Committee. A tentative code was presented to all the members present and considerable discussion followed, several exceptions being taken particularly to the pressures listed for ethyl chloride, sulphur dioxide and methyl chloride, which were said to be too high compared with the corresponding pressures given for ammonia. Other members took exception to the fixed specifications on electrical equipment as regards its being isolated from the refrigerating equipment in the power house. It was further agreed that the lower limit of three tons as the size of plant requiring a licensed engineer was an unreasonably low figure, which should be raised to twenty or thirty tons.

In the discussion on the Bureau of Standards work with anhydrous ammonia it was decided that the two fellowships which are maintained by the society at the expense of about \$6,000 per year should be continued for the coming year. By 1923 the work on the anhydrous ammonia tables will be completed and some work started on CO₂. Furthermore, it is expected that the Government will appropriate enough money to continue this work indefinitely for the benefit of the industry.

MULTIPLE EFFECT COMPRESSION

H. C. White of the Consumers Co., Chicago, delivered a paper on "Multiple Effect Compression," where a method is employed consisting of first filling the compressor cylinder with low-pressure gas and then near the end of the stroke switching over the valves and admitting gas at higher pressure to compress the charge and fill the cylinder with the denser gas. Machines of the Consumers Co. have been equipped with these Voorhees devices, resulting in considerable gain in economy.

Data were given on a single-acting compressor with a condenser pressure of 185 lb. and a suction pressure of first 20-lb. gage and then 35-lb. gage. In the first case it was necessary to compress 4.17 cu.ft. of gas per ton of refrigeration with a compression horsepower of 1.336, while in the second case 2.84 cu.ft. was compressed with a horsepower 0.98, showing that 47.5 per cent more capacity was obtained and 26.5 per cent less power was used per ton of refrigeration. For each pound increase in suction pressure the saving was placed at 1.76 per cent.

BRINE SPRAY REFRIGERATION

S. C. Bloom, in discussing "Brine Spray Refrigeration," compared a new type of nozzle which gave a hollow cone-shaped spray with the earlier inefficient devices giving a coarse flat spray. One of the earlier methods was to use a plugged nipple discharging against a plate, or an adjustable nozzle which the operator could change at will. Pressure ranged from 20 to 70 lb., although 25 lb. would have been sufficient in most cases. Spaces between nozzles in the older types varied from 12 to 48 in. according to the notion of the designer and mains were further connected in parallel so that reduction of pressure on one would affect all. Brine temperatures employed ranged from 8 to 20 deg. F. and the height from deck to ceiling averaged from 6 to 8 ft. It was further commonly thought that the stronger the brine solution the better would be the results.

Improvements in the deck system of spraying had been sought by the author and applied quite extensively in the Chicago plants of Armour & Co. A weak brine solution was used and the problem of obtaining better circulation and more rapid cooling was undertaken. The nozzles formed a spray of a hollow cone shape and were so spaced that the cones of spray intermixed and filled the entire space of the cooler loft. Experiments showed the most suitable pressure was 7½ lb. Gravity tanks were arranged above the nozzles to prevent variation in pressure and this, coupled with non-adjustable nozzles, made a system practically fool-proof. Experiments showed that the latter type of system was much more desirable. In modern installations more brine surface is presented to the air and more rapid circulation obtained through the brine and proper spacing of nozzles, all of which makes better concentration of ammonia at the power house.

SPRAY COOLING SYSTEMS

O. J. West read a paper on "Spray Cooling Systems," which brought out the great increase in cooling capacity obtained by the use of sprays as compared with a basin or pond without sprays. The proper use of piping arrangement was suggested, operating pressures were given and nozzles described. The spray system is coming into greater use, there now being over 2,000 installations in the United States.

FUNDAMENTAL CONSTANTS

E. F. Mueller, of the U. S. Bureau of Standards, presented a report on the progress in the determination of the fundamental constants of refrigeration engineering, including a set of standard anhydrous ammonia tables. These tables may be obtained by addressing the Bureau of Standards at Washington, D. C., or securing a copy of the January issue of the *Journal of the American Society of Refrigeration Engineers* published at 154 Nassau St., New York.

REFRIGERATION IN RUBBER MANUFACTURE

"Refrigeration in the Manufacture of Rubber" was given by J. H. Vance. Since the raw rubber arrives at the factory full of dirt, bark and wood chips, it is first necessary to wash it. This process is carried on by passing the material through cast-iron rolls made with chilled surfaces and so corrugated that a crushing and shearing action takes place as the rubber passes through. From these rolls it enters the washers and sheeters, whence it emerges in the form of a thin irregular sheet. The wash water at this point must be below 76 deg. F. to prevent tackiness, and often refrigerated water must be used to maintain this temperature.

After the rubber is thoroughly washed it is passed into drying rooms or vacuum driers and passes through hollow

rolls, where it is masticated. These rolls operate in pairs with a speed ratio of $1\frac{1}{2}$ to 1 revolution. From the drying room the material is passed to the mixing mill, which consists of sets of rolls for working the rubber. Each set consists of two hollow cast-iron cylinders with smooth surfaces operating at a speed of 1 to $1\frac{1}{2}$ revolution ratio. This operation causes a grinding of the rubber at the same time the additional compounds are being mixed in. The friction at this point generates so much heat that it is absolutely essential to use refrigerated water to keep these rolls at the proper temperatures. In a typical plant where 5,000 gal. of water per minute was used, figures were taken to determine the exact amount of refrigeration required.

The mixing heat on rolls varies widely but must be kept below 176 deg. F. to prevent scorching of the rubber. In this particular plant in question the water temperature on entering the inside of the hollow roll was 58 deg. F. and the return water was 64 deg. F. In making the calculations for refrigeration count was taken of the friction load, driving load, thickness of metal and other factors. It developed that 788 hp. was consumed in the operation, producing enough heat to require 167 tons of refrigeration. In carrying the figures down it developed that one-sixth of a ton of refrigeration was required per lineal inch of roll face to maintain the necessary temperature.

Other papers presented were "Automatic Appliances for Refrigerating Machines," "Modern Air Compressor Practice and Testing," "Water Treatment for Raw Ice" and "Egg Shell Sterilization for Cold Storage." The convention closed with an informal dinner at the Hotel Drake and various plant trips in the vicinity of Chicago.

Program Arranged for New Jersey Clay Workers Meeting

In connection with the program for the summer meeting of the New Jersey Clay Workers Association and Eastern Section of the American Ceramic Society, to be held at Trenton, N. J., on June 17, Prof. George H. Brown, director of the Department of Ceramics, Rutgers College, New Brunswick, and secretary of the association, has arranged for a number of interesting papers and addresses. Among these will be a technical paper on the subject of "Hollow Building Tile," by Walter A. Hull, United States Bureau of Standards, Washington, D. C., and a lecture by Prof. A. S. Watts, Ohio State University, Columbus, on "Factory Preparation and Burning of Whiteware Bodies." An address will be made by William Burgess of the United States Potters' Association. At both morning and afternoon sessions there will be a discussion of practical problems pertaining to the ceramic industry, such as kilns, kiln firing, saggers, etc. It is proposed to arrange a trip to a number of representative local potteries.

American Farm Bureau Federation Report on Muscle Shoals

The executive committee of the American Farm Bureau Federation has approved unanimously the report prepared by the special committee appointed to investigate the entire Muscle Shoals project. After thorough study the committee recommends that the Wilson Dam be completed by the Government without further delay and that the nitrate plants be placed under the direction of a Government owned corporation which may, at its discretion, operate the plants or maintain them ready for operation, but with strict regulations as to prices to be obtained for commodities in which the products of these plants are used.

Will Discuss Plastering Code

Chapter 3 of the proposed national plastering code will be discussed at a conference at the Bureau of Standards June 20. This chapter is devoted to plaster materials. Chapter 1 of the proposed code has been completed. It deals with masonry backing for plaster. Chapter 2 deals with lath backing and is nearly completed. Chapter 4, dealing with mixing and application of plaster, was recently started. Chapters to be written later include "Properties of Finished Materials," "Methods of Testing Finished Plaster" and "Patching and Decorating."

Chicago Section of American Ceramic Society Holds Spring Meeting

Members of the Chicago Section, American Ceramic Society, met at an informal dinner on May 23 for the spring business session and presentation of informal papers.

REFLECTOR ENAMELS

Cullen W. Parmelee abstracted a paper on the development of a reflector enamel, being the thesis of William R. Morgan and A. H. Charles of the University of Illinois. Tests were run to determine the combined effect of cobalt and nickel in ground coat for sheet steel enamel. Comparisons were made of color and texture and impact tests were carried out on the pieces. It was found that 900 deg. C. was the most favorable temperature to which the enamel should be heated. The toughness of the enamel decreased as the temperature was increased above this point. The best mixture of the two oxides was determined as 1 per cent nickel oxide and 1 per cent cobalt oxide. It was concluded that the presence of nickel is conducive to uniform color and that the amount of cobalt oxide necessary is in excess of that used in general practice. An increase in the percentage of total color oxide content decreases pinholing at the proper maturing temperature. Cobalt oxide is valuable as an indicator of maturity.

Further experiments were made with chromium oxide, spinel and tin oxide in enamel. The tests showed that tin oxide has the highest reflecting power, spinel the next highest and zirconia the least amount. The practical limit for the quantity of tin oxide added is 10 per cent. Spinel is interesting as a substitute for tin oxide using about 8 per cent. It is, however, about 10 per cent less efficient than tin oxide.

PYROMETRY

G. V. Nightingale and F. C. Baker conducted an instructive discussion on pyrometry, with particular reference to the types used in industrial practice. The recording pyrometer is an accurate check on the clay burner. The potentiometer is the most accurate type of instrument used but it is difficult to get the operators to give it the proper care.

BUSINESS MEETING

A motion was carried after considerable discussion to have a committee appointed for meeting with a similar committee from the Illinois Clay Manufacturers Association, such joint committee to consider the amalgamation of the Chicago Section of the American Ceramic Society with the Illinois Clay Workers Association.

Motion was carried to place the power in the hands of the executive committee of the local section to appoint four members for service on the advisory board of the University of Illinois.

Chester H. Jones was nominated to serve on the committee of the national society for selecting American Ceramic Society national officers for the coming year.

Research Work on Electrodeposition

During the past month a member of the Bureau of Standards staff attended meetings of the American Electrochemical Society in the interests of research work on electrodeposition. A great deal of interest was shown in the proposed program and plans were made for the formation of a division of the society to be concerned wholly with this kind of work. If such a division is organized, it will be a distinct advantage in bringing together persons interested in this field and thereby stimulating research work along electrochemical lines.

Letters have been sent out by the National Research Council to about 200 representative manufacturers in whose plants electroplating is an essential process. The purpose of these letters is to inquire whether they would be willing to furnish financial support toward research work on electrodeposition. If such support is received, it is expected that the funds will be expended for research work conducted at the Bureau of Standards under the general supervision of a representative advisory board.

Industrial Alcohol Makers Not Satisfied

Manufacturers of industrial alcohol are far from satisfied with Representative Volstead's bill, supplementing the national prohibition act. In its final form, as reported favorably to the House of Representatives, language was added specifically stating that nothing in the bill is to authorize the prohibition commissioner to limit the quantity of alcohol that may be manufactured.

The parts of the bill to which most objection is taken are sections 3 and 4. As presented to the House, these sections read as follows:

SEC. 3. The commissioner shall only grant the permits that are necessary to supply the actual needs for non-beverage purposes and shall limit the supply and use of all liquor save denatured alcohol and denatured rum unfit for internal use to such non-beverage needs. *But this provision shall not authorize the commissioner to limit the quantity of alcohol that may be manufactured, nor shall it be taken to repeal the right of the applicant for a review of the decision of the commissioner in refusing a permit by a court of equity as provided in the national prohibition act.* If the commissioner shall find that any article enumerated in subdivisions b, c, d, or e of section 4 of title 2 of the national prohibition act is being purchased for use as a beverage, or for intoxicating beverage purposes, he may require a change of formula of such article or cancel the permit for the manufacture of such article unless it is made clearly to appear to the commissioner that such use can only occur in rare or exceptional instances.

No intoxicating liquor other than alcohol shall be used in the manufacture of any article enumerated in subdivisions b, c, d, and e of section 4, title 2 of the national prohibition act unless it shall clearly appear to the satisfaction of the commissioner that the use of intoxicating liquor other than alcohol is essential as a component part of such article.

SEC. 4. Not less than twenty days before an annual permit is issued for the sale of any liquor or the manufacture of any liquor or any article enumerated in subdivisions b, c, d, and e of section 4, title 2, of the national prohibition act, the application therefor shall be filed with the commissioner and made a public record, and notice thereof shall be served by registered mail on the Attorney General and the commissioner may require such notice to be publicly posted at the applicant's place of business as regulations may prescribe. Any federal or state officer or any person authorized thereto by any such officer may oppose any such application.

Despite the objections raised to dual control by the prohibition commissioner and the Attorney General, no change was made in that part of the original bill. The committee did accede to the objections voiced against the requirement that a part of the component materials must be added to alcohol at the distilleries. Users of industrial alcohol also objected to the requirement that the permit be publicly posted at the applicant's place of business. It was argued that this requirement places the industrial users of alcohol on much the same footing as saloons formerly were.

Secretary Hoover on Trade Associations

The attitude of the federal administration toward the trade organizations of the various industries has been made clear by recent announcements by the Secretary of Commerce and by the Attorney General. The Attorney General has given notice that he will push a test case against one of the open-price associations. There will be no dragnet thrown over all the associations and there will be no wholesale indictments, Attorney General Daugherty declared. Secretary Hoover authorized the following statement:

The relation of trade associations and trade institutes to the anti-trust laws have been discussed at great length in the Administration. Of the many thousands of such organizations there are a small minority who have degenerated into ways that make for restraint of trade.

All are agreed that the purposes and actions of the vast majority of national associations are a constructive contribution of public welfare. Their activity in promotion of better business practices, advancement of technical processes, simplification of produc-

tion standardization of quality, extension of foreign trade, commercial arbitration, etc., makes for more efficient industry and business. Many of them collect information as to the production, stocks of raw and other material, percentage of industry in active operation, and total orders in hand, all of which when available to the public contribute both to stability and the increasing efficiency of industry and to the protection both of the smaller manufacturer and the consumer. The Department of Commerce wishes to co-operate and assist with all of this sort of effort.

A smaller number of such associations have been engaged in the collection of data on the prices for the exclusive use of their members. Some of these associations have been charged with delimiting areas of commodity distribution among their members and other misuse of information. Whether these latter practices constitute a violation of the national anti-trust laws must be determined by the courts, and this the Attorney General is vigorously proceeding to find out.

All this raises anew the question of the authority of the Federal Trade Commission. The original conception of the commission was that it should, among other things, advise business men as to what constituted a violation of the restraint of trade laws, but these powers were struck out in the course of original legislation. It seems to me that the seven years' experience with the commission should now enable a reconsideration of its powers with a view to giving it a more constructive function, subject say to review by the Attorney General, by which it could remove the uncertainties from the mind of business men as to the line between the field of co-operation for promotion of production and trade in public interest and the field of practices against public interest. There is nothing so destructive of business as uncertainty, and business has inherently enough uncertainty to deal with, without this one.

Hercules Powder Co. Acquires Aetna Explosives Co., Inc.

Rumors of the proposed purchase of the Aetna Explosives Co., Inc., by the Hercules Powder Co. received definite confirmation last week, when the Aetna stockholders sanctioned the sale of its properties, assets and business. This marks the culmination of a transaction that has interested financial and business circles for the past two years, and which in addition to being a deal of considerable moment also presents an unusual legal aspect.

Although it has been understood practically since the close of the war that negotiations were under way between these two manufacturers, it was not until the petition of the Hercules company for permission to purchase the Aetna company had been acted on favorably by the Circuit Court of Appeals, sitting as the United States Court for the District of Delaware, that the proposition assumed any real definiteness. The Hercules company was originally created by a decree of a federal court in an action brought by the United States against the du Pont company under the Sherman act. Although not a party to this action, the Hercules company is bound by certain injunctions in the final decree, and for this reason it was deemed necessary to petition the court for permission to effect the present transaction. On May 4, a decision was rendered on the Hercules company's petition, sanctioning the purchase of the Aetna company, in which the court expressed itself as convinced that in permitting the Hercules Powder Co. to buy the Aetna company actual competition would be undiminished and even probably increased, especially as regards the Hercules company's strongest rival, the du Pont company.

By this purchase the Hercules company will acquire high explosives, or dynamite, plants near Birmingham, Ala.; Emporium, Pa.; Sinnamahoning, Pa.; Ishpeming, Mich.; and Fayville, Ill.; two black blasting powder plants, one at Goes Station, Ohio, and the other near Birmingham, Ala.; a plant for the manufacture of blasting caps and electric blasting caps at Port Ewen, N. Y., and a plant for the manufacture of fulminate of mercury, for use in blasting caps, at Prescott, Ont., Canada.

The company states that reorganization and new alignments of branch office territories will take place gradually.

Water Purification

The last meeting on the 1920-21 program of the Connecticut Valley Section of the A.C.S. was held in Westfield, Mass., on May 22. The members were entertained for dinner at the Mt. Tekoa Country Club. The afternoon was given up to a trip to the Borden Brook reservoir and filter plant, which forms a part of the water supply of Springfield, Mass. About thirty members made up the party for the trip and thanks to the courtesy of the members of the staff at the filter plant enjoyed a most instructive excursion.

Prof. Whipple, of the Harvard Engineering School, was the speaker at the evening meeting. His subject was "Water Purification."

Dr. Whipple showed a series of charts illustrating the various qualities of the waters of Massachusetts used for town and city water supplies. These charts showed color, sediment—the sediment in these waters is so slight that it cannot be expressed in terms of the silica standard—iron, hardness, chlorine and other factors. For the most part the waters of Massachusetts are low in color and in carbon dioxide and are in general very soft waters. Some, however, are quite corrosive.

Some recent European work, he said, has shown a balance between carbon dioxide, carbonate and bicarbonate. If there is more carbon dioxide in the water than this relation calls for, the waters are corrosive. For this reason apparently the most corrosive waters of the state are soft waters.

Filtration of waters to be successful must do much besides cleaning up water from a sanitary standpoint. Some methods now used increase corrosion by increasing the carbon dioxide and reducing the bicarbonates in water. For this reason alum is not entirely satisfactory as a coagulant. He said that we formerly considered that the action of alum in water was simple. It is now known to be very complex. Conductivity methods have shown this especially well. He referred to the article by Abel Wolman and Frank Hannan, published in *CHEMICAL & METALLURGICAL ENGINEERING*, vol. 24, pp. 728-34, as illustrating this point and invited contributions along such lines as this from all chemists who might find opportunity to do work in this field.

Study of the reactions involved in various methods for water-treating which would show the time necessary for the reaction to be completed is very necessary, he said, for if the time between treatment and filtering is too short the reaction will go to completion afterwards and will probably cause trouble. He read a letter from Allan Hazen bearing on this point specifically. Mr. Hazen believes that the time factor in settling of waters has been underestimated and that more attention must be paid to it. Some waters contain compounds which retard the formation of the alumina flock.

With regard to industrial water purification Dr. Whipple said that he believed that there was a relation between color and dissolved alumina. Sometimes waters are found that will not respond to a softening treatment until they are heated. Soft waters are the most troublesome in this respect. He thought that new methods might be worked out to largely replace those now in use.

The corrosive problem has not yet been properly handled. He quoted Prof. Phillips of Harvard, who believes that the presence of electric currents generated by couples formed at the junction of dissimilar elements may be a source of some of the trouble. Another factor of importance in water-treatment, especially where mechanical filters are used, is the handling of the alumina flock and its removal by the filter bed. Pipes of the largest diameter possible should be used to pass the water to the filters so as to have the stream flow as slowly as possible in order that the alumina flock may not be broken up.

To Extend Aid to Export Industries

Details of the plan of the Secretary of Commerce to aid the export industries now are being worked out. Each of the industries is to be separated into subdivisions. Three of the chemical subdivisions have been agreed upon and others are to be chosen later. The three subdivisions which have been decided upon at the time of this writing are dyes, drugs and phosphates.

Personal

E. D. FROHMAN, of the S. Obermayer Co., Pittsburgh, Pa., has gone to Europe, where he will make a special study of the application of high-temperature cements for boiler and metallurgical furnace linings.

ELLWOOD HENDRICK, consulting editor of *CHEMICAL & METALLURGICAL ENGINEERING*, received the honorary degree of Doctor of Science from Franklin and Marshall College of Lancaster, Pa., on Commencement Day, June 8.

SIDNEY D. KIRKPATRICK has joined the editorial staff of *CHEMICAL & METALLURGICAL ENGINEERING*, with headquarters in New York. He was until recently a chemical expert for the U. S. Tariff Commission, Washington, D. C.

HARAI R. LAYNG, of the Eureka Holly Mining Co., has resigned and is now practicing as a metallurgical engineer in San Francisco. He was superintendent of both the Holly and Bullwhacker mines, and later designed and constructed a 15-ton experimental chloridizing volatilization plant, completed last March.

C. E. MCQUIGG is continuing research work for the Union Carbide & Carbon Corporation at the new Long Island City laboratory, instead of at Niagara Falls, N. Y.

Dr. ERNEST FOX NICHOLS was inaugurated as president of the Massachusetts Institute of Technology, Cambridge, Mass., on June 8.

F. H. PENDLETON, formerly chemist with the New England Bureau of Tests of Boston and more recently research chemist with the Gorton-Pew Fisheries Co., Gloucester, Mass., has joined the staff of Skinner, Sherman & Esselen, Inc., Boston, Mass.

WALLACE SAVAGE has resigned as assistant editor of *CHEMICAL & METALLURGICAL ENGINEERING* to take effect June 30. He will devote his attention to the commercial development of an asphalt expansion joint designed by him for use in concrete construction.

WILFRED W. SCOTT has resigned as research chemist of the General Chemical Co. and has accepted the position of associate professor of chemistry in the Colorado School of Mines, Golden, Col.

T. F. SULLIVAN, who has been in charge of construction for the new paper mill of the Riordon Co., Ltd., at Temiskaming, Que., has accepted a position as sales engineer with the Springfield Boiler Co., Springfield, Ill.

Obituary

W. B. COGSWELL, founder of the Solvay Process Co., died recently at his home in New York of blood poisoning resulting from an infected middle ear.

JOHN W. LEITCH died at Minesbridge, England, on May 20. Mr. Leitch was the pioneer British manufacturer of TNT and during the early days of the war was called upon to supply this explosive, which was so badly needed that it was used at the front within forty-eight hours after being manufactured. His plant and services were put at the disposal of the War Office and formed the nucleus of the great government TNT works. The heavy work of the early years of the war so told upon his health that toward the end of 1916 he had a breakdown following an attack of influenza which left his heart seriously affected. He recovered sufficiently, however, to resume his activities and in 1919 was appointed chairman of the mission sent to study some of the dye works in the occupied area of the Rhine. The two-volume report of this investigation is an eloquent testimony of the work done by this mission.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, June 13, 1921.

The heavy chemical market continues to show improvement, and activity is emphasized in several important items. It is sufficiently apparent that liquidation has brought about an actual shortage of goods in some instances and buyers have forced prices upward in their efforts to cover requirements. While this condition does not hold true throughout the entire list and while it is evident that manufacturers will readjust prices in some commodities, the fact that caustic soda, soda ash, oxalic acid, nitrite of soda and other important items have resisted any selling influence is quite significant that the bottom has practically been reached. If the strength shown in these commodities during the past week is to be permanent, then a decided improvement can be expected throughout the general list.

One of the most encouraging features was the intermingling of foreign inquiries with those for domestic requirements. It is reported that several inquiries were received from Italy, Mexico and the Far East. Europe is reported to have been in the market for numerous large quantities of caustic soda and in some instances these inquiries have turned into actual orders.

Importations have already been decreased since the new tariff legislation, which dampened the buying of foreign goods and shifted the inquiry to domestic materials. This has been particularly true in the case of oxalic acid. The heavy imports of oxalic, which have been flooding the country during the past six months, have been summarily stopped by a ruling from the Treasury Department classifying this article as a "synthetic organic chemical" and subject to the same license rulings as dyestuffs and intermediates under the emergency tariff measure. Quite a few importers, unaware that there would be any such decision, have been caught with goods afloat or ready to be shipped. The situation has thrown the market into confusion and holders of stocks in this country have forced their prices up as far as possible. Soda ash was among the commodities to report a net advance in the spot market at the close. Rumors were current throughout the week that buyers are greatly concerned over shipments of ash from England and many interests expected delays in view of the coal strike. The result was that domestic ash was taken and the buying movement was sufficiently heavy to reduce resale stocks and register a high market.

There was a noted improvement in the inquiry for caustic soda. It is stated that English caustic soda cannot be imported into this country below 5c. per lb. Small lots of bichromate of soda have attracted a great deal of attention from the consuming trade and the market recorded an advance for the week.

CHEMICALS

Small lot buying orders of *bichromate of soda* reached the open market in good volume during the past week and dealers have been able to advance quotations without much difficulty. It is the general opinion that the quantity of supplies in resale hands is comparatively small and there was a noticeable tightening up of offerings on various occasions. At the close the best price heard was 8½c. per lb. with most sellers asking 8½c. for standard brand material. A noticeable improvement in the general inquiry for *caustic soda* has taken place during the period under review. Demand has emanated from both foreign and domestic sources and enough buying orders have been shot into the market to keep prices as high as \$4.10 per 100 lb. Standard brands were offered sparingly in the late trading and the general outlook appeared quite favorable for maintenance of values. Outside makes were obtainable at a fraction below those named for standards. English caustic soda for shipment was offered at \$5 per 100 lb. N. Y. Producers quote

contracts for solid caustic at 3¼c. per lb., basis 60 per cent f.o.b. works, and 5c. per 100 lb. higher for single cars. Most dealers quoted *nitrite of soda* on spot at 7½@7¾c. per lb., and it is understood that small lot trading took place at 7¼c. per lb. and upward depending on seller. The feeling continues bullish in this material, although some factors are of the belief that the advancing tendency will likely be irregular on account of supplies being scattered. Spot *prussiate of soda* is quoted firm at 12¼@12½c. per lb., with sales noted at these figures. A fair inquiry is reaching the market for small lots and several interests are inclined to look for an advance in prices. There were rumors that eventually this chemical is likely to come under the same classification as oxalic acid and nitrite of soda, thereby requiring a license to import. Offerings of resale light *soda ash* continue quite small and dealers stated that it was doubtful if better than \$2.20 per 100 lb. could be done on any sizable quantity in single bags. Small lots were quoted at \$2.25@\$2.35 per 100 lb. Barrels were quoted at \$2.50@\$2.60 ex-store N. Y. The call for less than carlots was reported active.

Imported *barium chloride* was offered on spot at \$60 per ton and it is understood that some domestic goods can be purchased at the same price. Some business is reported in small quantities, but consumers show little interest in round lots at present. There was a noticeable scarcity of offerings in *oxalic acid* and prices were decidedly higher on a basis of 19½@20c. per lb. There was no lack of confidence on the part of dealers regarding the immediate trend of values. The ruling by the Government requiring a license to import this chemical is viewed by many to be a very strengthening factor. Leading producers of *zinc sulphate* have lowered their carlot price to \$2.90 per 100 lb. Small lots are moving at various figures up to 3¼c. per lb. The demand has not shown very much activity of late and prices have been established on a basis more attractive to the consumer. Prices on *white arsenic* are quoted lower at 6½@7½c. per lb. The demand has been extremely dull and stocks are heavy in many quarters. *Red arsenic* was also quoted slightly lower with the demand very slow. Quotations are now around 11@12c. per lb. Imported *ammonium nitrate* is offered around 7½@8c. per lb., according to seller and quantity. A fair demand has been noted. *Red phosphorus* in makers' hands is held at 50c. per lb., but the French imported material is offered at 40c. *Yellow phosphorus* from producers is quoted at 35c. per lb., as against 30c. per lb. named by importers. Carlots of *carbon tetrachloride* are offered by manufacturers at 10½c. per lb. f.o.b. N. Y. Small lots of five drums are held all the way up to 12c. per lb. Resale material is occasionally offered below these figures, but attracts little attention.

COAL-TAR PRODUCTS

Producers of coal-tar products are firmer in their views in most quarters and if any shading is possible it is only among second hands. There is a difference of opinion as to supplies among second hands, and while some say the surplus has been very much reduced, there are some who feel that stocks are still plentiful and in consequence inquiries are more to test prices and are not frequently followed by orders. There was a considerable improvement noted in the general condition of the textile industry, which is already reflected in the dyestuff market by an increase in the demand for colors.

Among intermediates *beta naphthol* is in steady demand and prices are firmer in most directions, ranging from 38@40c. per lb. Makers of *para nitraniline* are quoting prices around 85@95c. per lb., with many resellers quoting the same figures. No definite lots could be located below this level, although the majority of resellers in the market seem to be of the opinion that business on a firm basis could easily be done at 82c. per lb. The determined effort on the part of some factors to keep prices up to 85c. per lb. rather lead to the belief that the market is not very firm. Prices on *para-nitrotoluene* are lower at 85@95c. per lb., according to quantity and seller. The market on *dimethylaniline* continues quiet with prices on the spot around 41@45c. per lb. There is a probability that this figure can be shaded on firm business, but stocks in most quarters are reported quite light.

Makers are holding their prices around 60@65c. per lb., according to quantity. The market on *aniline oil* seems somewhat steadier on an increasing inquiry. Spot resale stocks are being greatly depleted and inquiries are being turned over to producers. The general market price at present is around 20c. per lb. and business can be done freely at this level in spite of the high figures named by makers, up to 27c. per lb. *Naphthalene* continues dull with the inquiry very small and resale holders willing to make concessions to move stocks. Prices as low as 7½c. per lb. are named in some directions and it is understood that even these figures can be shaded on firm business. Holders of stocks seem to be getting very tired. Refiners are still holding their quotations at 8½@9½c. for the flake and 9½@10½c. per lb. for the balls, with very little business passing.

WAXES

Traders reported a quiet market for *beeswax*, but prices held on a steady basis in nearly all instances. Primary markets are well maintained. Crude African beeswax closed unchanged at 16½@17c. per lb. Brazilian crude held at 24½@26c. With little change at primary centers the market for *carnauba wax* showed no important price revisions locally. The volume of trading was quite easy, but no selling pressure was in evidence. No. 2 North Country held at 25@26c. per lb. spot delivery. No. 3 chalky closed at 17@18c. per lb., with the No. 3 North Country at 16@17c. per lb. No. 3 North Country for forward shipment held around 15c. per lb. Arrivals of *Japan wax* were larger, but this apparently was not reflected in any weakness in prices. Importers continue to quote the market at 18@18½c. per lb. for spot goods, while for near by slightly lower figures prevailed. Mail advices from Tokio reported a quiet but steady market despite the fairly liberal holdings. The market for *paraffine wax* again seemed to favor buyers and quotations were barely steady throughout the trade, with some prominent factors credited with shading in order to attract business. The export inquiry was dull. Stocks of paraffine are said to be large considering the amount of trading. Scale wax, 118-120 deg. melting point, was offered at 2½c. per lb. in carlots.

VEGETABLE OILS

Irregularity was noted in the prices named on *chinawood oil* for forward delivery and operators said that the situation was slightly easier. Offerings were noted at 10¾@11c. per lb. in barrels, June-July shipment from the Orient, New York basis. Spot oil was nominally unchanged around the 15c. level, although scattered lots sold at points outside at some concessions. Buying interest in *coconut oil* was confined chiefly to spot and near by, in barrels, for which prices held steady in all quarters. Refined edible oil was held at 12½@12¾c. per lb., cooperage basis. Ceylon style oil in barrels closed at 10½c. asked, but this figure was not firm. Loose oil for shipment from Manila was offered at 7¾c., Coast basis, with buyers' ideas holding at 7½c. per lb. Copra was unchanged at 5c. asked, N. Y., and 4½c., nominal, Pacific Coast points. There were no sales reported. Crude domestic *peanut oil* held at 5¾@6c. per lb., buyers' tanks, f.o.b. mills. The demand was quiet and prices were barely steady. Oriental oil was in limited supply on the Coast and the prices were purely nominal around 6@6½c. per lb., sellers' tanks. Deodorized oil in barrels held at 10½c. per lb., N. Y. Crude *soya bean oil* for prompt shipment held at 5½c. per lb., sellers' tanks, Coast, with offerings reported light. Soya bean oil in barrels was unchanged here at 7¾@8c. per lb.

The St. Louis Market

ST. LOUIS, Mo., June 10, 1921.

A careful survey of the drug market disclosed that the second-hand lots in hands of weak holders are practically absorbed, which tended to give the market a better and firmer tone. The fine chemical business has been fairly good, while a more quiet condition prevails in the heavy and industrial chemical lines. Consumers are still indisposed to place large orders and anticipate their requirements. The commercial acids have improved considerably and orders of larger volume are being received.

The *caustic soda* demand continues very weak, with the big buyers adhering to the hand-to-mouth policy. Prices range from \$3.85@4.50 per 100 lb., basis 76 per cent, according to quantity purchased. The *soda ash* market is extremely dull with the prices still ranging at \$2.90 per 100 lb. and upward. *Bicarbonate of soda* is being offered in less than carlot quantities at \$2.50 per 100 lb., which figures less than the manufacturers' cost f.o.b. works, plus freight.

INDUSTRIAL CHEMICALS

Sulphur continues to enjoy a fair demand with prices holding firm at \$2 per 100 lb. for the commercial in bags. *Ammonia water* continued along the lines previously reported and some fair-sized orders are being placed. The *carbon bisulphide technical* market is not very active. The limited uses to which this material is put mitigate against an active market at this moment. *Copperas* has been slow and ruling at \$19.50@21 per ton. The *zinc* market has been very quiet the past week, with *sulphate* ruling at 3¼c. The *oxide leaded* 5 per cent is holding at 8c., while the *lead free* is ruling at 8¾c. *Soda hyposulphite* is enjoying a fair business in a routine way.

DRUGS AND PHARMACEUTICALS

Acetanilid has shown a stronger position lately. There is a limited demand for *acetphenetidin*. The *chloral hydrate* business is normal with a regular demand. *Bismuth* preparations are fairly active, but should show a greater demand, as this is the season for *bismuth salts*. The *bromides* continue to move in a very small way due to the large lots being sent into this market by the foreign manufacturers. There is a limited business transacted on *caffeine*. There has been a material increase in business for *scale salts*, particularly the iron and ammonium citrate brown scales, which has been moving very briskly in the last week or two. *Cream of tartar* is enjoying a very good demand and orders of large volume are being filled. *Ether* is holding its own. *Glycerophosphates* are moving very well at factor's schedule. The second-hand lots of *iodides* that are still disturbing this market tend to keep down an increase in business and manufacturers are getting only their routine business. Manufacturers have reduced their prices on *hard mercurials* with a fair demand. A fair-sized business on *saccharine* is reported and factors are in position to fill orders promptly. The demand for *sodium benzoate* is keeping pace with the season, and manufacturers report a brisk movement. Now that prices on *salicylates* seem to be more firmly established, there has been a noticeable increase in the demand. *Glycerine* is being freely contracted for at 16½c. for six months with protection, and buyers are urged to take advantage of what is generally considered too low a price for this item.

ACIDS

Manufacturers report an improvement in the demand for *hydrochloric*, *nitric* and *sulphuric*, commercial grades, which they attribute to the fact that many industrial plants are again in operation. *Carbolic acid crystals* has enjoyed a better demand recently. The demand for *citric acid* at this moment is practically nil, due to the unseasonable weather for soft drinks, but stocks should not be allowed to decrease as the summer season is just beginning. Due to the resumption of aniline dye manufacture, there has been a noticeable increase in the demand for *gallic acid*. The status of *phosphoric acid sirupy* is the same as *citric*, as the two commodities are allied in the manufacture of soft drinks. *Salicylic acid* is moving briskly and being a seasonable product a larger volume of business is to be expected. The market on *tartaric acid* has been firm and commanding a good demand. The *tannic acid* market is firm with a fair business.

VEGETABLE OILS

Linseed reached a maximum of 80c. and today holds at 78c. in cooperage from warehouse. The general impression of the trade is that even higher prices may prevail. *Turpentine* demand is routine with price at 61c. unfirm. The price of 10½c. for *castor oil* in drums continues very firm in spite of only a fair demand.

The Iron and Steel Market

PITTSBURGH, June 10, 1921.

The steel market in the past week has given a fresh exhibition of the depth of dullness to which it can sink. Literally an order for 100 tons is now a large one for a steel mill, and even carload orders are scarce.

STEEL PRODUCTION

The monthly report of the American Iron and Steel Institute, showing steel ingot production in May, indicates that the month's production was larger than had been estimated, even at the close of the month, for the rate of output was substantially the same as the rate in April, and indeed a shade heavier. The May average was, however, made up by a considerably higher rate than the average at the beginning of the month and a considerably lower rate at the close. An item in the same connection is that while the total output was about the same for the two months, the independents produced more in May than in April, while the Steel Corporation produced less.

Production of steel ingots, which was at a shade above 30 per cent of capacity in both April and May, is now at a rate of about 25 per cent, possibly somewhat less, and the present outlook, based on the extremely light buying and specifying of the past few days, is that a rate of 20 per cent or less will be reached before the end of June, making production at about 10,000,000 tons per annum, equal to the output in 1900, the year before the Steel Corporation was formed.

In recent weeks the steel trade has endeavored to form a conception of what is "the minimum rate of consumption" of steel, assuming simply the condition of there being "hard times" or "a severe industrial depression." Experience before the war showed that production never dropped below about 50 per cent of capacity, and it looked as if there might be a rule. The recent effort has been abandoned, it being made quite clear that the flow of steel from mills is not in relation to the severity of a business depression. The flow of steel could stop entirely and yet for a time the major part of the business of the country could be conducted, for the various users of steel could get along, to an extent, with what they had.

It is seen now that there must be a liquidation of stocks all along the line, not simply of stocks of steel in the hands of manufacturing consumers, but of stocks of their finished wares, whether in the hands of the manufacturers or the distributors, and the general public, the ultimate buyer, must develop a desire to buy and accumulate an ability. The process is expected to be slow, but the low point for many years in the flow of steel from mill is likely to be reached within a very few weeks. The probability is very strong that there will be an upturn in August, but it will be an upturn from such a low point that it will be gratifying chiefly as showing a trend in the right direction.

STEEL PRICES

It is said that there is "an open market" in steel products, though the term is not precisely defined. The attitude of the majority of sellers is that they have no particular incentive to maintain the prices lately in force and will make concessions in price if thereby they can get orders that are worth while. The difficulty is that practically no business is offered. There is reason to believe that the Steel Corporation will not do as it did last February and March, when it adhered to its regular prices despite cutting by practically all the independents. This time it is likely the corporation will meet any widespread cutting by independents. In wire products the corporation has already done this, and nails, plain wire and galvanized barb wire are quotable respectively at \$3, 2.75c. and 3.85c., or \$5 a ton below what are known as April prices. Plates, formerly at 2.20c., have sold at 2c. even in small lots, though it is not known at this writing that the Steel Corporation has met the figure. Shading in sheets is growing.

PIG IRON

Foundry pig iron at valley furnaces is off 5c. to \$22.50. Basic, which was uncertain at \$21.75, is now plainly quotable to \$21.50, bessemer remaining at \$23.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.			\$0.40 - \$0.45	
Acetone.....lb.	\$0.12½ -	\$0.12½	.13 -	.13½
Acid, acetic, 28 per cent.....100 lbs.	2.50 -	2.75	3.00 -	3.25
Acetic, 56 per cent.....100 lbs.	4.00 -	4.25	4.50 -	5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	9.75 -	10.00	10.25 -	10.50
Boric, crystals.....lb.	.13½ -	.14	.14½ -	.15
Boric, powder.....lb.	.15 -	.15½	.16 -	.16½
Citric.....lb.			.45 -	.46
Hydrochloric.....100 lb.	1.50 -	1.65	1.75 -	2.00
Hydrofluoric, 52 per cent.....lb.	.12½ -	.12½	.12½ -	.13
Lactic, 44 per cent tech.....lb.	.10 -	.11	.11½ -	.12
Lactic, 22 per cent tech.....lb.	.04½ -	.05½	.06 -	.07
Molybdic, C. P.....lb.	4.00 -	4.50	4.50 -	5.00
Muriatic, 20 deg. (see hydrochloric).....lb.	.06½ -	.06½	.07 -	.07½
Nitric, 40 deg.....lb.	.07½ -	.07½	.07½ -	.08½
Nitric, 42 deg.....lb.	.19½ -	.20	.21 -	.22
Oxalic, crystals.....lb.	.17 -	.17½	.18 -	.19
Phosphoric, Ortho, 50 per cent solution.....lb.	.20 -	.25	.27 -	.35
Picric.....lb.			1.90 -	2.15
Pyrogallic, resublimed.....lb.			11.50 -	13.00
Sulphuric, 60 deg., tank cars.....ton			13.00 -	15.00
Sulphuric, 60 deg., drums.....ton	18.00 -	20.00		
Sulphuric, 66 deg., tank cars.....ton	22.00 -	22.50	23.00 -	23.50
Sulphuric, 66 deg., drums.....ton				
Sulphuric, 66 deg., carboys.....ton	23.00 -	24.00		
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	25.00 -	26.00	26.50 -	27.00
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	31.00 -	32.00	33.00 -	34.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton			.90 -	1.00
Tannic, U. S. P.....lb.	.50 -	.52	.54 -	.57
Tannic (tech.).....lb.			.30 -	.32
Tartaric, crystals.....lb.			1.30 -	1.40
Tungstic, per lb. of WO.....lb.			4.75 -	4.95
Alcohol, Ethyl.....gal.				
Alcohol, Methyl (see methanol).....gal.			.31 -	.36
Alcohol, denatured, 188 proof.....gal.			.38 -	.42
Alcohol, denatured, 190 proof.....gal.	.03½ -	.03½	.04 -	.04½
Alum, ammonia lump.....lb.	.03½ -	.04	.04½ -	.04½
Alum, potash lump.....lb.	.13 -	.13½	.14 -	.14½
Alum, chrome lump.....lb.	.01½ -	.02	.02½ -	.02½
Aluminum sulphate, commercial.....lb.	.03 -	.03½	.03½ -	.04
Aluminum sulphate, iron free.....lb.	.07½ -	.07½	.08 -	.08½
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.30 -	.32	.33 -	.35
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.08 -	.08½	.09 -	.10
Ammonium carbonate, powder.....lb.	.06½ -	.06½	.07 -	.07½
Ammonium chloride, granular (white salamoniac).....lb.	.07½ -	.08	.08½ -	.08½
Ammonium chloride, granular (gray salamoniac).....lb.	.07½ -	.07½	.08 -	.08½
Ammonium nitrate.....lb.	2.50 -	2.75	2.80 -	2.90
Ammonium sulphate.....100 lb.			4.00 -	4.25
Amylacetate.....gal.			2.50 -	3.00
Amylacetate tech.....gal.	.06½ -	.07	.07½ -	.08
Arsenic oxide, (white arsenic) powdered lb.	.11 -	.11½	.12 -	.13
Arsenic, sulphide, powdered (red arsenic) lb.	60.00 -	62.00	63.00 -	65.00
Barium chloride.....ton	.19 -	.20	.21 -	.22
Barium dioxide (peroxide).....lb.	.08½ -	.09	.09½ -	.10
Barium nitrate.....lb.	.04½ -	.05	.05½ -	.06
Barium sulphate (precip.) (blanc fixe).....lb.				
Bleaching powder (see calc. hypochlorite).....lb.				
Blue vitriol (see copper sulphate).....lb.				
Borax (see sodium borate).....lb.				
Brimstone (see sulphur, roll).....lb.	.41 -	.42	.43 -	.45
Bromine.....lb.	2.00 -	2.05	.06 -	.06½
Calcium acetate.....100 lbs.	.05½ -	.05½	.06 -	.06½
Calcium carbide.....lb.	24.00 -	25.00	26.00 -	27.00
Calcium chloride, fused, lump.....ton	.01½ -	.02	.02½ -	.02½
Calcium chloride, granulated.....lb.	2.15 -	2.25	2.35 -	2.50
Calcium hypochlorite (bleach/gpowder) 100lb.			1.40 -	1.50
Calcium peroxide.....lb.			.15 -	.16
Calcium phosphate, tribasic.....lb.			.70 -	.72
Camphor.....lb.	.06½ -	.07	.07½ -	.08
Carbon bisulphide.....lb.	.10½ -	.10½	.11 -	.12
Carbon tetrachloride, drums.....lb.			.75 -	1.00
Carbonyl chloride (phosgene).....lb.				
Caustic potash (see potassium hydroxide).....lb.				
Caustic soda (see sodium hydroxide).....lb.	.08 -	.09	.09½ -	.10
Chlorine, gas, liquid-cylinders (100 lb.).....lb.			.42 -	.44
Chloroform.....lb.			3.00 -	3.10
Cobalt oxide.....lb.				
Copperas (see iron sulphate).....lb.	.20 -	.21	.22 -	.23
Copper carbonate, green precipitate.....lb.			.50 -	.62
Copper cyanide.....lb.	.05½ -	.05½	.06 -	.06½
Copper sulphate, crystals.....lb.				
Cream of tartar (see potassium bitartrate).....lb.				
Epsom salt (see magnesium sulphate).....lb.			1.00 -	1.05
Ethyl Acetate Com. 85%.....gal.			.50 -	.52
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.	.14 -	.14½	.14½ -	.15
Formaldehyde, 40 per cent.....lb.			3.00 -	3.25
Fusel oil, ref.....gal.			1.75 -	2.00
Fusel oil, crude.....gal.				
Glauber's salt (see sodium sulphate).....lb.			.16 -	.16½
Glycerine, C. P. drums extra.....lb.			3.65 -	3.75
Iodine, resublimed.....lb.			.10 -	.20
Iron oxide, red.....lb.	1.00 -	1.25	1.50 -	1.75
Iron sulphate (copperas).....100 lb.			.11½ -	.13½
Lead acetate.....lb.	.09 -	.09½	.10 -	.11
Lead arsenate, paste.....lb.			.15 -	.20
Lead nitrate.....lb.	.38½ -	.08½	.08½ -	.09
Litharge.....lb.			1.30 -	1.40
Lithium carbonate.....lb.	.09 -	.09½	.10 -	.11
Magnesium carbonate, technical.....lb.	2.75 -	3.00		
Magnesium sulphate, U. S. P.....100 lb.			1.10 -	2.25
Magnesium sulphate, technical.....100 lb.			.75 -	.77
Methanol, 95%.....gal.			.78 -	.82
Methanol, 97%.....gal.			.14 -	.14½
Nickel salt, double.....lb.			.15 -	.15½
Nickel salt, single.....lb.				
Phosgene (see carbonyl chloride).....lb.	.45 -	.46	.47 -	.50
Phosphorus, red.....lb.			.35 -	.37
Phosphorus, yellow.....lb.	.11½ -	.12	.12½ -	.12½
Potassium bichromate.....lb.				

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	\$	\$0.31 - \$0.32
Potassium bromide, granular	lb.		.16 - .25
Potassium carbonate, U. S. P.	lb.	.35 - .40	.45 - .50
Potassium carbonate, 80-85%	lb.	.06 - .06	.06 - .07
Potassium chlorate, crystals	lb.	.08 - .10	.10 - .14
Potassium cyanide	lb.		.26 - .28
Potassium hydroxide (caustic potash)	lb.	.05 - .05	.05 - .08
Potassium muriate, 80% K.C.	ton	50.00 - 53.00	
Potassium iodide	lb.		2.75 - 3.00
Potassium nitrate	lb.	.09 - .09	.10 - .12
Potassium permanganate	lb.	.31 - .32	.33 - .34
Potassium prussiate, red	lb.	.35 - .37	.38 - .40
Potassium prussiate, yellow	lb.	.24 - .24	.25 - .26
Potassium sulphate (powdered)	per unit		1.50 - 1.75
Rochelle salts (see sodium potassium tartrate)			
Salammoniac (see ammonium chloride)			
Sal soda (see sodium carbonate)			
Salt cake	ton		32.00 - 33.00
Silver cyanide	oz.		1.35 - 1.38
Silver nitrate	oz.		.40 - .41
Soda ash, light	100 lb.	2.25 - 2.30	2.40 - 2.75
Soda ash, dense	100 lb.	2.45 - 2.50	2.60 - 2.75
Sodium acetate	lb.	.04 - .04	.05 - .05
Sodium bicarbonate	100 lb.	2.25 - 2.40	2.50 - 2.75
Sodium bichromate	lb.	.08 - .08	.09 - .10
Sodium bisulphate (nitre cake)	ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphate powdered, U.S.P.	lb.	.05 - .05	.05 - .06
Sodium borate (borax)	lb.	.06 - .06	.07 - .07
Sodium carbonate (sal soda)	100 lb.	1.90 - 2.00	2.10 - 2.40
Sodium chloride	lb.	.07 - .07	.08 - .08
Sodium cyanide	lb.	.22 - .24	.25 - .30
Sodium fluoride	lb.	.12 - .12	.13 - .14
Sodium hydroxide (caustic soda)	100 lb.	4.00 - 4.05	4.10 - 4.50
Sodium hyposulphite	lb.		.03 - .03
Sodium nitrate	100 lb.	2.90 - . . .	3.00 - . . .
Sodium nitrite	lb.	.07 - .08	.08 - .10
Sodium peroxide, powdered	lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic	lb.	.04 - .04	.05 - .05
Sodium potassium tartrate (Rochelle salts)	lb.		.26 - .27
Sodium prussiate, yellow	lb.	.12 - .12	.12 - .13
Sodium silicate, solution (40 deg.)	lb.	1.25 - 1.35	1.40 - 1.50
Sodium silicate, solution (60 deg.)	lb.	.02 - .03	.03 - .03
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.05 - .05	.06 - .06
Sodium sulphite, crystals	lb.	.03 - .04	.04 - .04
Strontium nitrate, powdered	lb.	.15 - .15	.16 - .17
Sulphur chloride, red	lb.	.07 - .07	.07 - .08
Sulphur, crude	ton	20.00 - 22.00	
Sulphur dioxide, liquid, cylinders extra	lb.	.08 - .08	.09 - .10
Sulphur (sublimed), flour	100 lb.		2.25 - 3.10
Sulphur, roll (brimstone)	100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent	lb.	.18 - .19	
Tin oxide	lb.		.40 - .42
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran.	lb.	.11 - .11	.11 - .12
Zinc cyanide	lb.	.45 - .49	.50 - .60
Zinc dust	lb.	.12 - .13	.13 - .14
Zinc oxide, XX	lb.	.09 - .09	.09 - .10
Zinc sulphate	100 lb.	2.90 - 3.00	3.25 - 3.75

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	\$1.10 - \$1.15
Alpha-naphthol, refined	lb.	1.25 - 1.30
Alpha-naphthylamine	lb.	.35 - .40
Aniline oil, drums extra	lb.	.20 - .27
Aniline salts	lb.	.26 - .29
Anthracene, 80% in drums (100 lb.)	lb.	.75 - 1.00
Benzaldehyde U.S.P.	lb.	1.50 - . . .
Benzidine, base	lb.	.85 - 1.00
Benzidine sulphate	lb.	.75 - .85
Benzoic acid, U.S.P.	lb.	.60 - .65
Benzoate of soda, U.S.P.	lb.	.65 - .70
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)	gal.	.25 - .28
Benzyl chloride, 95-97%, refined	lb.	.28 - .30
Benzyl chloride, tech.	lb.	.20 - .25
Beta-naphthol benzoate	lb.	3.50 - 4.00
Beta-naphthol, sublimed	lb.	.70 - .75
Beta-naphthol, tech.	lb.	.38 - .40
Beta-naphthylamine, sublimed	lb.	2.00 - 2.25
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 - .18
Ortho-cresol, in drums (100 lb.)	lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums	gal.	.70 - .80
Cresylic acid, 75-97%, dark, in drums	gal.	.65 - .70
Cresylic acid, 50%, first quality, drums	gal.	.45 - .50
Dichlorobenzene	lb.	.06 - .09
Diethylaniline	lb.	1.20 - 1.25
Dimethylaniline	lb.	.41 - .50
Dinitrobenzene	lb.	.32 - .35
Dinitrochlorobenzene	lb.	.20 - .30
Dinitronaphthalene	lb.	.30 - .40
Dinitrophenol	lb.	.35 - .40
Dinitrotoluene	lb.	.27 - .30
Dip oil, 25%, car lots, in drums	gal.	.40 - .45
Diphenylamine	lb.	.60 - .65
H-acid	lb.	1.25 - 1.35
Meta-phenylenediamine	lb.	1.15 - 1.20
Monochlorobenzene	lb.	.12 - .14
Monothylaniline	lb.	1.75 - 1.85
Naphthalene crushed, in bbls.	lb.	.07 - .08
Naphthalene, flake	lb.	.07 - .08
Naphthalene, balls	lb.	.08 - .09
Naphthionic acid, crude	lb.	.70 - .75
Nitrobenzene	lb.	.12 - .15
Nitro-naphthalene	lb.	.30 - .35
Nitro-toluene	lb.	.16 - .18
Ortho-amidophenol	lb.	3.10 - 3.20
Ortho-dichlor-benzene	lb.	.15 - .20
Ortho-nitro-phenol	lb.	.80 - .85
Ortho-nitro-toluene	lb.	.15 - .20
Ortho-toluidine	lb.	.20 - .25
Para-amidophenol, base	lb.	1.50 - 1.60
Para-amidophenol, HCl	lb.	1.75 - 1.80

Para-dichlorobenzene	lb.	.15 - .20
Paranitroaniline	lb.	.85 - 1.00
Para-nitrotoluene	lb.	.85 - .95
Para-phenylenediamine	lb.	1.80 - 2.00
Para-toluidine	lb.	1.25 - 1.40
Phthalic anhydride	lb.	.50 - .60
Phenol, U. S. P., drums	lb.	.11 - .13
Pyridine	gal.	2.00 - 3.50
Resorcinol, technical	lb.	1.75 - 1.85
Resorcinol, pure	lb.	2.25 - 2.30
Salicylic acid, tech., in bbls.	lb.	.21 - .22
Salicylic acid, U. S. P.	lb.	.24 - .26
Salol	lb.	.80 - .85
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14 - .16
Sulphanilic acid, crude	lb.	.30 - .35
Tolidine	lb.	1.25 - 1.35
Toluidine, mixed	lb.	.40 - .45
Toluene, in tank cars	gal.	.25 - .28
Toluene, in drums	gal.	.28 - .31
Xylidines, drums, 100 gal.	lb.	.40 - .45
Xylene, pure, in drums	gal.	.40 - .45
Xylene, pure, in tank cars	gal.	.45 - . . .
Xylene, commercial, in drums, 100 gal.	gal.	.33 - .35
Xylene, commercial, in tank cars	gal.	.30 - . . .

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	\$0.23 - \$0.25
Beeswax, refined, light	lb.	.25 - .27
Beeswax, white pure	lb.	.42 - .45
Carnauba, H. ra.	lb.	.62 - .63
Carnauba, No. 2, North Country	lb.	.27 - .28
Carnauba, No. 3, North Country	lb.	.16 - .17
Japan	lb.	.18 - .18
Montan, crude	lb.	.07 - .07
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.03 - .03
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02 - .03
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 - .03
Paraffine waxes, refined, 125 m.p.	lb.	.04 - .04
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 - .05
Paraffine waxes, refined, 133-135 m.p.	lb.	.05 - .05
Paraffine waxes, refined, 135-137 m.p.	lb.	.05 - .06
Stearic acid, single pressed	lb.	.09 - . . .
Stearic acid, double pressed	lb.	.10 - . . .
Stearic acid, triple pressed	lb.	.11 - .11

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	\$5.10 - . . .
Rosin E-I	280 lb.	5.80 - 6.00
Rosin K-N	280 lb.	6.50 - 6.70
Rosin W. G.-W. W.	280 lb.	6.80 - . . .
Wood rosin, bbl.	280 lb.	6.25 - . . .
Spirits of turpentine	gal.	.62 - . . .
Wood turpentine, steam dist.	gal.	.60 - . . .
Wood turpentine, dest. dist.	gal.	.58 - . . .
Pine tar pitch, bbl.	200 lb.	. . . - 6.75
Tar, kiln burned, bbl. (500 lb.)	bbl.	. . . - 11.50
Retort tar, bbl.	500 lb.	. . . - 11.50
Rosin oil, first run	gal.	.36 - . . .
Rosin oil, second run	gal.	.38 - . . .
Rosin oil, third run	gal.	.43 - . . .
Pine oil, steam dist., sp.gr. 0.930-0.940	gal.	\$1.80 - . . .
Pine oil, pure, dest. dist.	gal.	1.50 - . . .
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.46 - . . .
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35 - . . .
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75 - . . .
Pine tar, ref., thin, sp.gr. 1.080-1.060	gal.	.35 - . . .
Turpentine, crude, sp. gr. 0.900-0.970	gal.	1.20 - . . .
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990	gal.	.35 - . . .
Pinewood creosote, ref.	gal.	.52 - . . .

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	\$0.41 - . . .
70-72 deg., steel bbls. (85 lb.)	gal.	.39 - . . .
68-70 deg., steel bbls. (85 lb.)	gal.	.38 - . . .
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30 - . . .

Crude Rubber

Para-Upriver fine	lb.	\$0.16 - .17
Upriver coarse	lb.	.09 - .09
Upriver caucho ball	lb.	.11 - .12
Plantation—First latex crepe	lb.	.15 - . . .
Ribbed smoked sheets	lb.	.14 - .14
Brown crepe, thin, clean	lb.	.15 - . . .
Amber crepe No. 1	lb.	.17 - . . .

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	\$0.08 - \$0.09
Castor oil, AA, in bbls.	lb.	.10 - .10
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.11 - .11
Cocanut oil, Ceylon grade, in bbls.	lb.	.10 - .10
Cocanut oil, Cochon grade, in bbls.	lb.	.11 - .11
Corn oil, crude, in bbls.	lb.	.07 - .08
Cottonseed oil, crude (f. o. b. mill)	lb.	.05 - .05
Cottonseed oil, summer yellow	lb.	.07 - .08
Cottonseed oil, winter yellow	lb.	.08 - . . .
Linseed oil, raw, car lots (domestic)	gal.	.76 - . . .
Linseed oil, raw, tank cars (domestic)	gal.	.70 - . . .
Linseed oil, in 5-bbl lots (domestic)	gal.	.79 - . . .

Olive oil, Denatured.....	gal.	\$1.40	—	\$1.60
Palm, Lagos.....	lb.	.06 $\frac{1}{2}$	—	.07
Palm, Niger.....	lb.	.05 $\frac{1}{2}$	—	.06
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.05 $\frac{1}{2}$	—	.06
Peanut oil, refined, in bbls.....	lb.	.10 $\frac{1}{2}$	—	.10 $\frac{3}{4}$
Rapeseed oil, refined in bbls.....	gal.	.86	—	.88
Rapeseed oil, blown, in bbls.....	gal.	.92	—	.94
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07 $\frac{1}{2}$	—	.....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.04 $\frac{1}{2}$	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.40	—	\$0.41
Yellow bleached menhaden.....	gal.	.42	—	.....
White bleached menhaden.....	gal.	.44	—	.....
Brown menhaden.....	gal.	.80	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	15.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	.....
Blanc fixe, dry.....	lb.	.05	—	.05 $\frac{1}{2}$
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.14	—	.16
Chalk, domestic, extra light.....	lb.	.05	—	.05 $\frac{1}{2}$
Chalk, domestic, light.....	lb.	.04 $\frac{1}{2}$	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04 $\frac{1}{2}$	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	40.00
China clay (kaolin), imported, lump.....	net ton	23.00	—	25.00
China clay (kaolin), imported, powdered.....	net ton	30.00	—	35.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07 $\frac{1}{2}$	—	.08
Graphite, Ceylon chip.....	lb.	.06	—	.06 $\frac{1}{2}$
Graphite, high grade amorphous crude.....	lb.	.02 $\frac{1}{2}$	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05 $\frac{1}{2}$
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1 $\frac{1}{2}$ @2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.75	—	.....
Shellac, orange superfine.....	lb.	.79	—	.82
Shellac, A. C. garnet.....	lb.	.55	—	.58
Shellac, T. N.....	lb.	.70	—	.72
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	35.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$35.00—50.00
Carborundum refractory brick, 9-in. { less than carlot	1,000	1250.00
Carborundum refractory brick, 9-in. { carload lots	1,000	1100.00
Chrome brick, f.o.b. Eastern shipping points.....	net ton	75—90
Chrome cement, 40—45% Cr ₂ O ₃	net ton	45—50
Chrome cement, 40—45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	 55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	40—50
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	40—50
Magnesite brick, 9-in. straight.....	net ton	90
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	100
Magnesite brick, soaps and splits.....	net ton	110
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	45—55
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	45—55
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	45—55

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00 — \$225.00
Ferrocchrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.15 — .16
Ferrocchrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.16 — .17
Ferromanganese, 76-80% Mn, domestic.....	gross ton	75.00 — 80.00
Ferromanganese, 76-80% Mn, English.....	gross ton	75.00 — 80.00
Spiegeleisen, 18-22% Mn.....	gross ton	30.00 — 32.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50 —
Ferrosilicon, 10-15%.....	gross ton	45.00 — 50.00
Ferrosilicon, 50%.....	gross ton	75.00 — 80.00
Ferrosilicon, 75%.....	gross ton	140.00 — 145.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45 — .50
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	6.00 —
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00 — 6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$8.00 — \$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.45 — .50
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.45 — .50
Coke, foundry, f.o.b. ovens.....	net ton	4.00 — 4.50
Coke, furnace, f.o.b. ovens.....	net ton	3.25 — 3.75
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00 — 16.00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	15.00 —
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	20.00 — 22.50
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 $\frac{1}{2}$ — .01 $\frac{3}{4}$
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.25 —
Manganese ore, chemical (MnO ₂).....	gross ton	60.00 — 65.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55 — .60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00 —
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.14 — .14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.14 — .14
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12 — .13
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15 —
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75 — 3.00
Tungsten, wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00 — 3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50 — 2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25 — 2.50
Vanadium pentoxide, 99%.....	lb.	12.00 — 14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50 —
Zircon, washed, iron free.....	lb.	.03 —

Non-Ferrous Metals

New York Markets

Copper, electrolytic.....	Cents per Lb.	13.00—13.25
Aluminum, 98 to 99 per cent.....		28.00@28.5
Antimony, wholesale lots, Chinese and Japanese.....		5 $\frac{1}{2}$
Nickel, ordinary (ingot).....		41.00
Nickel, electrolytic.....		44.00
Monel metal, spot and blocks.....		35.00
Monel metal ingots.....		38.00
Monel metal, sheet bars.....		40.00
Tin, 5-ton lots, Straits.....		29.50
Lead, New York, spot.....		4.50—4.75
Lead, E. St. Louis, spot.....		4.50
Zinc, spot, New York.....		4.85
Zinc, spot, E. St. Louis.....		4.45

OTHER METALS

Silver (commercial).....	oz.	\$0.58 $\frac{1}{2}$
Cadmium.....	lb.	1.00—1.25
Bismuth (500 lb. lots).....	lb.	1.50@1.55
Cobalt.....	lb.	4.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	75.00
Iridium.....	oz.	250.00@275.00
Palladium.....	oz.	70.00
Mercury.....	75 lb.	46.00—47.00

FINISHED METAL PRODUCTS

Copper sheets, hot rolled.....	Warehouse Price Cents per Lb.	20.50—20.75
Copper bottoms.....		28.00—28.25
Copper rods.....		19.25—20.00
High brass wire.....		18.25
High brass rods.....		15.25
Low brass wire.....		20.25
Low brass rods.....		20.25
Brazed brass tubing.....		29.00
Brazed bronze tubing.....		34.25
Seamless copper tubing.....		22.00
Seamless high brass tubing.....		21.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.25@9.50	9.25	9.50
Copper, heavy and wire.....	8.25@8.50	8.50	8.50
Copper, light and bottoms.....	7.25@7.75	7.50	7.25
Lead, heavy.....	3.25@3.50	3.25	3.75
Lead, tea.....	2.25@2.35	2.25	2.25
Brass, heavy.....	4.25@4.50	4.50	5.00
Brass, light.....	3.25@3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.25@4.50	4.25	4.50
Zinc.....	2.00@2.50	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by $\frac{1}{2}$ in. and larger and plates $\frac{1}{2}$ in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.60	\$3.23	\$3.23
Soft steel bars.....	2.50	3.00	3.13
Soft steel bar shapes.....	2.50	3.13	3.13
Soft steel bands.....	2.85	3.83	3.78
Plates, $\frac{1}{2}$ to 1 in. thick.....	2.50	3.30	3.23

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

California

FRESNO—The Fresno Tire & Rubber Co., has awarded a contract to the Unit Construction Co., Phelan Bldg., San Francisco, for the erection of a 3-story automobile tire and rubber goods manufacturing plant at Tehama and Belmont Aves., to cost about \$200,000 with machinery. S. H. Christian, sales manager, is in charge.

SACRAMENTO—The United States Electric Steel Products Co., Inc., is planning for the erection of a new plant at Sacramento, and has acquired a large tract of land for this purpose. According to a statement from officials of the Chamber of Commerce, Vallejo, Cal., the company is planning for the erection of a branch plant on the Vallejo waterfront. Headquarters of the company are at San Francisco; it is capitalized at \$50,000,000. The Electric Furnace Construction Co., 908 Chestnut St., Philadelphia, Pa., is interested in the project, and will handle the electric furnace installations at the plants. It is said that the main Sacramento works will cost about \$5,000,000.

SAN MATEO—The Illinois-Pacific Glass Co., Fifteenth and Folsom Sts., San Francisco, is negotiating with the Chamber of Commerce, San Mateo, for a suitable site for the erection of a new local plant for the manufacture of glass products.

Connecticut

WATERBURY—The Scovill Mfg. Co., East Main St., manufacturer of brass products, has filed plans for the erection of a 1-story brick plant addition, 49 x 96 ft., to cost about \$15,000.

WINDSOR—The Apothecaries Hall Co., 24 Benedict St., has awarded a contract to the Clark Construction Co., 168 Grand St., Waterbury, Conn., for the erection of a new 1-story fertilizer manufacturing and mixing plant, 64 x 140 ft., to cost about \$27,000. William Stall is head.

NORWALK—Charles H. Harris, Inc., 136 West 24th St., New York, has awarded a contract to Levering & Garrigues, 552 West 23d St., for the erection of a new 1-story plant on Main St., 100 x 200 ft., for the manufacture of glass for automobile windshields. The new plant will cost about \$75,000. Charles H. Harris is president.

Florida

LAKE WORTH—The Florida Sugar & Food Products Co., 110 South Dearborn St., Chicago, Ill., F. E. Bryant, president and manager, is perfecting plans for the erection of its proposed new sugar mill in the vicinity of Lake Worth to be 100x200 ft., with equipment to provide for an initial daily capacity of 500 tons of cane sugar. N. K. Williams, Canal Point, Fla., is construction engineer for the project.

Illinois

CHICAGO—The By-Products Coke Corp., 332 South Michigan Ave., has arranged for a bond issue of \$4,000,000 for operations, financing, etc. H. H. S. Handy is president.

BLOOMINGTON—The Illinois Oakoal Corp., Bryant Bldg., Kansas City, Mo., has awarded a contract to the Frank P. McClure Construction Co., Kansas City, for the erection of its proposed new plant at Bloomington, estimated to cost about \$100,000 with equipment.

CHICAGO—William J. Korber & Co., 413 North Carpenter St., operating a general iron works, have taken construction bids for a 1-story addition, 50x110 ft., on California St., to cost about \$12,000. William J. Korber is head.

Indiana

COLUMBUS—The Indiana Oil Refining Co. has awarded a contract to the Graver Corporation, East Chicago, Ind., for the erection of its proposed new local oil refinery, consisting of a first plant unit, estimated to cost about \$120,000. It is proposed to have the plant ready for operation in the fall.

SOUTH BEND—The Odell Rubber Co., recently organized with a capital of \$50,000, is planning for the erection of a new plant for the manufacture of automobile tires at Paducah, Ky.

TERRE HAUTE—The American Car & Foundry Co. has plans under way for the rebuilding of the section of its local plant, recently destroyed by fire with loss of about \$150,000, including equipment.

Kansas

WICHITA—The Wichita Dehydration Co., 616 Mutual Bank Bldg., has broken ground for the erection of a new 1-story and basement dehydration plant, with initial capacity of about 50 tons per day, estimated to cost about \$50,000 with equipment. T. C. Naylor, 311 Beacon Bldg., is the contractor. J. H. Elem is president.

Kentucky

SCOTTSVILLE—The Massey Refining Co. is planning for the erection of a new oil refinery, with initial capacity of about 500 bbl. per day. S. H. Massey and L. R. McKee head the company.

Maryland

BALTIMORE—The Virginia-Carolina Chemical Co., 11 South Twelfth St., Richmond, Va., is considering the construction of a new fertilizer manufacturing plant at Baltimore, with main building 100x200 ft., estimated to cost in excess of \$2,500,000. S. D. Grenshaw is secretary.

BALTIMORE—The Holtite Mfg. Co., 919 East Baltimore St., has awarded a contract to R. B. Mason, 308 West Madison St., for the erection of its proposed new local plant, 50x142 ft., for the manufacture of rubber specialties, estimated to cost about \$58,000, and of which amount approximately \$30,000 will be used for equipment. Albert A. Esterson is secretary and treasurer.

CUMBERLAND—The Queen City Brick & Tile Co. is making extensions and improvements in its plant for increased production. The company recently increased its capital from \$100,000 to \$200,000. Henry J. Glick is president.

BALTIMORE—The American Sugar Refining Co., 117 Wall St., New York, N. Y., has filed plans for the main refinery unit at its new local plant at Woodall and Clements Sts., to be 9-story, 60x164 ft. Stone & Webster, 120 B'way, New York, have the building contract.

Massachusetts

BROCKTON—George Baker & Sons, Inc., 103 Belmont St., manufacturer of nails, studs, staples, etc., will occupy the new 1- and 2-story plant, 83x223 ft., to be erected by the Baker Realty Co., an affiliated organization, on North Monticello St. It will cost about \$75,000. George Howard & Sons, Inc., 633 Warren St., is the contractor.

Michigan

MONROE—The River Raisin Paper Co. has placed the first unit of its new local plant in operation, consisting of a building section 60 to 80 ft. x 720 ft., with capacity of about 60 tons per day. The new unit will be used primarily for the manufacture of corrugated strawboard. The entire plant of the company as now designed will develop an output of about 700,000 lb. of stock per day, and will give employment to approximately 1,500 operatives.

Missouri

CHILLICOTHE—The Moonshine Mfg. Co. has preliminary plans under way for the erection of a new plant for the manufacture of lubricants, cleaners, etc.

SELIGMAN—The Silver Lake Mining Co. is planning for the installation of new mining machinery and operating equipment at its local silver mines. A large new acreage will be developed. T. R. Gilliam is vice-president.

KANSAS CITY—A. W. Estabrook, 729 Holmes St., has construction under way on a new chemical laboratory, 2-story and basement, 40x60 ft., estimated to cost about \$15,000.

ST. LOUIS—The Missouri Chemical Works, 1501 South Second St., is reported to be planning for the rebuilding of the portion of its plant, recently destroyed by fire, with loss estimated at \$50,000. Arthur G. Whittaker is secretary.

LEEDS—The National Lumber & Creosoting Co., Houston, Tex., is planning for the establishment of a new creosoting plant at Leeds, with annual capacity of about 40,000,000 ft. of material.

KANSAS CITY—The Kansas City Wire & Iron Works is planning for the rebuilding of the portion of its plant recently destroyed by fire with loss estimated at \$80,000.

New Jersey

NEWARK—John Campbell & Co., New York Ave., manufacturer of bookbinders' materials, leather, etc., have filed plans for extensions and improvements in their refinery to cost about \$10,000.

New York

NEW YORK—The Pierce Oil Corp., 25 Broad St., is planning for a bond issue of \$12,000,000, the proceeds to be used for expansion, refinery extensions, operations, etc.

North Carolina

WILMINGTON—The Shepard Chemical Co. is reported to be planning for the rebuilding of the portion of its plant recently destroyed by fire. E. C. Dickinson is head.

Oklahoma

BEGGS—The Taylor Oil & Gas Co., Okmulgee, Okla., is planning for the erection of a new two-unit compression gasoline plant in the vicinity of Beggs.

ARDMORE—The Cameron Refining Co. has commenced enlargements at its plant, to increase the capacity from 3,000 to 4,000 bbl. per day.

BARTLESVILLE—The Chamber of Commerce, E. L. George, secretary, is developing plans for the establishment of a new local plant for the manufacture of automobile tires and rubber goods.

Pennsylvania

BUTLER—The Valvoline Oil Co. is planning for the rebuilding of its local works, destroyed by fire May 29, with loss estimated at about \$400,000, including equipment and stock.

PHILADELPHIA—Samuel McDowell, 1215 Filbert St., manufacturer of chemicals, has taken title to a plant building at Girard Ave. and 59th St., on site 178x223 ft., to be used in connection with local operations. The structure was used formerly by the Providence Worsted Mills.

Tennessee

CHATTANOOGA—The Ocoee Copper Co. is planning for the erection of a new flotation plant in the vicinity of Ducktown, Tenn., with initial capacity of about 300 tons per day, and estimated to cost about \$200,000. P. B. Carter is secretary and treasurer.

Texas

BETHANY—J. B. Haynes, Houston, Tex., and associates are organizing a company to construct a large plant in the vicinity of Bethany for the manufacture of carbon black. It is proposed to utilize natural gas from the oil wells in this district for the new works, and application for permission to carry out the plans has been made to the State Railroad Commission.

TEMPLE—The T. S. Huddleston Mining Co., Belton, Tex., is planning for the establishment of a new works in the vicinity of Temple for the production of fullers earth. The company has extensive deposits in this section.

Virginia

WINCHESTER—The Cornwall Lime Marl Co., Romney, W. Va., has plans under way for the erection of a new plant for lime production in the vicinity of Winchester, with initial capacity of about 125 tons of material per day. The company will develop extensive lime marl deposits in this district. John J. Cornwall is president.

Wisconsin

SOUTH MILWAUKEE—The Bucyrus Co., manufacturer of excavating machinery, is taking bids for the erection of a new 1-story addition to its iron foundry, 66x220 ft.

Capital Increases, Etc.

THE ALUMINUM CHEMICAL Co., Chicago, Ill., has filed notice of increase in capital from \$100,000 to \$200,000.

THE CHAMPLAIN PULP & PAPER CORP., Saratoga Springs, N. Y., has filed notice of dissolution under state laws.

THE ANSBACHER INSECTICIDE Co., 527 Fifth Ave., New York City, has filed notice of increase in capital from \$10,000 to \$150,000.

THE A. H. ANDERSON FOUNDRY Co., 218 Ann St., Chicago, Ill., manufacturer of brass castings, etc., has filed notice of increase in capital from \$5,000 to \$100,000.

THE ROWELL OIL MILLS Co., Bastrop, Tex., manufacturer of cottonseed oils, etc., has filed notice of increase in capital from \$27,000 to \$75,000.

THE LONG ISLAND BRICK Co., 280 Madison Ave., New York City, with brick manufacturing plant at Farmingdale, L. I., has filed notice of increase in capital to \$800,000.

THE LYSTER CHEMICAL Co., 61 B'way, New York City, has filed schedules in bankruptcy with liabilities stated as \$184,458, and assets as \$98,180.

THE ROOSEVELT DRUG & CHEMICAL Co., 117-19 Smith St., Perth Amboy, N. J., has filed notice of dissolution under state laws.

THE AMERICAN SILICA PRODUCTS Co., Indianapolis, Ind., has filed notice of dissolution under state laws.

THE MONARCH-NUSBAUM PAPER BOX Co., 106 B'way, Buffalo, N. Y., has filed notice of increase in capital from \$10,000 to \$150,000.

THE MILES FIBER PRODUCTS Co., Chicago, Ill., has filed notice of increase in capital from \$20,000 to \$60,000.

THE HOSKIN-MORAINVILLE PAPER Co., Menominee, Mich., has filed notice of increase in capital from \$750,000 to \$1,000,000.

New Companies

THE NORMAL APPARATUS Co., 217-23 West Huron St., Chicago, Ill., has been incorporated with a capital of \$15,000 to manufacture chemicals and affiliated products. The incorporators are Carl F. W. Pfeiffer, Charles J. Deegan and E. Merckle.

THE ATLANTIC TANNING EXTRACT Co., New York City, has been incorporated under New Jersey laws, with capital of 2,500 shares of stock, to manufacture synthetic extracts for tanning and kindred products. The company is represented by Arthur W. Britton, 65 Cedar St.

THE AMERICAN METALLURGICAL CORP., Boston, Mass., has been incorporated with a capital of \$50,000 to operate a metallurgical works. Harry O. Breaker is president, and Kristian A. Juthe, Newton Center, Mass., treasurer.

THE EASTERN CHEMICAL Co., Boston, Mass., has been incorporated with a capital of \$50,000 to manufacture chemicals and chemical byproducts. Henry A. Smith is president, and Joseph J. McCloskey, 294 Washington St., treasurer.

THE NEW JERSEY LITHO & PRINTING INK Co., East Rutherford, N. J., has been incorporated with a capital of \$25,000 to manufacture inks. The incorporators are Frederick Prinzing, John F. Lavery and Albert E. Williams, East Rutherford.

THE EAGLE CONVEX GLASS SPECIALTY MFG. Co., Clarksburg, W. Va., has been incorporated with a capital of \$50,000 to manufacture glass products. The incorporators are Edgar Forneus and Frank Aucremanne, Clarksburg.

THE FI-BISTOS MFG. Co., New York City, has been incorporated with a capital of \$100,000 to manufacture chemicals and chemical byproducts. The incorporators are H. H. Blackmer, G. Pantzer and D. C. Godwin, 165 West 31st St.

THE NATIONAL CASEIN Co., 613 West 80th St., Chicago, Ill., has been incorporated with a capital of \$15,000 to manufacture glues and kindred products. The incorporators are Richard P. Poulton, Joseph A. Rogers and William E. Rodrigues.

THE STONE FORT OIL Co., Houston, Tex., has been incorporated with a capital of \$150,000 to manufacture petroleum products. The incorporators are Taylor J. Hughes, T. P. Griffin and V. F. Nehaus, Houston.

J. E. TEMPLETON & Co., Inc., Westfield, Mass., has been incorporated with a capital of \$20,000 to manufacture chemicals, oils, etc. Louis M. Fuller is president; and James E. Templeton, Westfield, treasurer.

THE NEW ENGLAND SMELTING WORKS, INC., Springfield, Mass., has been incorporated with a capital of \$25,000 to manufacture metal products. Abraham J. Saffer is president, and Morris Levin, 119 Massachusetts St., treasurer.

MIR, CODINA & MARQUES, INC., Jersey City, N. J., has been incorporated with a capital of \$125,000 to manufacture cork products. The incorporators are Lewis Mir, Peter Codina and Michael Marques, 592 Montgomery St.

THE DARLING PRODUCTS, INC., Albany, N. Y., has been incorporated with a capital of \$25,000 to manufacture compounds, baking powders and kindred specialties. The incorporators are F. E. B. and H. S. Darling, and A. Bonesteel, Albany. T. J. Quillinan, Troy, N. Y., represents the company.

THE A. A. NOE CHEMICAL Co., Rogersville, Tenn., has been incorporated with a capital of \$15,000 to manufacture chemicals and chemical byproducts. A. A. Noe and J. L. Cunningham, Rogersville, head the company.

THE CRAFTEX OIL Co., Crafton, Pa., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are S. H. Fisher, H. C. Schada and A. T. Cushing, Crafton.

THE HUMMEL & ROBINSON CORP., New York City, has been incorporated with a capital of \$100,000 to manufacture chemicals and chemical byproducts. The incorporators are J. C. Robinson, C. P. Swaffield and A. Hummel. The company is represented by G. J. Gruenberg, 320 B'way.

THE SOUTH JERSEY IRON FOUNDRY, INC., Pleasantville, N. J., has been incorporated with a capital of \$10,000 to manufacture iron and steel castings. Wray C. Arnold, Commonwealth Bldg., Philadelphia, Pa., represents the company.

THE LANG-HORTON TANNING Co., INC., Hutton, Garrett Co., Md., has been incorporated with a capital of \$100,000 to manufacture leather products. The incorporators are J. Harry Lang, Nathan Fried and LeRoy Morton, Hutton.

PHILLIPS & JAFFRAY, INC., New York City, has been incorporated with a capital of \$25,000 to manufacture soluble oils, sizing, etc. The incorporators are H. C. Good, B. D. Phillips and S. L. Jaffray. The company is represented by J. W. Hyde, 29 B'way.

THE BRISTOL STOVE & FOUNDRY Co., INC., Bristol, Va., has been incorporated with a capital of \$50,000 to manufacture iron and steel castings, etc. H. E. Wilkinson is president and J. C. Rucker, secretary, Bristol.

THE TANGHE BROTHERS Co., Detroit, Mich., has been incorporated with a capital of \$25,000 to manufacture bricks and other burned clay products. The incorporators are R. M., Henry F. and Edward F. Tanghe, 1233 Pine St.

THE MOCHAR LEATHER GOODS CORP., New York City, has been incorporated with a capital of \$15,000 to manufacture leather specialties. The incorporators are B. Char-sky, W. E. Mock and H. J. Woronov. The company is represented by A. M. Bloch, 185 Madison Ave.

THE ARKANSAS CRUDE OIL Co., Little Rock, Ark., has been incorporated with a capital of \$200,000, to manufacture petroleum products. The incorporators are Charles Leiger and E. W. Emerson, Little Rock.

THE RIVERSIDE FULLERS EARTH Co., Riverside, Tex., has been incorporated with a capital of \$50,000 to operate a producing works for fullers earth and similar products. The incorporators are T. R. Buell, E. P. Darrigrand and S. C. Collins, Riverside.

THE ORION PAINT Co., New York City, has been incorporated with a capital of \$10,000 to manufacture paints, varnishes, etc. The incorporators are C. D. Cregan, J. W. Linck and L. Bennett, 61 B'way.

THE BLUE GRASS PRODUCTION Co., 1504 Standard Trust Bldg., Chicago, Ill., has been organized to manufacture refined oil products. George B. Harker and A. S. Sorenson head the company.

THE PINEVILLE PETROLEUM Co., Pineville, Ky., has been incorporated with a capital of \$40,000 to manufacture petroleum products. The incorporators are W. L. Moss and A. R. Anderson, Pineville.

THE CHEMICAL SERVICE & SALES CORP., New York City, has been incorporated with a capital of \$15,000 to manufacture chemical specialties. The incorporators are E. Celler, M. Kraushaar and J. Maroona. Celler & Kraushaar, 51 Chambers St., represent the company.

HARRY L. IKE, INC., Dover, N. J., has been incorporated with a capital of \$25,000 to manufacture paints, varnishes, etc.

The incorporators are Harry L. Ike, Arthur V. Casterline and Herbert T. Hartley, Dover.

THE ALTO RUBBER Co., New York City, has been incorporated with a capital of \$6,000 to manufacture rubber varnish, glues, and kindred products. The incorporators are R. Schliesel, S. Moore and H. Hewitt. The company is represented by S. D. Levy, 302 B'way.

THE MENDENHALL TORPEDO Co., Duncan, Okla., has been incorporated with a capital of \$20,000 to manufacture explosives. The incorporators are G. L. Wilson, Duncan; W. B. Hamilton and T. W. Mendenhall, both of Wichita Falls, Tex.

THE TEXAS EAGLE OIL & REFINING Co., Fort Worth, Tex., has been incorporated with a capital of \$25,000, to manufacture refined oil products. The incorporators are E. B. Eakle, and F. A. Cok, Fort Worth.

THE SCHAEFER DRUG CORP., New York City, has been incorporated with a capital of \$50,000 to manufacture chemicals, drugs, etc. The incorporators are O. and E. W. Schaefer, and M. Boehringer. The company is represented by B. Swartz, 192 B'way.

THE HUDSON RIVER FOUNDRY Co., Poughkeepsie, N. Y., has been incorporated with a capital of \$10,000 to manufacture iron and other metal castings. The incorporators are J. Hanson, H. B. Vosburgh and C. W. H. Arnold, Poughkeepsie.

THE MAURICE OIL CORP., Duncan, Okla., has been incorporated with a capital of \$200,000 to manufacture petroleum products. The incorporators are W. E. Hawley, Duncan; and J. L. Hill, Wichita Falls, Tex.

THE RAE DRUG & CHEMICAL Co., Pittsburgh, Pa., is being organized by Joseph Davis, Harry J. Kane and N. Leivrerri, to manufacture chemical products. The company is represented by Harrison Bock, 1412 Berger Bldg., Pittsburgh.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY's summer meeting will be held at Canton, Alliance, Sebring and East Liverpool, Ohio, July 25 to 27. Headquarters will be at the Hotel Courtland, Canton, Ohio.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS will hold its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

AMERICAN SOCIETY FOR TESTING MATERIALS will hold its 1921 annual meeting in the New Monterey Hotel, Asbury Park, N. J., during the week of June 20. Technical sessions are scheduled as follows: Tuesday, on Preservative Coatings and Textiles; Wednesday, on Cement, Concrete and Road Materials; Thursday, on Ceramics, Lime and Gypsum, on Petroleum Products and on Testing Methods; Friday, on Metals.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NATIONAL FERTILIZER ASSOCIATION will hold its twenty-eighth annual convention at the Greenbrier Hotel, White Sulphur Springs, W. Va., the week beginning June 20.

NATIONAL LIME ASSOCIATION is holding its annual convention in New York City June 15 to 17.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

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Useful Statistics for The Chemical Industries

STATISTICS should be useful as well as interesting. We note, with a great deal of interest, the preliminary figures for the quinquennial census of manufactures, which indicate that in 1919 the chemical industries and those closely allied with them had an output valued at 15.65 billions of dollars, or almost exactly one-quarter of the total for all manufactures of the country. To the historian and the economist these figures are of value, but they are not useful in the sense that they are vital to the daily conduct of business. There is a recognized need for quick diagnosis.

Recently the report of the American Engineering Council's committee on the elimination of waste in industry pointed out that, among other needed reforms, "A national industrial information service should be established to furnish more timely, regular and complete information covering current production and consumption and stocks of commodities." This is in keeping with Mr. HOOVER's announced plans for making the work of the Department of Commerce more effective as an aid to business. The Secretary has repeatedly advocated the collection of industrial statistics which would be broad enough in scope to furnish an accurate picture of the business conditions of the country, and at the same time would be limited to a relatively few articles for which the data could be quickly compiled and distributed. Fortunately such a movement is already in progress. Directly following a recent conference between Mr. HOOVER and representatives of the industry, the Census Bureau has prepared to collect and publish promptly the monthly production and stocks of a few basic chemicals which will serve as an index to the trend of business in the chemical industries. A tentative list of a half-dozen commodities has been selected, and included in this number, of course, is sulphuric acid, the recognized barometer of all industrial activity. Later, perhaps, the work thus started can be extended. Additional commodities can be covered or the field can be broadened to include other useful data, such as the proportion of the productive capacity in actual operation, stocks in the hands of dealers and consumers, and wholesale and retail prices.

Much benefit can confidently be expected from this service. A program of industry based on accurate statistical information will encourage the manufacturer to produce his output for a consuming rather than a speculating market. The consumer will be assured of a safe and adequate supply at a price determined by sound economic principles. Waste caused by unbalanced production will gradually be eliminated.

Our chemical manufacturers should be among the first to recognize this opportunity, and we feel justified, therefore, in urging their support to the Government's efforts to establish a useful statistical service.

Industrial Alcohol And Prohibition

"INDUSTRIAL alcohol be dammed; you know it's all booze." This statement, reported to have been made by one high in the councils of prohibition, expresses rather forefully a belief which is all too prevalent among laymen. Misconceptions such as this have been largely responsible for certain pending legislation, the enactment of which will mean disaster for the chemical industries. The ostensible purpose of the Volstead supplemental prohibition bill is to prevent the use of beer as a medicine, but it has been used as a means of striking a blow at industrial alcohol, the chemical essential to the production of important medicinals and pharmaceuticals, of dyes and organic chemicals, of celluloid and smokeless powder, and of innumerable other daily necessities.

It is a well-known fact that the new legislation is sponsored by the Anti-Saloon League and has largely been brought about through its influence. The prime movers in this powerful organization are either ignorant of the requirements of the chemical industries or, with complete disregard of the national welfare, have determined to penalize these industries because prohibition has failed in certain important respects. It has been proved conclusively that these failures are attributable to maladministration of the national prohibition act and not to inadequate law. Representatives of the chemical industries in a recent meeting, which is reported elsewhere in this issue, have vigorously protested against the administration of the existing act by careless, inefficient prohibition officials, whose ignorant and often criminal laxity has continually discouraged and annoyed legitimate enterprise.

The national prohibition act gave industrial alcohol a definite legal status, since one of its expressed purposes was "to insure an ample supply of alcohol and to promote its use in scientific research and in the development of fuel, dye and the lawful industries." Another section of the law was designed "to place the non-beverage alcohol industry and other industries using such alcohol as a chemical raw material or for other lawful purposes upon the highest plane of scientific and commercial efficiency."

The proposed supplementary legislation in many ways nullifies the provisions of the original act. For instance, the unrestricted use, under proper regulations, of non-beverage alcohol is repealed and the power is given to the prohibition commissioner to grant only "the permits that are necessary to supply the actual needs for non-beverage purposes and shall limit the supply and use of all liquor save denatured alcohol and denatured rum, unfit for internal use, to such non-beverage purposes." Objection is also raised to the new bill because it is believed that the dual control of applications and permits by the Attorney General and the prohibition

commissioner will place additional delay and restrictions in the path of the legitimate consumer. Other features viewed with alarm are the provisions that the applicant must post a public notice that he intends to use alcohol in his business and that "any federal or state officer or any person authorized thereto by any such officer may oppose any such application." The alcohol user is thus not only given the former status of the saloonkeeper but the conduct of his business is safely placed in "official" hands.

The new Volstead bill, whether it is enacted or not, has proved a lesson to all friends of industrial alcohol. It has pointed out an urgent duty to be performed by chemists individually and as a profession. The public must be educated to appreciate the difference between industrial alcohol and "booze"; the essential needs of the chemical industries must be recognized. The layman must be brought to a realization of the important rôle played by alcohol—the chemical—in the industries which contribute his medicines, his foods, his recreation and his defense.

High Costs in Producing Steel

WITHIN the space of a single twelvemonth we have two cases, arising from precisely opposite influences, of the abnormally high cost of producing steel. A year ago and less the cost was abnormally high because the demand was exceptionally heavy. Now it is because the demand is exceptionally light.

In the summer of last year blast furnaces paid \$18 and more per net ton at ovens for Connellsville coke, and steel mills paid \$12 and more per net ton at mine for gas and steam coal. Some workmen got bonuses or special emoluments for working or for being on hand with a chance that they might work. They were classed in some cases as being more skilled than they were, so that they could be listed on the payroll at higher wage rates. All this was done simply to swell production slightly. Not all mills engaged in these practices, there being some well-marked exceptions. Those that did could have run along with a slightly lower output and a much lower cost of production, but demand was exceptionally insistent and fancy premiums, over and above fancy base prices, were bid for prompt shipment of steel.

At the present time the cost of producing steel is abnormally high because the demand is so very light. In calling the production cost abnormally high it is meant that if mill-working conditions now, as to tonnage relative to capacity, were the same as in 1897 and 1898, with full allowance for increased rates of wages, freight rates and prices of supplies, but with the advantage of improvements that have been introduced, the cost of making steel would be much lower than is being shown by the cost sheets.

The extra cost at the present time is not due entirely to poor distribution of overhead, though that is obviously an important factor. Bond interest to be paid by 15,000 or 25,000 tons a month instead of by 100,000 tons falls very heavily per ton, but that might be taken care of. It is not necessarily unbusinesslike to spread fixed charges over periods of time. There is much more in the high costs of today than that, for various items of operating expense are heavy per ton, when they would disappear entirely if the plant were idle. In particular, the labor cost with the present low operating rates is exceptionally high. It is not a matter

of wage rates per hour, but of the number of man-hours per tons of output. A plant producing at 25 per cent of capacity has much more than 25 per cent of a full payroll.

Last year relief from high costs might have been proposed by making buyers wait their turn, giving the buyers only the steel that could be produced economically. The buyers, however, refused to wait. They needed the steel just then, and some of them doubted very much whether they would need steel later. The mills probably agreed with this view, though they had no occasion to say so.

As for relief at present, making stocks of steel against possible requirements in future is out of the question. As a rule the product could not be stocked advantageously and economically, and buyers' specifications vary, steel being usually rolled to order. Relief might be suggested in the form of some mills closing entirely and others running at fair rates, but that would increase the hardships of the workmen and the idea is rejected on that basis.

The philosophy of the steel trade therefore is that it has nothing to do but peg along and make the best of the situation. In its present depth the depression cannot last long, it is argued, for the country is certainly using and wearing out steel at a greater rate than the present production of steel, so that some sort of reaction must come soon.

American Leather

Chemists Association

IN VIEW of the chemical and physical complexity of materials as well as reactions involved in the production of leather, it is not strange that the development of analytical methods has occupied a very considerable portion of the chemist's attention in this field. The earlier independent workers were confronted with strange inconsistencies when attempts were made to interchange methods and compare data. Quite naturally this led to the formation of groups of chemists in different countries for the purpose of standardizing analytical methods. A brief outline of this evolution as it took place in America may be of interest in connection with the report of the eighteenth annual meeting of the American Leather Chemists Association which will be found elsewhere in this issue.

In attempting to determine the tannin content of certain foreign tanning materials which were exhibited at the Columbian Exposition at Chicago in 1893, WILLIAM H. KRUG became strongly impressed with the need for a uniform method of analysis. The desirability of close co-operation was evident and after considerable discussion the Association of American Leather Trades Chemists was organized in Chicago, Oct. 30, 1893. At the next meeting, which was held in conjunction with that of the Association of Official Agricultural Chemists on Aug. 23, 1894, at Washington, it was decided to become a section of the latter organization. For a time this arrangement was satisfactory, but gradually it became apparent that the interests of the two groups were drifting apart. Accordingly a small group of leather chemists who had been active in the work of the tannin section of the A.O.A.C. met Nov. 3, 1903, and formed the American Leather Chemists Association, which, however, did not assume independent existence until the fall of 1905. At this time the council authorized the publication of a monthly journal and appointed W. H. TEAS editor. The first

issue appeared in January, 1906. The subsequent development of the association was marked by steady growth and broadened interests, and at present it has over five hundred members.

Of necessity, much of the research work done has been of a routine analytical character and many of the methods developed are empirical in nature, requiring strict adherence to the minutest details of manipulation in order to obtain concordant results. Even today, in spite of years of experiment, there is no satisfactory direct method for the determination of tannin. These difficulties are due in large measure to the complex chemical and physical nature of the materials, and it is becoming increasingly evident that their solution will require intensive application of physicochemical principles, colloid chemistry being included within the meaning of this term. Prof. H. N. HOLMES' brilliant address on colloids should be particularly effective in stimulating appreciation of this fundamental subject.

The chemist's first efforts in this industry were looked upon with mistrust by the practical tanner, and it would seem that even at the present time there is in many cases an unnecessarily wide gap between the chemist and the tanner. Thus it was somewhat of a surprise to learn at the recent convention that this was the first time that Tanners' Council had extended a wish for a successful meeting. However, this feeling of astonishment was tempered somewhat by the remarks of L. J. ROBERTSON, vice-president of Tanners' Council, who spoke most highly of the work done by the chemists in the leather industry and suggested consideration of a plan whereby members of Tanner's Council would receive copies of the journal of the association.

Although the leather chemists can point with considerable pride to past accomplishments, they show no disposition to rest on laurels already gained and their attitude is rather one of eagerness to push forward into the vast unexplored regions upon which their feet have just begun to tread.

Easy Money From Work

SOME time ago we published an article entitled "Easy Money From Peat." All you had to do was to buy stock and wait for the returns. The investors are still waiting, but so long as they have abundant faith they can enjoy themselves. There is another source of easy money, for detailed information of which we are indebted to the Boston *Herald*. That newspaper published a series of editorials on the building situation in the Hub, and these have been collected and republished in the form of a little book. It tells us how to make good money by joining building trades unions.

For instance in the regulations of the Plumbers' Union of Boston Article 9 reads: "It shall be the duty of all foremen to report any man late on his job to his employer at the time it occurs." That sounds all right, but in labor circles there seems to have entered a quality of talmudic scholarship that qualifies rules, giving them new and unexpected meanings. Another rule requires that all foremen shall be union men and Article 9 has been construed to indicate that a foreman may not report a workman for delinquency in any other respect than tardiness. In the Painters and Decorators' Union it is said that a foreman is restricted from commenting on whether a man is doing a proper or an inadequate measure of work.

In the Plasterers' Union there is a rule that, no matter how many men may be employed in a shop, no more than three apprentices may learn the trade in it. Article 14 in the local Plumbers' Union reads: "It is expressly understood that no employer will be entitled to more than two apprentices."

Among bricklayers it was discovered that apprentices could not be employed unless they were the sons of members of the union engaged on the job. The plasterers have a rule which requires them, when traveling to and from work out of town, to take the train nearest 8 in the morning, and 5 in the evening.

If you can crank a Ford car you can operate a gasoline diaphragm pump, and if you can operate a gasoline diaphragm pump and the union admits it and gives you a card, you are an "engineer." Time was when the water boy who carried kettles of water or beer to the men working on a job used to run half a dozen of them with ease. It wasn't supposed to be skilled work. But now it is, and an "engineer" runs a single pump, getting \$10 a day for starting it in the morning, pouring a little oil on it occasionally, and stopping it at night. If he doesn't have to stop the pump at noon and start it up again at 1 o'clock, but can just let it run, then he gets overtime pay for the noon hour.

An instance is given of a building operation in the Back Bay district in which an automatic electrically-driven pump with float control was installed. It was placed in a wooden shack, under lock and key. The union declared that it must be under the constant supervision of an "engineer" and the easy work of sitting outside the shack cost the builders \$168 a week.

A hoisting engine needed repairs. The regular engineer was asked to perform the work over Saturday afternoon and Sunday. He refused. The work had to be done and the employer obtained outside men to do it. But the regular engineer received double time for the work done by the outside machinists, even though he refused to do it himself, for the union held that the work "belonged" to the union man.

To build a brick wall cost last year ten times as much as it did a few years ago. The pay of masons was doubled, the work per day per man was cut down from 2,000 bricks a day to 500, and owing to shortage of masons, builders had to bid up from \$1 to \$1.35 an hour. It was brought out that the mason who picks up a brick and places it in a wall receives as much as the manufacturer does for the same brick, for excavating the clay, molding it, burning it, handling and storing it and all the risk and charges of doing business.

No brush over 4½ in. in width may be handled by a member of the Painters' Union, and sprayers are forbidden.

These are a few, only a very few, of the ways of getting easy money from work brought out in the Boston *Herald* book. We do not offer them as arguments against union labor as an institution. We mention them as sequelæ of a theory to which we lately referred, that opportunity is property. If opportunity is property, we might as well face the fact, and organize our institutions to meet it. The Declaration of Independence claims that every man is entitled to life, liberty and the pursuit of happiness. Such title involves the freedom of opportunity, and this has been our theory of government and of conduct. It has ceased to be our practice in the building trades and, indeed, in many other unionized occupations.

Industrial Alcohol and Prohibition Enforcement

Chemical Industries Protest Against the Volstead Supplemental Prohibition Bill—Lawful Uses of Industrial Alcohol Are Defended—Provisions of Existing Law Are Declared Adequate, but Its Administration and Enforcement Are Denounced

THE Volstead supplementary prohibition bill was vigorously opposed at a protest meeting of the New York Section of the American Chemical Society, held at the Chemists' Club on June 10. The general interest in the subject and the fact that this was the last meeting before the summer intermission were responsible for an unusually large attendance. In the course of his introductory remarks the chairman, Dr. John E. Teeple, said: "I wish to make it perfectly clear that we are not here to discuss prohibition, its advantages or its disadvantages. This is a matter of private opinion and not a subject for action by this organization of chemists. We are not here to discuss the desirability of enforcing the prohibition enforcement act or any other act on the statute books. But the prohibition enforcement act clearly distinguishes between alcohol for industrial use and alcohol for beverage use. We are vitally interested in the first form of alcohol, and as a society are not at all interested in the second form.

ATTITUDE OF THE ANTI-SALOON LEAGUE

"The enforcement act instructs the commissioner to prevent the use of alcohol as a beverage. This is accordingly his duty. But just as definitely and clearly it instructs him to insure an ample supply of alcohol and promote its use in scientific research, and in the development of fuel, dye and other lawful industries. Consequently this is also a lawful duty of the commissioner. If the commissioner attempts to carry out his proper function in both cases, he will of course at times meet difficulties, and will probably develop a tendency to lean toward one duty at the expense of the other in order to avoid these difficulties. The Anti-Saloon League propagandists can see only prohibition in the law or in the duty of the commissioner. The chemist sees another duty which is just as important and just as much a matter of law; that is the duty of promoting the use of alcohol in the industries.

"I have received a very courteous letter from Wayne B. Wheeler, general counsel of the Anti-Saloon League, in which he states that the announcement of our meeting gives him the impression that some of our members have been misled concerning the provisions of the pending supplemental enforcement bill and that many of those who spoke against the bill in its original form were unduly alarmed about the possible effects of it. The bitter experiences of legitimate chemical firms of long standing who have occasion to use alcohol for legitimate purposes are a matter of record. Some of these experiences and difficulties will be related to you tonight. A little careful thought will indicate that these people, with a continued history of unnecessary interference with their business still fresh in their minds, are not likely either to be misled or to be unduly alarmed. They know what is happening and what will result from the present trend. They have reason to see

this situation much more clearly than Mr. Wheeler could possibly see it, and at this meeting tonight the various speakers want to give you a clear picture of the situation as it exists."

The first paper to be presented was that of Dr. Martin H. Ittner, chairman of the industrial alcohol committee of the American Chemical Society.

Report of the Committee on Industrial Alcohol

BY MARTIN HILL ITTNER

At the spring meeting of the American Chemical Society in Rochester, Dr. Raymond F. Bacon called attention of the society to the danger threatening the industries of the country if prohibition enforcement legislation is allowed to become enacted without properly providing for the unhampered use of industrial alcohol. A committee on industrial alcohol was appointed to study the subject and represent the society, if need be, before legislative bodies on matters pertaining to alcohol on which there was practically a unanimity of opinion within the society.

The bill, H. R. 5033,¹ which was recently introduced in Congress to amend the national prohibition act, contains features which are unquestionably seriously objectionable to many industries, and the committee on industrial alcohol requested a hearing before the Committee on the Judiciary of the House of Representatives. This request was finally granted and the alcohol committee presented the resolutions of the American Chemical Society and a few specific suggestions for the modification of some of the more objectionable provisions in H. R. 5033.

The resolutions of the American Chemical Society are as follows:

Whereas the use of alcohol in many important industries is absolutely necessary not only to the continuance of such industries but also for the manufacture of articles needed by other industries and even for the production of articles necessary to the protection of, and sustenance of life itself, and

Whereas it is the policy expressed in the national prohibition act to encourage the use of industrial alcohol for non-beverage purposes, such as the manufacture of thousands of necessary medicinals, and countless dyes, chemicals and perfumes, and for the production of heat, light and power.

Be it Resolved, That the American Chemical Society advises, and most strongly urges, for the national welfare, that all legislation for the enforcement of prohibition be so clearly drawn as not to restrict the activities of legitimate industries which must have industrial alcohol, and that all such legislation be so drawn as to provide in specific sections for the encouragement of the proper use of alcohol in the industries.

LIMITS THE SUPPLY AND USE OF ALCOHOL

For the benefit of those who are not familiar with bill H. R. 5033, I will say that its ostensible purpose is to control and prohibit the use of beer and light

¹EDITOR'S NOTE: H. R. 5033, referred to here, was subsequently amended and reported June 2, 1921, as H. R. 6752. See CHEM. & MET. ENG., vol. 24, p. 1076, June 15, 1921.

wines for medicinal purposes, but instead of confining itself to this, as it might have done, it does not even mention beer, but goes on to limit the supply and use of alcohol.

It would not allow any pure alcohol to some of the important industries unless the manufacturer, in each case, could clearly establish to the satisfaction of the commissioner that it would substantially interfere with his manufacture if he used a medicated or compounded alcohol. The burden of proof is put on the manufacturer. He is denied the alcohol at the outset and he *may* get it if he is lucky enough to convince the commissioner. If a manufacturer makes a hundred different articles with the use of alcohol, and some of them make more than that, it will be necessary, in the case of each article, to present a separate argument or the use of pure alcohol will be denied for the manufacture of that article. Respectable, long-established manufacturers are even now subject to frequent and unnecessary delays and hold-ups on their supply of alcohol, and this new bill, if enacted as introduced, would bring about an intolerable condition.

After making it obligatory to "medicate or compound" alcohol, to use the language of the bill, or to denature it, in plain English, a "joker" is introduced which reads, "Liquor, including alcohol, so medicated or compounded shall not be exempted from any tax to which liquor is subject," thereby greatly restricting the use of tax-free denatured alcohol in some of the important industries.

The first glaring defect in the bill, as introduced, to which the committee on industrial alcohol called attention was the power conferred on the commissioner to restrict the supply and uses of alcohol. In the first part of section 2 the bill apparently permits the manufacture of alcohol without restriction as to quantity, but further along in the same section the commissioner is told that he *shall* limit the supply and use of all liquors, *not* excluding alcohol. If he is directed to limit the supply of alcohol, he must necessarily restrict manufacture. He is directed to limit the supply "to the actual needs for non-beverage uses." No commissioner can know the actual needs and he is almost sure to restrict the supply of alcohol so that it will be insufficient.

AMENDMENTS PROPOSED BY COMMITTEE

The committee proposed an amendment by introducing the words "save alcohol" after "all liquors," line 11, page 2, section 2, so that it would read as amended: "The commissioner shall limit the supply and use of all liquors, save alcohol, to the actual needs for non-beverage uses," etc. It ought to be perfectly evident that the commissioner should not be allowed to restrict the supply and use of alcohol. For instance, he should not be permitted to restrict the supply of denatured alcohol, but if he limited the supply of pure alcohol in accord with his guess as to the actual needs, he would thereby restrict the supply of denatured alcohol; for you cannot have an adequate supply of denatured alcohol if you limit the supply of pure alcohol, as denatured alcohol is made from pure alcohol. The supply and uses of pure alcohol as such for industrial purposes should not be subject to the absolute control of one man.

Section 3 of the bill contains even more objectionable blows at industry. As I have already explained, the

bill seeks to force manufacturers to use "medicated or compound alcohol," or, in plain English, *denatured* alcohol, in the manufacture of all articles, and then after this thrust at industry gives the bayonet a final vicious twist by providing that "alcohol so medicated or compounded shall not be exempted from any tax to which liquor is subject."

To meet these objectionable parts of the bill, the committee on industrial alcohol offered an amendment to section 3, cutting out the most objectionable parts and adding an amendment that would not only encourage the proper use of alcohol in the industries but would also tend to prevent much of the diversion of alcohol to unlawful purposes. Section 3, with the amendment proposed would read:

No other intoxicating liquor than alcohol shall be used in the manufacture of any article enumerated in subdivisions b, c, d, and e of section 4, title 2, of the national prohibition act unless it shall clearly appear to the satisfaction of the commissioner that without considering palatability the use of some other intoxicating liquor than alcohol is essential as a component part of such article; and *in furtherance of the provisions of title 3 of the national prohibition act, tax-free alcohol suitably and lawfully denatured may, under regulations, be used in the manufacture of any such article.*

USE OF TAX-FREE DENATURED ALCOHOL

Your committee after careful consideration decided they could not take any other ground. If a manufacturer in legitimate business, and we are not considering any other at present, finds that he must have pure alcohol in his work, let him have it under suitable regulations and he will pay the tax that is due on pure alcohol. If he can gradually find suitable denaturants so that in the manufacture of some of his articles he can use alcohol denatured in one way or another, but all unfit for use for beverage purposes, he should then be allowed to use such alcohol tax free. The Government should not hinder him, but should co-operate with the manufacturer in finding new opportunities for the use of denatured alcohols. Each article so made which was previously made with tax-paid alcohol lessens the possibility of alcohol being diverted to beverage purposes. There is no more reason why denatured alcohols used under regulation should be taxed than that coal should be taxed, and there is no reason why any legitimate industry should be denied the use of tax-free denatured alcohol.

OTHER OBJECTIONABLE PROVISIONS

The committee on industrial alcohol looks upon all of section 4 of H. R. 5033 as unnecessary and objectionable and requested that it be stricken out entirely. This section provides nothing essential to prohibition enforcement and is unnecessarily obstructive. It provides a delay of not less than twenty days to any permit to sell any liquor, including alcohol, to manufacture alcohol, or to manufacture articles from alcohol such as medicines and the like. It requires the public posting of the fact at one's place of business so that any fanatic may become informed thereof, and then provides a means whereby any fanatic may hold up such a permit and even force a man to go to court to get what the Government ought to aid him in getting at the outset. The provision referred to is as follows: "Any federal or state officer or any person authorized thereto by any such officer may oppose any such

application." It is not unreasonable to suppose that somewhere there might be found an overzealous state officer who would come under the designation of "any state officer," and it is not outside the range of possibility to assume that such a state officer might authorize all his zealous friends to oppose alcohol permits, these zealots answering the description of "any person authorized thereto by any such officer," thereby giving them the authority of law to "oppose any such application" for alcohol.

With respect to the other sections of the bill we made no recommendations, but our silence is noncommittal.

I cannot refrain from giving my impressions with regard to the hearing before the Committee on the Judiciary. At first, it was not at all certain that we would get a hearing, and the chairman evinced a desire from the start to hear as little as possible against the bill. His frequent remarks tended to divert the testimony of the speaker so that he was forced involuntarily from his intended line of argument. I wish to add that some of the members of the committee impressed one as being both intelligent and fair, but it is doubtful whether many of them realize the injury that legislation of this kind would do industry.

IMPORTANCE OF INDUSTRIAL ALCOHOL

The future prosperity of the country hangs in the balance as much now as it did during the war; more perhaps, for then with an outside objective we presented a united front and worked together, but now, with war out of the way, we are already beginning to forget the necessities of yesterday, unmindful of what the morrow will bring forth. In war time we were absolutely dependent upon industrial alcohol and on our industries. The same is just as true in times of peace, and we are courting disaster when we encourage obstructive legislation.

A year and a half ago all manufacture was going full speed. Now many lines of business are in a bad slump. Though economic conditions, like foreign exchange and war-inflated prices, not the least of which is labor, are responsible for much of the business depression, a greater factor is the uncertainty that we have to face in legislative matters. With Congress continuously mindful of the needs of American industries we cannot help but prosper. We have faith that they see the need of adequate protection against attacks from without, but let us hope that they will also protect us from the dangers that arise within, like those in H. R. 5033.

Industrial Alcohol and Its Relation to Prohibition Enforcement From the Manufacturers' Standpoint*

BY M. C. WHITAKER

The chemical profession has cause to be concerned over the present and future status of alcohol for legitimate industrial and scientific purposes. Chemists may well ask such questions as: Why am I unable to get alcohol to continue the manufacture of U.S.P. medicinals, antiseptics, flavoring extracts, perfumes and the infinite variety of daily household necessities requiring pure alcohol in their production? Why is it

so difficult for me to get alcohol for scientific use for research and for educational purposes? Why do I have to pay a tax of 1,000 per cent on alcohol used in my industry when we have a fifteen-year old law giving us tax-free alcohol for industrial purposes? What has the prohibition of intoxicating liquors got to do with alcohol for industrial uses and for purposes of national defense?

Let us first clarify our problem, and then possibly suggest remedial measures. The national prohibition (Volstead) act was passed with three principal divisions, or titles: Title I. To provide for the enforcement of war prohibition (automatically replaced by the second section—which became operative on Jan. 16, 1920, the effective date of the Eighteenth Amendment); Title II. Prohibition of intoxicating beverages; and Title III. Industrial alcohol.

Alcohol is defined in the prohibition section of the act as follows:

The word "liquor," or the phrase "intoxicating liquor," shall be construed to include alcohol, brandy, whiskey, rum, gin, beer, ale, porter and wine, and in addition thereto any spirituous, vinous, malt or fermented liquors, liquids and compounds, whether medicated, proprietary, patented or not, and by whatever name called, containing one-half of one per cent or more of alcohol by volume, and which are fit for use for beverage purposes.

The same alcohol is defined in the industrial alcohol section of the same act as

The term alcohol means that substance known as ethyl alcohol, hydrated oxide of ethyl, spirit of wine, from whatever source or whatever process produced.

Thus it is, at the very outset of our problem, that law has combined with nature to give a Dr. Jekyll and Mr. Hyde character to one of our greatest chemicals, alcohol.

In the administration of this law, when there is an apparent conflict of language, the prohibition officers appear to work under the injunction usually given to beginners learning to drive an automobile: "When in doubt, push both feet." Prohibition is regarded by them as their first duty, and when in doubt, "stop everything—engine and all."

LEGAL INTERPRETATIONS OF PROHIBITION

Narrow rulings under these provisions have led to such ridiculous interpretations as may be illustrated by the following instances:

(1) The general counsels of the telephone company in both Boston and Baltimore advised their clients that the listing of the name "U. S. Industrial Alcohol Co." in the directory would be an illegal act under the prohibition law. The company was obliged to obtain an official ruling from Washington in order that its corporate title might be listed in telephone books.

(2) The prohibition commissioner, under date of March 22, 1921, advised the U. S. Industrial Alcohol Co. that the use of the words "Cologne Spirits and Alcohol, Pure and Denatured" on their letter heads (standardized for fifteen years) was illegal under the prohibition act, and must be stopped. As result of an appeal to the solicitor of the Internal Revenue Department, this ruling was finally reversed under date of May 12.

(3) E. B. Badger & Sons, of Boston, attempted to purchase a copy of "Young's Fractional Distillation" from a local book store, and were advised by a clerk

*Dr. Whitaker was prevented from attending the meeting because of his father's death, and his paper, which is printed here in abstracted form, was read by the chairman, Dr. Teeple.

that they had the book, but that it could not be sold under the prohibition law. On May 6, 1921, the following letter, signed by John F. Kramer, prohibition commissioner, was directed to the firm:

Gentlemen: Replying to your letter of April 29, 1921, you are informed that if "Young's Fractional Distillation" is a scientific publication which is commonly used by scientists, this office perceives no reason why it should not be purchased by you for the use of your engineering department.

This office issues no permits to enable scientific persons to procure such technical works, but it is anticipated that this letter exhibited to any bookseller who has such a work for sale will serve the purpose.

(4) On May 15, 1920, the U. S. Industrial Chemical Co. of Baltimore delivered to the steamship piers thirty-two drums of iso-butyl alcohol for export to France. The ship's agent refused to accept the goods, because he noted the word "alcohol" on the package and in the bill of lading, stating that they were not permitted under the prohibition laws to handle alcohol.

The goods had to be reloaded, trucked back to the plant, a round trip distance of twelve miles, relabeled and new bills of lading prepared under the name "iso-butyl solvent." Under this name the steamship company accepted the consignment and the reason for the disguise had to be explained to the French buyers as well as such a thing can be explained to a chemist of a sister republic.

(5) The Bishop Gutta Percha Co. applied for a permit to use tax-free alcohol in its laboratories. The answer to the application, under date of May 6, contains the following paragraphs:

This permit is granted on condition that the permittee agrees to keep on hand a stock of tax-paid alcohol for the routine work of the laboratory and that the tax-free alcohol withdrawn under this permit will be used only for original research and development work. When the research work has been developed into an actual working process and the function of the laboratory is merely to continue the operation of this process, tax-free alcohol may not be used.

Routine work such as tests or analyses for purity of various materials both during the process of manufacture and in determining the purity of the finished product does not appear to be exclusively scientific research, and tax-paid alcohol should be used for such purpose.

ATTITUDE OF PROHIBITION ADVOCATES

Wayne B. Wheeler, general counsel of the Anti-Saloon League, made, before the Judiciary Committee, on Friday, May 20, the following very significant statement: "If it comes to the point where it must be a choice between medicaments for medical preparations and the enforcement of the law, I think we must choose law enforcement." Likewise C. R. O'Connor, until recently federal prohibition director of New York, is reported to have said, in answer to a protest by manufacturers in regard to the reluctance of his office to approve permits to obtain alcohol for their industrial operations, "Industrial alcohol be damned; you know it's all booze!" One of the greatest difficulties connected with the separation of industrial alcohol from prohibition enforcement is reflected in these two statements by high authorities in the prohibition-enforcement program. The do-or-die fanaticism reflected in Mr. Wheeler's statement and the utter lack of knowledge as to the existence of an industrial alcohol problem as reflected in Mr. O'Connor's statement represent the frame of mind of 90 per cent of the prohibition advocates.

It is a notorious fact that the Anti-Saloon League

dominates prohibition legislation and enforcement. When the prohibition law to enforce the Eighteenth Amendment was presented to the Judiciary Committee by Mr. Wheeler, it consisted of what are now Titles I and II, for the enforcement of prohibition, with absolutely no provision for industrial alcohol. What is now Title III, the industrial alcohol section of the prohibition bill, was drafted and introduced as a Government measure at the direct suggestion of the then commissioner, Daniel C. Roper, in order to save industrial alcohol. It was through the foresight and influence of the officials of the Bureau of Internal Revenue, and not due to any consideration on the part of the promoters of the Anti-Saloon League bill, that the bills presented to Congress to enforce prohibition carried any provision whatever for industrial alcohol.

The entire disregard of the right of existence of alcohol, the chemical, for industrial purposes can only be explained on the assumption that they are totally lacking in knowledge of its essential relations to chemical industry, to their home comforts, to the health of themselves and their families, to the progress of science, and to national defense. Granting this ignorance, it is not surprising that they believe and advocate, as the best method of enforcing prohibition, the complete extermination of all alcohol.

NEED FOR EDUCATIONAL CAMPAIGN

This is a condition for which the chemists, in a large measure, are responsible, and a condition which they and the industries using alcohol can and must remedy. They have not adequately educated the public, who make and enforce our laws, in the matter of the essential needs of chemical industry. To educate that public is a big contract, but it must be undertaken and successfully carried through by the chemists working individually and collectively, if alcohol and all industry directly and indirectly related to it is to be saved.

Chemists look upon alcohol as one of the most essential and important materials of their industry. They put it in the same class with sulphuric acid, benzene or caustic soda. They know there can be no great development of chemical industry without alcohol, any more than there could be a steel industry without pig iron, an electric industry without copper, or a fertilizer industry without potash and fixed nitrogen. While alcohol may not be used directly in the manufacture of textiles, automobiles or sugar, any chemist can draw a flow sheet to show its relation to some of the contributing industries.

Furthermore, petroleum experts issued a warning at the last meeting of the American Chemical Society in Rochester in regard to the visible supply of liquid fuels, which ranks in importance with the famous warning of Sir William Crooks in reference to nitrogen for fertilizer. They have pointed out that in from fifteen to twenty years the rapidly diminishing supply of petroleum will compel the world to turn to some other source for liquid fuel. The only possible solution to the problem in this distressingly short time is alcohol.

DIVISION OF INDUSTRIAL ALCOHOL CREATED

The industrial alcohol section of the national prohibition act (Title III) theoretically became effective on Oct. 28, 1919, although administrative regulations (No. 61) were not approved thereunder until Jan. 31, 1920, and Feb. 5, 1920. Laws will not administer themselves, and this is especially true of the national prohibition

act. No provision whatever was made by the Government, at the outset, to separate the administration of industrial alcohol from prohibition. All energies were arbitrarily directed, under the ceaseless pressure of the Anti-Saloon League, to organizing for and administering prohibition, while the industrial alcohol provisions of the law were literally lost in the fog.

The situation for alcohol for the industries, for research and for education became so serious that in June, 1920, a large committee representing leading educators, investigators, chemical societies, consumers and producers and the War and Navy Departments journeyed to Washington and strongly protested at the neglect of the legitimate alcohol industry in the scramble to enforce prohibition.

This protest finally resulted, in October, 1920, in the creation of the Division of Industrial Alcohol and Chemistry, under Captain D. S. Bliss, deputy prohibition commissioner, with Dr. J. M. Doran, of the Bureau of Internal Revenue, a chemist of high professional standing and long experience, in charge. This division has not had an opportunity to achieve the full measure of its importance, because it is still subordinated to the prohibition provisions of the law. A Division of Industrial Alcohol and Chemistry, directed by competent chemists equipped with adequate facilities, and charged with the full responsibility of administering all alcohol for industrial, scientific and non-beverage uses, is clearly implied when industrial alcohol was given a separate section of the law, and the legal provisions to "place the non-beverage alcohol industry and other industries using such alcohol as a chemical raw material or for other lawful purpose upon the highest possible plane of scientific and commercial efficiency" are made mandatory.

The chemical profession and the chemical industry should unite to make the Division of Industrial Alcohol and Chemistry what it is legally stated to be, and what the economic future of this country demands that it should be—an organization to control alcohol, the chemical.

NEW VOLSTEAD BILL THREATENS CHEMICAL INDUSTRIES

Let us turn our attention to the new bill now before the House, which is a further encroachment upon chemical industry. The development of industry as a whole is a matter of bread and butter to the chemist; the greater that development the more bread and the more butter will be available to those men who have chosen chemistry or the chemical industry as their profession. New legislation, of which we are threatened with a surfeit, and which threatens chemical industry, deserves the attention of all chemists.

This new bill (H.R. 6752) introduced by A. J. Volstead, chairman Committee on Judiciary, and sponsored by Wayne B. Wheeler, counsel of the Anti-Saloon League, is admittedly intended to prohibit beer, although the word "beer" is not used once in the proposed act.

For purposes of discussion, the bill may be divided into three parts: (1) The prohibition of beer, and limiting prescriptions; (2) the extension of governmental control, under the guise of prohibition, to the U.S.P. medicines, the proprietary, the perfume and the flavoring extract industries; (3) the penalties.

We as a profession are not concerned with the prohibition features of this bill. It might be fair to assume that our professional associates, the medical

men, would wince at the idea of having the judgment of a commissioner of prohibition supersede that of the 150,000 medical practitioners in the United States.

GOVERNMENT CONTROL IS EXTENDED

The proposal to include under this bill a group of industries conforming in every respect to the provisions of the Eighteenth Amendment, the national prohibition act and every other law of the land is plainly an effort to extend government control where it is neither necessary nor desirable.

Your home town laws used to require a man who proposed to open a saloon in a neighborhood to post a notice of his intention upon the doors and walls of the building, in order that the whole neighborhood might be advised of the impending stigma that was about to be placed upon it and have an opportunity to work up opposition.

Similarly, the pending bill, in the case of a manufacturer proposing to engage in the business of making pharmaceutical, proprietary, toilet and antiseptic articles or flavoring extracts, requires that "notice thereof shall be served on the Attorney General and publicly posted at applicant's place of business" . . . and further, "any federal or state officer or any person authorized thereto by any such officer may oppose any such application." Why should a legitimate chemical industry and its owners and employees be stigmatized and put in the class with the corner saloon or the bootlegger, and the clear implication held out that he is engaged or is about to engage in a business of questionable character? Why should legitimate business plans be disclosed by "notice of intention," and why should another opportunity be created, by law, for graft?

Another provision of the bill gives concurrent power to the Commissioner of Internal Revenue and to the Attorney General, and also provides that the Attorney General may designate "some suitable person or persons to have charge of and perform the duties imposed upon him by this act."

This means, in plain English, that these legitimate industries, because they require and use alcohol, will have to submit their business, their operations and their employees to control, not only by two independent Government departments, but also by an additional unknown quantity designated as "some suitable person or persons." Who do you think it or they will be? The risks of doing business under such conditions would alienate legitimate investors.

STIGMA ON CHEMICAL PROFESSION

No chemist could afford to risk a fine of \$1,000 or a jail sentence for five years for some alleged or technical violation of the law. Such provisions as these stigmatize an important division of chemical industry, and that stigma passes to the chemical profession as a whole. Successful enforcement of prohibition requires the co-operation of the chemists to a greater extent than that of any other profession, and that co-operation can not be obtained by wholly unnecessary or misdirected stigmatization.

Does the spirit of the proposed bill conform to the principle of placing "the non-beverage alcohol industry and other industries using such alcohol as a chemical raw material, or for other lawful purposes, upon the highest possible plane of scientific and commercial efficiency" as already provided in the industrial alcohol section of the existing prohibition enforcement law?

Relation of Industrial Alcohol to Pharmaceuticals, Perfumery and Flavoring Extracts

W. L. Crounse of Washington, the counsel for the National Wholesale Druggists Association and the Manufacturing Perfumers Association, told of the interesting experiences of these industries with prohibition enforcement. Former Prohibition Commissioner Kramer was quoted as authority for the statement that of 75,000 permits issued during the first year of prohibition, 12,000 at least were issued to persons who had never before been engaged in any line of industry in which alcohol was used. Over 4,000 of these were issued in New York City alone, and it can be safely estimated, according to Mr. Crounse, that five of every six of these were used illegitimately. "These fly-by-night concerns either diverted their alcohol to beverage purposes without pretending to manufacture a legitimate product, or mixed it with some bland essential oil, a little coloring matter and a small amount of sugar, and 'bootlegged' it through low-grade barber shops under 'hair tonic,' 'face lotion' or similar labels."

One of the most demoralizing phases of prohibition enforcement, according to Mr. Crounse, has been the character of the organization charged with its administration. Protests of honest dealers and manufacturers have often been unheeded by prohibition directors, but "intimations were frequently received to the effect that if anyone who had difficulty in obtaining a permit would apply to certain ex-officials of the prohibition unit, relief would be speedily forthcoming." A number of illustrations were cited to show the graft and criminal laxity on the part of enforcement officials.

PERFUMERS FORCED TO SUPPLY FORMULAS

Many difficulties have been experienced by the legitimate perfumers and manufacturers of toilet articles.

One of the best-known manufacturers of toilet goods in the country was called upon by the local prohibition director for the complete formulas by which his goods were manufactured. As the existing regulations did not require such data to be submitted, the manufacturer was very reluctant to comply with the director's demand, but finally submitted quantitative formulas. A fortnight later he was greatly surprised at receiving a second demand for the same data and upon investigation learned that all the formulas originally submitted had disappeared from the director's files. These formulas have never been recovered."

FLAVORING EXTRACT MANUFACTURERS PROTEST

F. M. Boyles of Baltimore stated that the Flavoring Extract Manufacturers' Association was unalterably opposed to the additional restrictions on lawful industry such as would be imposed by the enactment of the Volstead supplemental prohibition bill. Sections 3, 4 and 5 were declared to be the most objectionable to the food industries.

"The first sentence of section 3 gives the prohibition commissioner the arbitrary power to grant only such permits as are necessary to supply the actual needs for non-beverage purposes, and to limit the supply and use of all liquor save denatured alcohol and denatured rum unfit for internal use to such non-beverage needs. This is an entirely unnecessary provision, because the Volstead act itself determines that there is no use or need for alcohol save for non-beverage purposes.

"In section 4 we manufacturers are classed with the corner saloonkeeper, and required to post publicly in our

places of business notice that we have applied to the prohibition commissioner for a permit to use alcohol in our business, and anyone in the community who may have a personal grudge against us or any federal or state officer who is looking for graft can oppose our application. We object to notifying anybody how, when or where we purpose to use alcohol.

"Section 5 gives concurrent authority to the Attorney General and to the prohibition commissioner to suspend or cancel a permit. The result of this would be to subject the manufacturer to the decisions of two tribunals instead of one. In decisions pertaining to business, we believe that only one department of the Government should have such authority."

LEGAL STATUS OF INDUSTRIAL ALCOHOL EXPLAINED

The concluding speaker, Alfred D. Van Buren, general counsel of the legal division of the Bureau of Internal Revenue, was introduced by the chairman as one of the Government officials who has been most helpful to the legitimate users of alcohol. In referring to the legal status of industrial alcohol, Mr. Van Buren said:

"Industrial alcohol is absolutely no different, whether it is the pure alcohol designated in the definition of Title I as a liquor, or whether it is used industrially and chemically under Title III. It is the same product which Congress has classified within the term of "intoxicating liquor," but bear in mind that the Eighteenth Amendment was simply for the prohibition of intoxicating liquor for beverage purposes.

"Congress recognized the fact that there was a legitimate use and value for all liquor, and consequently provided for the non-beverage use of liquors, including alcohol. The non-beverage industry is a general or descriptive term, but the industrial use of alcohol, and the use of alcohol as a chemical is, without the slightest doubt, a non-beverage use. It is therefore not prohibited by federal amendment nor by the national prohibition act.

"Alcohol as booze or liquor has no legal status, but alcohol as a chemical has a legal status which must not be disturbed, but on the contrary, promoted and encouraged."

The proper extension of the policy of denaturation was emphasized by the speaker as one of the ways in which the chemist can increase the usefulness of alcohol without coming into conflict with the operations of the prohibition act.

"The only thing that stands in the way of the open door for denatured alcohol is the question of taxes. I have tried to explain that the tax on intoxicating liquors was for the purpose of collecting revenue and for stamping out a malicious commodity. If, therefore, by denaturation you can destroy the intoxicating character of alcohol as a liquor, you are certainly solving one of the great problems of prohibition, for the records at Washington show that 90 per cent of the alleged liquor seized consisted of diverted alcohol, or alcohol which has been converted into spurious liquor and medicinal compounds.

"I believe that if prohibition, as incorporated in the Eighteenth Amendment of the Constitution, was again submitted to the people, it would carry overwhelmingly; but I do not believe that this prohibition contemplates or means that the legitimate non-beverage industry, represented by industrial alcohol or by the use of alcohol as a chemical, was ever intended to be disturbed by the people of this country."



American Leather Chemists Association, Atlantic City Meeting

Committee Reports—South America and the Leather Industry—Synthetic Tanning Materials—Explosiveness of Tannery Dusts—Chestnut Wood Tannin—Conditions in Leather Industry—Colloids—Tanning Materials in the Far East

THE eighteenth annual meeting of the American Leather Chemists Association was held at the Hotel Ambassador, Atlantic City, June 9, 10, and 11. Over one hundred members attended and many took active part in the discussions which followed the presentation of papers. In the following report no attempt has been made to cover any of the papers in detail, since they have been or will be published in full in the journal of the association.

OPENING REMARKS

In opening the meeting the president, F. H. Small, reviewed the work of the association during the year. In order to relieve the financial condition of the society it became necessary to increase both dues and advertising rates in the journal. The results of this step have been most encouraging, as only thirty members have resigned since the dues were increased and only seventeen of these gave the increase as the specific reason for resignation. The May, 1921, journal shows an increase of 50 per cent in amount of advertising compared with the May, 1920, issue in spite of the higher rates.

Turning to the subject of research, Mr. Small pointed out that the association was built upon committee work which is research directed toward the establishment of uniform control methods. That the British and German organizations of leather chemists are working with renewed vigor is evident from a perusal of their respective journals. During the year the American Leather Research Laboratory, which had been maintained at New York under the auspices of the Tanners' Council for the past three years, was removed to the University of Cincinnati and placed in charge of George D. McLaughlin, a well known-member of the association.

While the year had presented many unusual problems to the leather chemist Mr. Small expressed the opinion that the tide had turned and that the day of wasteful and extravagant production had passed.

In his report as secretary-treasurer, H. C. Reed stated that on June 1, 1921, the association had 177 active, 230 associate and 99 mutual members—a total of 506.

EFFECT OF HUMIDITY ON MOISTURE DETERMINATIONS

F. P. Veitch read a paper by T. D. Jarrell on "The Effect of Atmospheric Humidity on the Determination of Moisture in Leather." These experiments were undertaken in an effort to account for the difficulty of checking moisture determinations. Analyses carried out at one constant relative humidity were compared with those made at another humidity. It was found that drying at a lower relative humidity gave consistently higher results. As an example, the average of four determinations of total solids in a chestnut wood extract was 93.09 per cent at 65 per cent relative humidity and 93.60 per cent at 30 per cent relative humidity.

SOAKING AND LIMING HIDES

C. M. Morrison treated the subject of soaking and liming hides in a most instructive and interesting manner. He discussed the problems which confront the tannery superintendent and gave practical suggestions for the successful conduct of these important steps in the preparation of hides for tanning.

SOUTH AMERICA AND THE LEATHER INDUSTRY

Personal observations formed the basis of G. A. Kerr's paper on "The Relation of South America to the Leather Industry." In order to avoid the possibility of drawing erroneous conclusions from abnormal war conditions, the review was based rather on pre-war figures.

Hides and Skins. Of the eleven South American countries, nine raise cattle and export hides and skins. As a hide producer Argentina takes first place in the world. The establishment of the frozen meat industry in 1877 gave a great impetus to cattle raising, Argentina being the first country to ship frozen beef. In 1913 Argentina had 29,000,000 cattle with an annual volume of 4,000,000 hides available for export, two-thirds green salted and one-third dry. During recent years foot-and-mouth disease and anthrax have become prevalent. Argentina also had 80,000,000 sheep in 1913, these being raised primarily for their wool.

Brazil ranks next, although progress will probably be slower owing to the difficulty of securing suitable

grazing land and to the presence of ticks. It is claimed that there are 37,000,000 cattle, but as the population is 27,000,000 (compared with Argentina's 9,000,000) only 2,500,000 hides are available annually for export.

Uruguay resembles Argentina, although developments are naturally on a smaller scale. There are about 7,750,000 cattle and 11,000,000 sheep.

The other countries figure less prominently in the world's leather market, but the total from all of South America is about 15 per cent of the world's consumption of hides.

Tanning Materials. Argentina, Paraguay, Venezuela and Colombia are important producers of tanning materials. Here again Argentina leads with twelve plants having a capacity of 125,000 metric tons of solid quebracho extract. Paraguay has five plants with a capacity of 50,000 metric tons. Owing to labor conditions the maximum capacity has never been attained. Thus in 1914 exports of quebracho extract amounted to 80,000 tons from Argentina and 11,000 tons from Paraguay. The quebracho forests, which were described by Mr. Kerr in the April issue of the journal of the association, are ample for seventy-five years. In Brazil the industry is still undeveloped, but the other countries seem to be able to meet domestic requirements.

Leather. Almost every town has a little tannery, although the demand for leather is not very great, since two-thirds of the population never wear shoes. Not over \$10,000,000 gold is spent abroad annually for leather goods. Although workers have become unionized and wages have increased, the greater part of the demand will be met from domestic manufacture. The development of any extensive industry would require outside capital, which will not be readily available until government and finance are stabilized and export duties abolished.

SAMPLING AND PREPARATION OF LEATHER FOR ANALYSIS

Results of an exhaustive study of sampling and preparation of leather for analysis were given by F. H. Small. Sides of leather were divided into sections and each section was analyzed for hide substance. As would be expected, the sections near the tail gave higher figures than those near the belly and shoulder. A careful examination of these results showed that it was possible to get two or at the most three samples, each 2 x 8 in., which would be representative of the standard cuts of leather such as backs, bellies, bends, sides, and shoulders. A chart was prepared giving the relative location of the samples to be taken for each cut.

SYNTHETIC TANNING EXTRACTS

Some points to be considered in the application of synthetic tanning extracts were discussed by J. B. Hill and G. W. Merryman. The time of tanning can be reduced by the use of more concentrated baths only if the rate of diffusion can be increased. This result may be obtained in many cases through the application of syn-tans. For success the hydrogen-ion concentration must be controlled and the quality of the syn-tan must be high and uniform. There are two classes of syn-tans, those which act as real tans and may be used alone, and those which must be used with other tans. Neradol D and the cresolsulphonic acid-formaldehyde condensation products belong to the first class, although it is better to use them in conjunction with vegetable tanning materials. When applied in this way, they act as accelerators or drivers for the

vegetable tans, produce a tougher leather with a smoother grain, contribute to the tanning action and exert a clarifying influence on the extract and a bleaching effect on the leather.

Syn-tans may also be used as deliming and plumping agents in the preparation of hides.

For sole leather, syn-tans may be added at several points in the process: In deliming, directly in the rockers, in the retaining wheel, with the bleach or filler, in the oil wheel or with the dope.

In discussing the paper C. R. Oberfell suggested that the antiseptic action of these materials might cause sterilization all through the yard. He also stated that experiments led him to believe that the sulphonic acids had no plumping action when freed from excess sulphuric acid. This contention was disputed by Dr. Hill.

EXPLOSIVENESS OF TANNERY DUSTS

Attracted by the grain-dust explosion investigations in progress at the Bureau of Chemistry, Ralph W. Frey had tests made of the explosiveness of tannery dusts. Those examined were found to explode vigorously when suspended in air and it was planned to demonstrate this property to the members of the association. Unfortunately the conditions prevailing in the convention room made this impossible. In view of recent disastrous explosions in the finishing department of an aluminum ware plant and in pulverizing hard rubber, Mr. Frey thought it wise to direct attention to the possibility of similar explosions in tanneries unless proper precautions are taken¹.

EXTRACTION OF LEATHER

The committee report by John Arthur Wilson on "The Determination in Leather of Matter Extractable by Water" was published in the May journal of the association, and in Mr. Wilson's absence the conclusions and discussions were read by G. W. Schultz.

The subject was also considered by F. P. Veitch and R. W. Frey, battery extractors of the Soxhlet type being used. The effect of repeated extractions at various temperatures was studied. In no case was an absolute end point obtained, although after the second or third period the amount extracted settles to a low, fairly constant value. This may be due to the presence of some slightly soluble substance, or to hydrolysis, but it is not due to the decomposition of hide substance or collagen.

OBSERVATIONS ON WILSON-KERN METHOD OF TANNIN ANALYSIS

Further observations on the Wilson-Kern method of tannin analysis² were made by G. W. Schultz. As a result of several sets of experiments, Mr. Schultz maintains that while the official method may not be fully accurate, the error is not large and is lower than the true value, rather than higher as indicated by the Wilson-Kern figures.

CHESTNUT WOOD TANNIN

The characteristics of chestnut wood tannin were outlined by R. W. Griffith. The function of tannin in plant physiology is but little understood. Tannin is obtained

¹See CHEM. & MET. ENG., vol. 23, No. 19, pp. 915-920, Nov. 10, 1920; vol. 24, No. 1, pp. 29-32, Jan. 5, 1921; vol. 24, No. 11, pp. 473-475, March 16, 1921; vol. 24, No. 17, pp. 737-740, April 27, 1921.

²See J. Ind. Eng. Chem., 1920, vol. 12, p. 465; J. Amer. Leather Chem. Assoc., 1920, vol. 15, p. 64; CHEM. & MET. ENG., vol. 23, p. 613, Sept. 29, 1920.

commercially from practically every part of the plant—roots, bark, wood, leaves and fruit. In chestnut wood the tannin exists in the pores or ducts which separate the fibers. It is present probably as a glucoside and the percentage of glucose is quite characteristic of this material. The glucose is not absorbed by the hide powder and is included under non-tannins in the analysis. Nevertheless it supplies acetic acid by fermentation during tanning and should thus be considered as a valuable constituent of the extract. It might also be possible to convert the glucose into lactic acid, which would be of even more value in the bath.

CONDITIONS IN THE LEATHER INDUSTRY

L. J. Robertson, vice-president of the Tanners' Council and chairman of the committee on the tanning school, said that conditions were about all that the leather industry had today, so that viewing conditions from the schoolboy's standpoint the industry might be said to have flunked. The attitude of Secretary Hoover is encouraging, however, particularly in regard to extending credits to foreign trade for the purpose of helping the export business. The duty on raw hides and skins, which seems to be demanded by the agricultural interests, was declared unsound, since 40 per cent of the raw material for the leather industry is imported.

A better spirit of co-operation between seller and customer is noted and the feeling of hopelessness is passing away. This is fortunate for the industry, since it is very difficult to operate tanneries on a hand-to-mouth basis with rapidly changing styles.

In preparing to meet foreign competition, the tanners have encouraged research, established a tanning school and made studies of such problems as cost accounting methods, elimination of grubs and ticks, etc.

Mr. Robertson is of the opinion that tanners generally should have the benefit of the work done by the A.L.C.A. and he suggested that Tanners' Council should consider some plan by which dues would include a subscription to the journal of the A.L.C.A.

COLLOIDS

Prof. H. N. Holmes of Oberlin delivered a most instructive and entertaining address on "Colloids." The chemistry of colloids is the chemistry of very small things—that is, particles having the dimensions of a few hundred molecules. Bancroft prefers to call it the chemistry of grains, drops, bubbles, filaments and films with at least one dimension very small. Examples of the different types of colloidal suspensions were exhibited and passed around for inspection.

A property of colloidal suspensions which attracts immediate attention is their stability, which is found to be influenced by several factors: Brownian movement, the electric charge carried by the particles, protective films formed by substances such as gelatine or glue, which are consequently called protective colloids; viscosity, equal density in the two phases.

Colloidal suspensions may be prepared in many ways. Grinding is sometimes employed, but one of the most usual methods is peptization. This phenomenon takes place when glue is treated with water, for example. The glue does not dissolve to form a molecular solution, but is merely peptized (or subdivided) into aggregates of molecules. Silver bromide can be precipitated in a coagulated form only when exact equivalents of AgNO_3 and KBr are taken. The slightest excess of either results in the formation of a colloidal suspension

due to the adsorption of silver or bromide ions as the case may be. This is known as preferential adsorption of ions.

There are two general types of colloids—suspensoid and emulsoid. The former are very sensitive to added salts and give solutions having practically the same viscosity as the solvent used. Thus a 20 per cent suspension of precipitated chalk in water has practically the same viscosity as water. Emulsoid colloids are not sensitive to the addition of salts and yield viscous solutions or gels. Thus a 1 per cent sodium stearate suspension is solid.

Many interesting examples of gels and emulsions were shown and explained. One particularly striking observation was that precipitated silica is $\frac{5}{8}$ air by volume, whereas calculations show that there would be only 24 per cent air space if the particles touched. It is evident that the particles are not in contact, which accounts for the free flow observed in these very fine powders.

TANNING MATERIALS IN THE FAR EAST

Dr. Lloyd Balderson told of his experiences in search of tanning materials in China and Japan. The per capita consumption of leather in these countries is small, the Japanese wearing wooden shoes and the Chinese for the most part none at all. China does, however, produce some hides and skins for export and some leather is made in certain districts. Tanbark is unknown and smoke or mineral tannage is employed as a rule, although in Manchuria fermented milk is used in a manner similar to oil tannage. There are a few modern tanneries in the Canton district making black upper leather by the one-bath chrome process, using tanning materials imported from America.

Wattle and quebracho are imported into Japan and in a search for suitable domestic supplies of tanning materials, the speaker examined the bark from twenty-five species growing in northern Japan. Several of these were found to offer possibilities.

OTHER COMMITTEE REPORTS AND PAPERS

Dr. Thomas Blackadder's report of the findings of the committee on "Color Measurement of Vegetable Tanning Solutions" having been published in the May journal of the association, he merely summarized the results of the comparison of the Hess-Ives tint photometer with the Lovibard machine.

Other committee reports and papers presented during the convention were "The Estimation of Oils and Greases in Leather," by F. P. Veitch; "The Sugar Content of Leather," by J. S. Rogers; "Post-Mortem Changes in Fresh Hides," by G. D. McLaughlin; "Plumping Power of Tan Liquors," by A. A. Clafin; "Available Calcium Oxide," by F. P. Veitch and T. D. Jarrell; "Rapid Washing of Chromed Hide Powder," by R. W. Frey and L. D. Clarke; "Determination of Ep-som Salts," by R. W. Frey.

EXECUTIVE SESSION

President Small read the invitation extended to the Society of Leather Trades Chemists to send representatives to the meeting and the reply from the president, J. Gordon Parker, announcing the bi-annual conference to be held in London during the first week in September. Mr. Small also stated that a recent book of Josef Jettmar on "Eisengerbung" had been dedicated to the A.L.C.A. G. D. McLaughlin and G. W. Schultz were elected members of the council.

Recent Progress in High-Frequency Inductive Heating*

Notes on Design, Operation, Melting Rate and Power Input of Electric Furnaces Using High-Frequency Inductive Heating—Most Pretentious Furnaces Yet Constructed Are Melting Precious Metals at the United States Mint and for a Leading Silver Broker

BY E. F. NORTHRUP

Vice-President and Technical Adviser, Ajax Electrothermic Corporation

FURNACES for melting practically all metals and also glass and refractories by means of high-frequency currents¹ have been designed, built and sold:

- (a) High temperatures and vacuum type furnaces.
- (b) "Electric crucible" type furnaces.
- (c) Mint type furnaces.
- (d) Heat-treatment furnaces.
- (e) Graphitization furnaces.
- (f) Miscellaneous heating and muffle type furnaces.
- (g) Large tilting and pouring-type furnaces.

It is obvious that if the available power is limited to a definite maximum by the capacity of the transformers and condensers supplied, the highest temperature can be obtained only by restricting the volume of the mass to be heated.

HIGH-TEMPERATURE AND VACUUM FURNACE

The highest temperatures may be obtained with a furnace energized with a standard 20-kw. high-frequency

converter set when patterned after the standard high-temperature furnace shown in Fig. 1. It is of the non-tilting type, and its contents are removed through the bottom by withdrawing a slide of asbestos board. This type of furnace under favorable conditions will melt molybdenum and can be used to melt electrolytic iron in 5- to 6-lb. (2.3- to 2.7-kg.) lots strictly carbon free. The furnace is very suitable for the recovery of platinum scrap. When a crucible of carbon or Acheson graphite 2½ in. (5.6 cm.) inside diameter by 7 in. (17.5 cm.) long is used, and this is heat-insulated with lampblack, it is not difficult to obtain temperatures in from fifteen to twenty minutes which are more than sufficient to completely graphitize carbon.

For melting in vacuum, a quartz tube closed at the bottom is used which just fits the coil. This tube is fitted at the top with a water-cooled cover with a connection for exhausting the air. Refractories insulate better under high vacuum conditions, and the highest temperatures are easily obtained in vacuum with an expenditure of 10 or 15 kw.

"ELECTRIC CRUCIBLE" FURNACES

This type of furnace has been constructed in four sizes. The inductor coil and crucible are conical. The furnace sits upon a low table and makes contact with the high-frequency converter terminals by means of two metallic feet.²

All furnaces of this type are designed for pouring the metal contents in the same manner in which the contents of an ordinary crucible are poured, over its edge; hence the term "electric crucible." An "electric crucible" may be lifted by handles, placed on two opposite sides, entirely off the table and poured; or it may be pivoted, around an axis passing through its pouring spout, on trunnions. In this case it is lifted by a handle on the side in the back, and poured.

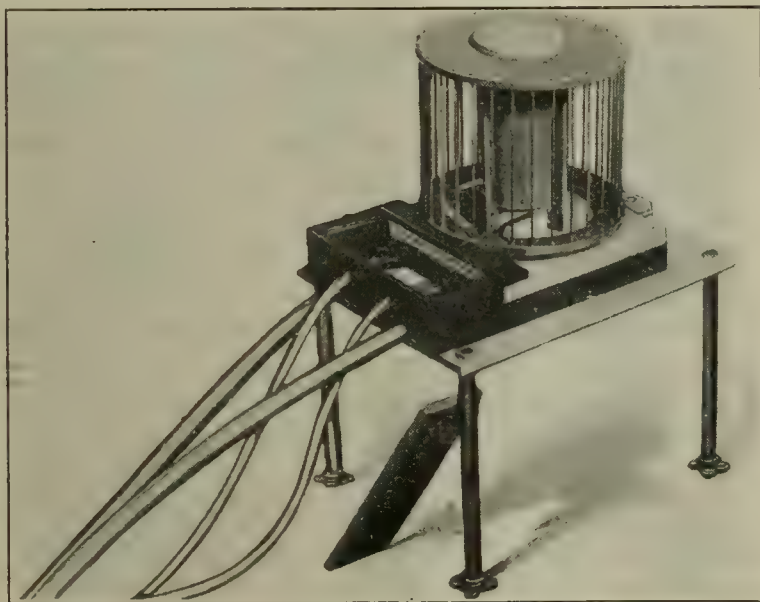


FIG. 1. STANDARD D-1 MODEL

converter set when patterned after the standard high-temperature furnace shown in Fig. 1.

The inductor coil of this furnace is made of forty-two turns of ¾-in. (1-cm.) flattened copper tubing. The inductor is wound as a solenoid and is 9 in. (23 cm.) long and 4⅝ in. (10.5 cm.) in inside diameter. The high-frequency potential is applied to the terminals of this solenoid and also a water pressure of 30 lb. (13.7 kg.) or more, which maintains a flow of water through the flattened tubular solenoid. The furnace may be used as a vacuum or as a non-vacuum furnace.

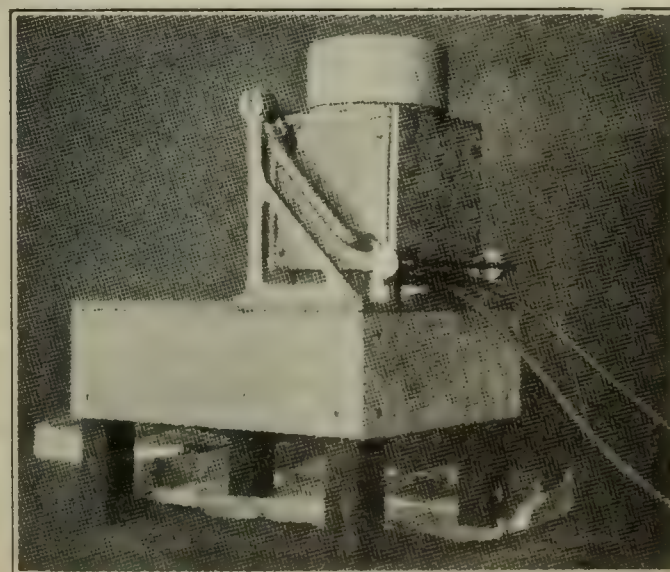


FIG. 2. SIX-INCH "ELECTRIC CRUCIBLE"

*A paper presented at the thirty-ninth general meeting of the American Electrochemical Society, held at Atlantic City, April 21-23, 1921.

¹See CHEM. & MET. ENG., vol. 20, p. 381 (April 15, 1919) and vol. 21, p. 258 (Sept. 1, 1919).

²Described in detail in CHEM. & MET. ENG., vol. 24, p. 309 (Feb. 16, 1921).

Fig. 2 is a view of a 6-in. (15-cm.) "electric crucible." This one either can be tilted around the axis supported by trunnions, or it may be lifted by the handles on its side, entirely off the table, and poured. If it is remembered that all types of furnaces operated by high-frequency induction are substantially at room temperature on the outside, the practicability of handling a furnace in these ways is readily seen.

This particular style and size of furnace is well adapted to melting precious metals, especially gold and platinum alloys. The furnace will melt and pour about 10 to 15 lb. (4.5 to 6.8 kg.) of copper, or about 8 to 10 lb. (3.4 to 4.5 kg.) of steel. The melting is extremely rapid, and when non-conducting crucibles are used, as would be the case when melting a platinum-gold alloy or a ferrous metal, the molten metal stirs violently—a circumstance which assures the perfect mix of an alloy.

Fig. 3 is a cross-sectional view of an "electric crucible" in which the crucible is about 10 in. (25 cm.)

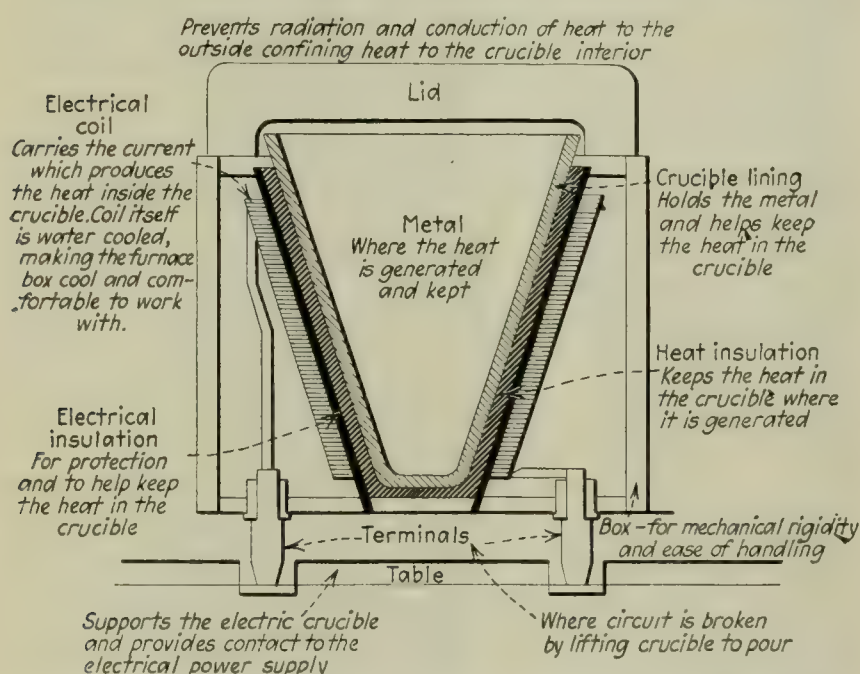


FIG. 3. CROSS-SECTION OF 10-IN. "ELECTRIC CRUCIBLE"

in diameter at its top. It is designed to hold and melt about 50 lb. (22.7 kg.) of copper or brass and about 25 lb. (11.4 kg.) of steel. In this case a pour is made by lifting the "electric crucible" clear off the table on which it rests. The crucible is lifted and tilted for pouring by two persons, using detachable handles.

Twenty pounds (9.1 kg.) of chromium steel has been melted in a non-conducting crucible from steel turnings (hence the carbon content of the steel has not been changed) requiring 15 kw. and fifty-five minutes, starting with the furnace cold.

For melting pure platinum and iridium free from all contamination, an "electric crucible" has been made with a conical crucible 5½ in. (13.4 cm.) in diameter at its top. This conical crucible is made of molded silica ware. Fitting in this is the crucible proper, which holds the metal to be melted. This crucible can be molded of such suitable materials as lime, electrically shrunk magnesia, or the like. The purpose of the outside quartz crucible is to give perfect electrical insulation between the conical inductor coil and the metal contents of the crucible. The melting is, of course, produced by the currents which are generated by the inductor in the metal itself.

In using the above three "electric crucibles," in which it may be required to obtain very high temperatures, it has been found advantageous to maintain a flow of

water through the inductor coil. The water connections to the coil are made with rubber tubing a meter or more long, and it has been found that the resistance of this length of water column is sufficiently high to prevent the water circuit from acting as a shunt on the electric circuit.

A larger "electric crucible" without water connections and with a practically cylindrical crucible is, at the date of this writing, under construction. It is designed for melting and pouring brass or bronze in 200-lb. (91-kg.) lots. To secure more rapid melting, a 25-kw. high-frequency single-phase converter set will be used. As this type is a very recent development, performance data are not yet available.

In the 6- and 10-in. (15- and 25-cm.) "electric crucibles" copper melts and superheats to a suitable pouring temperature at the rate of about 4.2 lb. (1.9 kg.) per kw.-hr. As will be shown later, the melting rate with larger furnaces and more power is very considerably increased, 25 per cent or more.

MINT TYPE FURNACES

The Mint type of furnace was designed specially for use at the United States Mint in Philadelphia, Pa., in connection with work carried on in the deposit melting room.

Four furnaces of the same general type have been installed at the Mint for over a year, and two of these "have been operating daily since March 20, 1920, on small deposits, two small crucibles being used to each furnace, which practice has been followed on combustion furnaces for years past." The other two furnaces have more recently been put into continuous operation. "The results of a test run, melting fine silver bars, were as follows: Total amount melted, 13,478.50 oz. (382,115 g.); total time consumed, seven hours; total current used, 156.50 kw.-hr.; pounds melted per kw.-hr., 5.905 (2.68 kg.); average load per phase, 12½ kw. The results will be greatly improved when the capacity of furnaces is reached by having a full quota of condensers (which are now being installed) using 16 kw. per phase instead of 12½. The fuel cost at the rate of consumption shown above compares favorably with gas."

These furnaces are cylindrical, stationary furnaces and are designed for melting metals in a crucible which may be lifted out of the furnace and poured. In the larger furnaces the molten metal is dipped out until only a little remains in the bottom of the crucible. This last portion of metal is removed by then withdrawing the crucible and pouring it out. In the smaller furnaces the metal deposits are placed in small crucibles and lowered into a thin-walled graphite crucible within the furnace, which remains permanently in the furnace.

The four furnaces of this type installed at the Mint use a total of 48 kw.

Fig. 4 is a cross-sectional view of one of the two smaller furnaces which is used exclusively for melting down precious metal scrap in small crucibles.

In the 1920 report of the Director of the Mint, on page 20, a very favorable comment is made on these furnaces and it is there stated that their adaptation to Mint work on precious metals is advantageous.

FURNACE CRUCIBLES—COATED CRUCIBLES

In high-frequency induction heating of ferrous metals and other metals of high resistivity, as platinum, non-conducting crucibles are used. In melting gold, silver,

*Annual Reports Director of the Mint (1920), p. 19.

(a) The crucible and inductor coil are housed in a box made of sheet steel $\frac{5}{8}$ in. (8 mm.) thick. The box is $45\frac{1}{2}$ in. (114 cm.) high, $31\frac{1}{2}$ in. (78 cm.) wide, and $27\frac{5}{8}$ in. (69 cm.) deep. The top of the box is fitted with a heavy molded refractory piece. This has a central hole 10 in. (25 cm.) in diameter—the inside diameter of the crucible—and a carefully shaped pouring spout.

(b) The crucible and its steel housing may be rotated for pouring around an axis which passes exactly through the end of the pouring spout. The crucible may be raised in the process of pouring 15 deg. above the horizontal.

(c) The movable portion of the furnace is counter-weighted, whereby very little exertion is required to tilt and pour the charge.

(d) The space in front of the spout is free from mechanism, which permits molds to be brought by a carrier directly beneath the end of the spout.

(e) The furnace is free for approach by a man or a truck from behind, which arrangement gives facility to the charging.

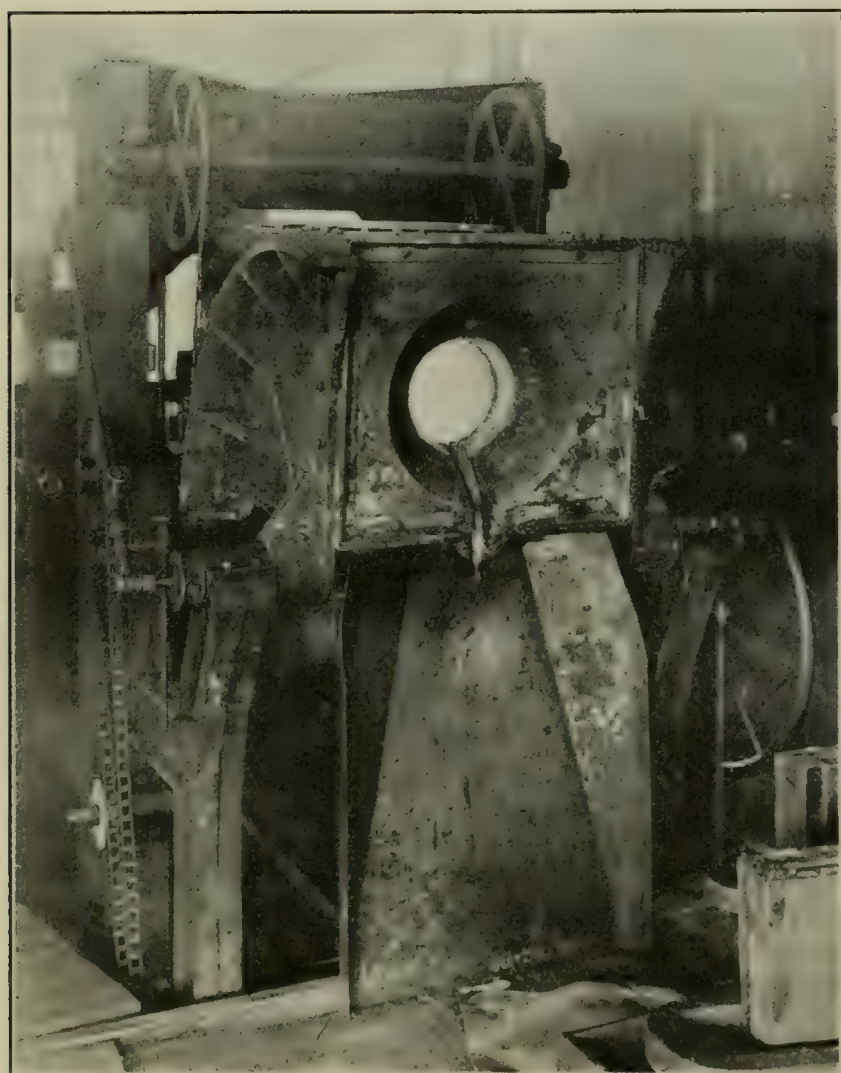


FIG. 5. FURNACE FOR HANDY & HARMAN IN POURING POSITION

(f) The furnace when in its vertical position makes electrical contact with three leads from the high-frequency converter, and when tilted for pouring breaks these contacts with no arcing. The furnace has, therefore, no moving electrical conductors.

(g) The inductor coils, three in number and star-connected, have water circulating through them. The water is led in and out of these coils at the two ends of the axis of rotation of the furnace, by which device all movable water connections are avoided.

(h) The inductor coils and the housing of the crucible and inductor coils are at all times at or near

room temperature, which makes the furnace very comfortable to work around.

(i) The crucible is of carbon or Acheson graphite. It may be molded or turned out of a section of 12-in. (30-cm.) Acheson graphite electrode.

(j) The electrical insulation between inductor coil and crucible is a cylinder of micanite of a $\frac{3}{8}$ -in. (1-cm.) wall (and thus is avoided the use of a rather fragile quartz cylinder), which material has been found suitable for many of the small furnaces that have been made.

TABLE I. REPORT OF ONE DAY'S OPERATION OF SILVER MELTING FURNACE

Time	Kw.-Hr. Meter	Current	Kw.	Weight Sterling Silver, Oz.	Notes
7:45	2,727.3	8.5			
9:00	2,759.0	8.5	53		Crucible at 961° C. Put silver in.
9:40	2,796.5	8.5	56		Put copper in.
9:50	2,805.0	8.5	56	6,550.99	All melted.
10:00	2,812.5				Start to pour 1135° C.
10:15	2,812.5	8.5	35		Put silver in.
11:00	2,854.0	8.5	50	7,462.20	All melted.
11:15	2,875.5	8.5	50		Started to pour.
11:30	2,875.5	8.5	35		Put silver in.
12:15	2,915.0	8.5	50	7,500.00	All melted.
12:25	2,926.0				Started to pour.
12:40	2,926.0	8.5	35		Put silver in.
1:35	2,968.5	8.5	50	7,500.00	All melted.
1:50	2,979.0				Started to pour.
2:15	2,979.0	8.5	35		Put silver in.
3:50	3,034.0	8.5	45	7,545.30	All melted.
4:00	3,044.0				Start to pour.
Totals....	316.7			36,558.49	

Melt	Melting Time Only Lb./Kw.-Hr.	Rate of Melting Melting and Superheating Time Only Lb./Kw.-Hr.	Material
1	9.8	8.4	Fine silver and copper.
2	12.3	8.15	Sterling scrap.
3	12.7	10.2	Sterling scrap.
4	12.1	9.7	Sterling scrap.
5	9.4	8.0	Fine silver and copper.
Average.....	11.3	8.89	

Rate of melting: Average for all the time, 7.95 lb. per kw.-hr.

The performance of this furnace mechanically, electrically and metallurgically appears to be quite satisfactory. It is capable of continuous operation for eight hours or more and is actually being operated at the Handy & Harman plant in Bridgeport throughout a working day.

Table I shows the performance of one day's operation, and may be taken as typical of what the furnace is capable of doing.

GENERAL PERFORMANCE

It may be said in conclusion that the highly useful accomplishments of high-frequency inductive heating are simply unlimited—provided high-frequency power is available in commercial quantities, and at a cost which is not prohibitive. Certain it is that high-frequency converters, of a static character, are now available at reasonable price in single units up to 60 kw., and that these units may be multiplied for operating a single large furnace without any undue complication.

Two years' experience in building and operating many high-frequency equipments—over 500 kw. were in service at the end of last February—have proved beyond a doubt that the principles of high-frequency induction presented before this society in April, 1919, are perfectly sound, and both laboratory and commercial installations have been made which show that this new method of electric heating has come to take its place with other electrical methods of heating for the permanent service of science and the industries.

Trenton, N. J.



COCONUT RAFTS

Oils, Fats and Waxes in Latin America

A Survey of the Resources—Linseed, Coconut, Palm Nut, Castor Bean, Sesame, Peanut, Brazil Nut, Mustard, Manihot, Argemone, Nigerseed—Essential Oils: Linaloe, Cayenne, Petitgrain, Orange, Lime, Bay and Pimento—Vanilla and Tonka Beans—Carnauba and Candelilla Waxes

By OTTO WILSON

EXCEPT for a few stock products the area included under the term Latin America is almost an untapped reservoir of commercial commodities. In spite of the fact that South and Central America contained large and busy cities of 50,000 and more inhabitants before there was a permanent settlement in what is now the United States, most sections are still but thinly settled and their wealth continues to be largely latent. What is true of commercial commodities in general applies also to vegetable and animal oils. Outside of half a dozen products the resources of Latin America in this field have hardly been touched and great areas still await the explorer and cataloguer. The stretches of tropical forest and interior plains constitute a vast storehouse of these materials which can be unlocked only with the keys of labor, capital and transportation.

ARGENTINE LINSEED

So far as volume of exports is concerned the most important oil material that now comes out of Latin America is linseed. This is an Argentine product, one of the four or five chief crops of the wide River Plate plains. The area sown to flax each year in Argentina is greater than that in any other country of the world, being on the average about 3,000,000 acres, and at times the year's output from these plantings goes to over a million tons, or about 42,000,000 bushels, of seed. Before the war most of this production went to Europe, but in recent years the United States has been the chief buyer. So firmly established did this trade with Argen-

tina become during the war that it has been steadily increasing ever since the armistice, and in 1920 importations reached the high value of \$69,000,000. As the total imports of linseed into this country were about \$74,000,000, it will be seen that Argentina has become the great source of raw materials to our producers of linseed oil. During the last year of the war this source of supply was so valuable that the United States Government for a while requested weekly reports as to the state of the flax crop.

In Argentina itself there has been a small development of the oil-crushing industry, principally in Buenos Aires, where five plants have a reported capacity of about 8,000 tons of oil a year. These are all under the management of Italians. Another large plant near Rosario is backed by Dutch capital. War conditions brought about some overseas exportation of linseed oil produced by these mills, but for the most part their output goes to satisfy local demands and the requirements of consumers in neighboring countries. The mills do not run to capacity and there does not appear to be much prospect of the expansion of the industry. There has also been some crushing of linseed in Sao Paulo, Brazil, the seed being brought from Argentina and also from southern Brazil, where it is grown to a limited extent.

COCONUT RESOURCES

Contrasting with the linseed industry, which has probably come near its peak of development, at least for

many years, is the coconut industry of the tropical countries, the expansion of which is largely a matter of the future. Although coconut trees are found in all the lands washed by the Caribbean, along the Pacific coasts of Mexico, Central America, Colombia and Ecuador, and in Brazil, the output of American lands is only a small percentage of the world's total. It is roughly estimated that throughout the world from seven to eight billion coconuts ripen every year, and of this number probably not more than 200 million are produced by the Western Hemisphere. Many millions of these grow in uncultivated groves and are lost entirely, or are used locally by natives of the forest. Most of those that enter into commerce come from the plantations, which are found chiefly in Jamaica, Trinidad and Tobago, the Bay Islands, Old Providence and St. Andrew's Islands off the coast of Central America, and in Honduras and Panama. Along the Pacific coast line from middle Mexico to Guayaquil, Ecuador, and along the northern coast of South America the tall trees are found in profusion, now scattered and now concentrated in thick groves, but in few places are the trees regularly cultivated or the nuts systematically gathered. According to an estimate transmitted in a report from an American

garine, constituting 21.7 per cent of the total vegetable oils used in that industry in 1917, as compared with only four-tenths of one per cent in 1916 and before the European war. Since 1918, however, imports of coconut products have shown a marked falling off. Practically all of these heavy imports have been brought half-way round the world, from the Philippines and other Far Eastern lands, and scarcely any from the groves at our own doors.

The coconuts that come from Latin America are all imported "in the shell," and our total supply of whole nuts comes from these importations. Except for the sparsely settled condition of most Latin American countries and the consequent scarcity of labor and primitive conditions of transportation, there is no reason why that section should not some time send us our requirements in copra and oil as well as in nuts for confectionery and direct consumption. There is, however, no present indication that this change in traffic will take place. There is a considerable production of oil in Trinidad, Panama has an American factory of fairly large capacity, and some oil is produced in other localities, but this is all for local consumption. There is no effort to compete with the Philippines and other Far Eastern mills in shipping to the United States or European markets, and it will be a long time before the American coconut sets up as a rival to its Oriental cousin in the oil-producing business.

PALM NUT AND CASTOR BEANS

Two other tropical oil materials which can be produced in great quantities when the need becomes sufficiently pressing felt the stimulus of war demands, and one of them has been gathered in Brazil in continually increasing quantities since the armistice. These are palm nuts and castor beans. The former is the product of several different species of palm belonging to the same family as the coconut and the West African palm, and the trees are found all the way from Mexico to southern Brazil.

There are various names for the different species, such as cohune, corozo and coquito, and there is a confusion of names in the different localities. What is usually known as the cohune nut (*Attalea cohune*) is found most plentifully in British Honduras, Honduras and Guatemala, but trees also grow to an undetermined extent in Mexico and the Caribbean side of Panama. A cousin of the cohune tree (*Attalea gomphococca*) with narrower nuts and thinner shell, grows plentifully in western Mexico, the Pacific side of Central American states and on down through tropical South America, and other species are found scattered through the jungles of all this tropical region. Brazil has a number of them, and one of them which bears a fruit very similar to the well-known West African palm nut occurs in Panama and the adjoining Atrato district in Colombia.

Like the West African palm nut the nuts of these various species yield two oils, a kernel oil similar to coconut oil, and an outside oil contained in the pulp surrounding the seed, which must be expressed in the country where the palms grow, as it evaporates when the nuts are shipped overseas. Various attempts have been made to utilize the tens of thousands of tons of these nuts which ripen annually, but so far with little success in Latin America. The coconut-oil factory in Panama mentioned above has worked up limited quantities and a few thousands of dollars' worth of the oil has been exported by a factory in Colombia, but production



INDIAN WOMEN OF BRAZIL WITH BASKETS
OF PALM NUTS

consul Brazil has about 1,250,000 trees and produces annually 50,000,000 nuts, but they enter but little into any except local trade.

Throughout tropical America there is immense room for the expansion of coconut planting—the possibilities, in fact, are limited only by the demand for coconut products. There are two contingencies which will bring about this expansion. One is a steady increase during the next twenty-five or fifty years in the call from the world's markets for coconuts and coconut oil which will be loud and continuous enough to induce capital to tie itself up in this long-range investment. The other is a diversion of the United States import trade from the distant Orient to her southern neighbors.

During the war period, with its skyrocketing of prices for animal fats, the demand in the United States for coconut oil showed an immense and unprecedented expansion. In a short time imports of copra and coconut oil increased 700 or 800 per cent, reaching their highest point in 1918, when our copra purchases amounted to almost a quarter of a million tons and our purchases of coconut oil to more than 250,000,000 lb. This imported oil and that obtained from the imported copra went largely into the manufacture of oleomar-

is largely a side line to that of coconut oil. The war demand for these nuts was not for the oils, but for the shell, which was found to be one of the best of all materials for making absorptive charcoal for gas masks. Thousands of tons were gathered for this purpose, but only the extraordinary conditions made it profitable to get them out, and collection stopped short with the armistice.

When it became known that castor oil was in demand for airplane engines and the allied governments sent out calls for immense quantities, there was a wave of interest in nearly all countries of Latin America, as the castor-bean plant was found growing everywhere and in many places was looked on as a pest. Thousands of acres were quickly planted in Cuba, the Dominican Republic and other West Indian islands, in several Central American countries, and in Colombia, Venezuela, Peru and Brazil.

When the war demand ceased the cultivation of the plant in general dropped off and the industry of gathering and crushing or exporting the seeds returned to about what it had been before the war, serving mostly local needs. But in Brazil the momentum acquired during 1917 and 1918 has continued, as is strikingly indicated by the export figures. In 1915 the exports of castor seed were only 234 tons and of castor oil about 8 tons. By 1918 they had mounted to 4,066 tons of seed and 3,830 tons of oil, and by 1919 to 23,777 tons of seed and 1,389 tons of oil. In the first six months of 1920, according to the latest available statistics, exports were 15,570 tons of seed and 450 tons of oil. It is evident that the Brazilian castor seed is making a strong bid for the trade formerly held by India. Most of the seed has been coming to the United States, with smaller proportions going to Great Britain, Portugal, Belgium and Germany, while Italy, Spain and France have taken most of the oil. Pressing is carried on largely in the Sao Paulo district in connection with the



SEPARATING BROWN COTTON FROM WHITE AT A COTTON GINNEY IN PERU

production of other vegetable oils, and activity fluctuates with the demand for the product. Much of Brazil's seed comes from the wild trees, although planting has reached many thousands of acres.

COTTONSEED OIL

Cottonseed crushing has also reached its greatest development in Brazil, which country indeed seems to be the great future field for the production of vegetable oils. Cotton seed is obtained when the home-grown cotton is cleaned and prepared for spinning into yarn and thread for the several hundred textile mills of the country, and in many cases the seed is obtained and sold or crushed by these mills themselves. The growing of cotton and the manufacture of cloth, as well as the crushing of seed, are directly encouraged by the federal and state governments by loans and otherwise, and the future expansion of the industry is assured. Other countries in which cotton is grown and the seed crushed are Peru, Colombia, Venezuela, Argentina, Mexico and various West Indian islands.

SESAME OIL

In addition to these oil-producing plants those whose development in Latin America is advanced to only a fraction of their possibilities make a long list. Without attempting to catalog them all, the following may be mentioned: The sesame plant has been cultivated chiefly in Mexico, where it is known as "ajonjoli." According to an official report of a United States trade commissioner, "sesame seed is one of the articles of Mexican agricultural production which is capable of tremendous development and wherein lies almost unlimited commercial possibilities. There are two easily distinguishable varieties of sesame, the white and the brown. Both of these are produced in Mexico. . . . Authoritative and expert opinion testifies that the only requisite needed to produce an almost unlimited supply is increased utilization of the acreage now lying idle.

"In view of the world demand for edible oils, there is reason to expect a development along this line in the near future. The oil content of sesame, according to Mexican Government estimate, is 50 per cent. Others place the content at 56 per cent. Aside from this the pulp is highly nutritious. In view of these facts, sesame compares favorably with cotton seed in food value. It is almost equal to the olive in oil content, and in taste, odor and adaptability for commercial uses it is quite as desirable as the latter. . . . The white variety is said



PALM TREES IN BRAZIL

The thick vegetation adds materially to the difficulty and expense of collection.

to be richer in oil content than the two subvarieties of black or brown sesame.

"There are fifteen factories of different sizes and of varying importance in the city of Mexico engaged in the extraction of sesame oil and in its preparation for market. The greater number of these, however, are one-press affairs with very slight capacity. . . . The first-grade oil is used for seasoning and for the same miscellaneous culinary purposes that olive oil and lard are used for. The better grades of oil are used also in the manufacture of oleomargarine and to adulterate other edible oils. The inferior oils are used for soap-making, as a combustible, and as a basis for perfumes. [This use in perfumery manufacture has been questioned and is subject to verification.—O. W.] The leaves of the sesame have medicinal value and contain gelatinous substances. The pulp which remains after the oil is extracted is valuable as stock food."

PEANUT OIL

Peanuts, also known as groundnuts, earthnuts, monkey nuts, etc., are found in all parts of Latin America and in many places are crushed for oil, notably Uruguay, Argentina and Brazil. Exports of peanuts from Brazil have reached as high as 1,100 tons in one



PEANUT FIELD, CAMPO LARGUA, ARGENTINA

year. Olive trees take up several thousand acres in Chile, and the fruit is also raised in the neighboring country of Argentina. Peru has olives of good quality and exports a few tons each year, but consumes most of the production herself. Olives are grown commercially in several states of Mexico, the fruit being sent to the refineries of the capital.

BRAZIL NUTS

Brazil can fairly claim first place as the home of new oil-bearing seeds and nuts that promise to develop into important commercial commodities. Among these are the babassu and ucuhiba nuts and those commonly known as Brazil nuts, all of which have been exploited sufficiently to form considerable items of export. The babassu nut is a palm nut related to the coconut, whose meat is similar to coconut meat and whose oil is said to be excellent for oleomargarine. The nut yields about 66 per cent oil. The trees are found mainly in the interior of the north, along the Parnahyba River, and gathering has progressed to the point where some thousands of tons are exported annually.

Ucuhiba nuts (*Myristica bicuhyba*) yield a fat which becomes hard and brittle and may be refined to an almost odorless condition, although as marketed the nut is yellowish brown and has an odor similar to

that of coconut oil. It consists mostly of myristin with about 10 per cent of olein and a small amount of an ethereal oil. It has a melting point of 35 to 42 deg., a specific gravity of 0.871 to 0.912, and an iodine value of 9.5 to 18.5 per cent¹. These nuts also come from northern Brazil and in 1918 and 1919 exports amounted to over 1,000 tons, besides which large quantities were used in Brazil candle manufacture.

The Brazil nut so familiar in confectionery stores yields a fine semi-drying oil said to be valuable for cooking and also for use by watchmakers and artists. The nuts contain up to 73 per cent of oil, which is of a pale yellow color and has a taste similar to that of the nut itself, but is without odor. In South America the oil is used for edible purposes, and soap is made from nuts that become moldy in shipping. The oil has a saponification value of 193.4 to 202, according to tests made, an iodine value of 98.3 to 106.2, and a specific gravity of 0.918.

MUSTARD OIL

Both the black and the white mustard are found in Brazil, and the seeds yield 10 to 15 per cent of their weight in a semi-drying oil, similar in chemical properties to rape oil. The oil from the black seed is not suitable for burning and is chiefly used in making soap, while that of the white seed is used both as a burning and a lubricating oil. No tests of the Brazilian seeds are reported, but Italian black seed showed a specific gravity of 0.917, an iodine value of 112.7 and 116.1, and a saponification value of about 175. The white seed is similar to the black except that it has a lower iodine value.

Cashew or caju nuts are a regular item of export. It is said that they are growing in favor in the manufacture of chocolates. The oil is a non-drying oil with an iodine value of 84 and a saponification value of 195. Brazil can supply all that the trade requires.

MANIHOT OIL

The seeds of the famous rubber trees of Brazil yield two different kinds of oil, one from the species of tree growing in the State of Ceara, called manihot oil, and the other from the Para rubber tree and known by that name. Both are drying oils. The former is of a yellowish-green color, with an odor resembling that of olive oil and a slightly bitter taste, and in Brazil it is expressed to be used as a substitute for linseed oil. The latter is of a light yellow color with an odor like that of linseed oil. The cake is said to be unsuitable for cattle feed because of the presence of a small amount of prussic acid. For both oils the specific gravity has been found to be about 0.923 and the saponification value around 189; the iodine value of the manihot oil, according to one test, was 137 and that of the Para seed oil 117.6 to 133.3.

ARGEMONE OIL

The Mexican or prickly poppy, native to Mexico and the Caribbean islands, yields an oil called "argemone" oil, which is used for burning and lubricating purposes and also has a recognized therapeutic value. It is of a light yellow color with a distinctive acrid odor and is classed as a drying oil. The seeds yield commercially

¹Data relating to properties of fixed oils are taken largely from Lewkowitsch, J. L., "Chemical Technology and Analysis of Oils, Fats and Waxes," Vol. II, and data relating to properties of essentials from Parry, E. J., "The Chemistry of Essential Oils and Artificial Perfumes."

about 25 per cent of their weight in oil. The oil has a specific gravity of 0.924, a saponification value of 187 to 190, and an iodine value of 119.9 to 122.5, according to the results of laboratory analyses. Brazil also produces poppy-seed which is said to give 28 liters of oil to 100 liters of seed, the oil being expressed for use by painters, particularly in painting wood.

NIGERSEED OIL

Nigerseed oil, a yellow, drying oil with a nutty taste, is found in the West Indies, but has not been developed into a product of commercial importance. In India this oil is used as a substitute for ghee, or native butter. Lower grades are also of value for soapmaking, the saponification value running about 190, and as a substitute for linseed oil. Another oil used for much the same purposes is sunflower oil, considered as a drying oil, although it dries more slowly than most others of that class. The soap made from it is said to be especially suitable for textiles. It also enters into varnish manufacture, and is used locally for cooking and burning purposes. It has a saponification value of about 190, a specific gravity of about 0.92, and an iodine value of 119 to 135. Sunflowers are indigenous to Mexico and planting there can be indefinitely extended if the demand grows. In Argentina they form a minor crop of some importance, exports of sunflower seed in 1919 amounting to over 4,000,000 lb. valued at about \$120,000.

MISCELLANEOUS OIL-BEARING SEEDS

The soya bean of the Orient has been successfully grown in the Guianas of South America, but it is not produced in quantities. Corn oil is pressed out from some of the abundant crop of maize in Argentina and in 1917 shipments to the United States amounted to over 330,000 lb., although this was due to extraordinary conditions and normally this country does not import from Argentina. The seeds of the kapok plant, which is grown in many parts of tropical America for its fiber, yield an oil very similar to cottonseed oil, which is used locally for edible purposes and in Europe for soapmaking. It has a saponification value of 181 to 205 and an average iodine value of about 120. A semi-drying oil called "pinot" oil, the fat of which is known as Para butter, is taken from the kernels of the pinot or ouassey palm in Brazil and French Guiana, where it is used for edible purposes.

In Central America some attention has been given to the production of piñon or curcas oil, which has purgative qualities much more pronounced than those of castor oil. It is used locally for soapmaking and as an illuminant and also occasionally as a lubricating oil, although it is not very suitable for that purpose, as it dries in about twenty-four hours. Jamaica produces a non-drying oil called ben oil which has been known for a century as especially valuable for lubricating delicate machinery. It is odorless, has a sweet taste, and in the East has been used as a cosmetic and as an agent in the extracting of perfumes from flowers. It has a specific gravity of about 0.92, a saponification value of 184 to 187, and an iodine value of about 111.

French Guiana grows a tree whose seeds are known as "Java olives," which yield a yellowish-colored oil which when heated solidifies to an india-rubber consistency. In Brazil and the Guianas occur the "paradise-nut" trees, the nuts of which are about one-half oil, and resemble Brazil nuts, although with larger kernels. They are highly esteemed as a food article and so are



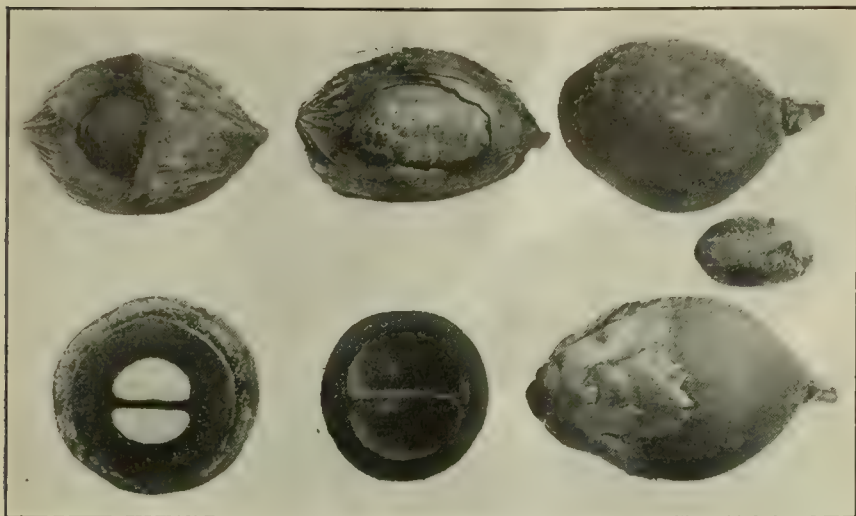
COHUNE-NUT TREE IN CENTRAL AMERICA
Showing size of bunches of nuts as compared with size of a man.

seldom exported, although the trees are found all over Brazil. Corapa oil is obtained in the Guianas from a plant of that name and is used by the natives to protect themselves against insects and also for lighting. French Guiana has a palm oil called aoura or tucum oil, which is used for cooking, and the Guianas also produce a butter-nut from which an edible fat called "suwarri" is obtained.

Argentina produces and exports considerable quantities of rapeseed from which the well known rape oil or colza oil is expressed. In 1919 shipments abroad amounted to 1,200,000 lb. valued at \$41,000. This oil is widely used as a lubricant, and for two other special but very different purposes. Bakers use the better grade of colza oil for greasing the ends of their loaves, and the commoner grades are used for quenching steel plates.

ESSENTIAL OILS

In the field of essential oils the contributions which Latin America is making or stands ready to make to the world's commerce are also numerous and valuable. For the most part they are the products of the tropical regions of northern South America, Mexico, Central America and the West Indies, wide areas of which yet remain to be explored. It is reasonable to expect that this *terra incognita* contains many oils, nuts and woods not yet catalogued. The value of the essential oils now produced is small compared with that of other commercial products, but that is due not to small resources or



THE COHUNE NUT OF CENTRAL AMERICA

The thick, hard shell of this nut was what made it so valuable for gas-mask manufacture and led to the gathering of some thousands of tons during the war.

possibilities, but to the fact that the demand is not insistent enough to overcome costs of exploitation in undeveloped territories.

LINALOE OIL

Mexico and French Guiana produce one of the best known perfumery oils distilled from wood—the linaloe or linaloe oil, but the product that goes by that name in Mexico is quite different from the Cayenne or French Guiana product. The Mexican oil is obtained from a tree known locally as “bois de citron du Mexique,” which is found in the southern part of the country. The best oil comes from trees 40 to 60 years old, although oil is also obtained from younger trees and from the fruit. Distilling is carried on both in Mexico and in Europe, to which quantities of the wood are regularly shipped. The oil is colorless or pale yellow, with a sweet odor, and a specific gravity of 0.875 to 0.898. It is soluble in 3 volumes of 70 per cent alcohol or in 4 or 5 volumes of 60 per cent alcohol. The most important characteristic of the oil is the free linalol, which has an odor like lily of the valley and which is present to an undetermined extent. Parry also mentions two samples of linaloe oil from Mexico which had an odor of blended lavender and petitgrain, a specific gravity of 0.897 and 0.893, and an ester content of 52.4 per cent and 48.7 per cent, of which he says:

“Particular attention is directed to this oil, because it may be that it would be well to develop the distillation of this particular wood for its content of linalyl acetate and for the purposes for which oils containing that ester are used, rather than for linalol and the purposes for which oils containing that alcohol are employed.”

CAYENNE, LINALOE AND SANDALWOOD OILS

The Cayenne oil is derived from a species of wood distinct from that of Mexico and usually known as “bois de rose femelle,” although the botanical origin is not quite clear. The oil is very similar to Mexican linaloe oil and is not to be confused with the oil known commercially as rosewood oil, which is quite a different product. The wood from which the oil is distilled, however, is gathered in and exported from French Guiana under the name of rosewood. Both the wood and the oil are exported. The wood yields about 1 per cent of oil, which in the pure state has a specific gravity of 0.87 to 0.88 and an ester value of 3 to 7. French Guiana also produces limited quantities of a wood which has taken the name of that most ancient and historic of aromatic woods, sandalwood, although it is quite

different from the Indian product. Its botanical and chemical characteristics do not appear to have been yet determined accurately. There is also a West Indian sandalwood, very similar to the rosewood of French Guiana, known as the “bois de citron” of Domingo, which has been shipped to Europe for over a century. The oil is a thick yellow oil with an odor similar to that of cedarwood oil. It has a specific gravity of 0.948 to 0.972 and is soluble in an equal volume of 90 per cent alcohol. It has been used as an adulterant and substitute for the genuine sandalwood oil.

PETITGRAIN OIL

Citrus plants yield a number of different kinds of essential oils all of which figure as more or less important Latin American products. The oil of petitgrain, distilled from the leaves, buds and young fruit of the orange tree, forms the chief item of direct export to the United States from Paraguay, where the industry of extracting it has been considerably developed because of the existence there of great numbers of bitter orange trees. The oil or essence is obtained by passing steam through a quantity of leaves packed in a specially designed receptacle, from 500 to 600 lb. of leaves being required to produce a quart of oil. This South American product is inferior to most other petitgrain oils received on the world markets, probably because the extraction is carried on under rather primitive conditions. Its specific gravity, about 0.887, and its ester content, about 36.5 per cent, are both higher than other petitgrain oils. Oil of petitgrain is used as a basis of perfumes and perfumed toilet soaps. Another valuable product of the Paraguay orange groves, exported to a limited extent, is oil of neroli, obtained from orange blossoms.

ORANGE OIL

The production of orange oil, which comes from tiny vesicles in the skin of the fruit, has been especially prominent in Jamaica, and exports have at times amounted to more than \$100,000 a year. Both bitter oranges and sweet oranges are used as a source of this oil, but that from the sweet oranges is considered best. It takes almost 500 oranges to supply a pound of filtered oil. Most of the Jamaican product comes to the United States and is used in the making of perfumes, flavors for soft drinks, and essences, and particularly for flavoring a certain kind of fancy biscuit. It is also used in drug manufacture and to a small extent in the manufacture of soaps. The Jamaican orange oil is said to be equal or superior to the Sicilian product.

OIL OF LIMES

Oil of limes in the West Indies is of two kinds, one which is distilled, being obtained as a byproduct in the concentration of limejuice, and the other hand-pressed, of a higher specific gravity (0.878 to 0.902, as compared with 0.860 to 0.872 for the distilled) and a higher commercial value. The distilled oil is the usual oil of commerce. It forms a regular export item from many West Indian islands, among which the more important producers are the islands of Montserrat, Jamaica and Dominica. The leaves of the West Indian lime tree also yield an essential oil on distillation. Lemon oil is also a possibility of these regions, particularly of Jamaica, but its production has not yet become an industry. Mexico is a particularly promising field for the establishment of a lime-juice and lime-oil industry. Lime trees are at present cultivated hardly at all, but they

grow wild over a wide area and could be utilized in producing large quantities of oil of limes, lime juice, and citrate of lime.

BAY AND PIMENTO OILS

Besides orange and lime oils the chief essential oils found in the West Indies are bay oil and pimento oil. The bay tree grows abundantly in Jamaica, St. Thomas, Guadeloupe, Antigua, Barbados and Dominica. Both the leaves and the oil are exported to the United States, and are constant items in the lists of exports of those islands. Bay oil, which is used in perfumery and as a basis of bay rum, when distilled from the leaves separates into two portions, one lighter and the other denser than water, the two being combined to give a normal distillate. The oil contains 55 to 68 per cent of phenols, but the amount is found to vary with the different seasons of the year.

Oil of pimento is distilled from the fruit of *Pimenta officinales*, indigenous to the West Indies and found especially in Cuba, Haiti, Trinidad, Santo Domingo, Antigua and the Leeward and Windward Islands, and abundantly in Jamaica. It also occurs in Mexico, Costa Rica and Venezuela. Pimento berries, which are gathered green, have an aromatic odor in which can be detected the odor of cinnamon, nutmeg, pepper and especially cloves—hence the popular name of “allspice” applied to them. They yield 3 to 4½ per cent of a dark-reddish oil of the same aromatic odor as the fruit. It contains phenol-eugenol, which gives it the clove-like odor, the phenols being present to the extent of about 65 to 80 per cent. The oil has a specific gravity of 1.024 to 1.056.

Other possibilities of Jamaica, not yet developed, include vetivert and camphor. Camphor trees grow in considerable numbers in Jamaica, and a special test of the camphor derived from their leaves and wood which was made several years ago showed that it was of fully as good quality as that from the Far East.

In the River Plate countries, Argentina and Paraguay, grows a tree indigenous to that region which yields an oil of some importance commercially. This is the champaca or guaiacum wood oil, not, however, to be

confused with the true champaca oil of Europe. The wood yields 4 to 8 per cent of essential oil which is practically solid at ordinary temperatures. It has an exceedingly delicate odor described as resembling that of tea and violets, and it is used in perfumery to produce a tea-rose odor and to blend with stronger perfumes for ordinary scents, and sometimes as an adulterant of otto of roses. It is often mixed with geranium oil and used under the name “essence de la gaïac à la geranium.” Its specific gravity is given as \$.965 to 0.975 at 30 deg., and it is soluble in 3 to 5 volumes of 70 per cent alcohol.

MISCELLANEOUS ESSENTIAL OILS

Other essential oils and materials from which they can be distilled cover a wide range. Flowers and blossoms of trees which yield fragrant perfumes abound in rich profusion throughout the tropical forests of the Amazon and Orinoco valleys, French Guiana alone being credited with half a hundred or more. In Brazil, to mention two or three of the many plants aside from those described above, the leaves of a plant called the “false jaborandi” yield a light-greenish oil of spicy mint-like odor and pungent burning taste; the leaves of the “catingueira” furnish an oil with a greenish fluorescence and an odor resembling bergamot; the wild lemon tree leaves contain an oil having an odor of bergamot and lemon, and those of the wild coffee tree an oil with a lemon-like odor; from the bark of *Cassia caryophyllata* is obtained an oil containing eugenol and having a clove-like odor. In Bolivia is a grass which belongs to the same family as lemongrass and citronella, yields an oil similar to vetivert, and grows very abundantly. In British Guiana and Brazil the priprica tree's branches contain an essential oil somewhat similar to linaloe oil. Throughout Mexico, especially around Mexico City and other cities and towns, grow a great profusion of cultivated flowers such as poppies, pansies, carnations, chrysanthemums, violets, gladioli, and irises. Nutmeg or mace oil is a product of several localities. Mexico and Central America yield turpentine, which may some day be drawn upon to help preserve the diminishing supplies in the United States.

A well-known oil which comes from Brazil, Venezuela and Colombia is copaiba oil, imported into the United States usually in the form of copaiba balsam. Northern Brazil has seven species of *Copaifera officinalis*, from which the balsam is taken. In Bahia the oil is extracted by means of suction pumps. Closely related to copaiba balsam is balsam of Peru, which comes largely from Salvador. Tolu balsam, a similar product used in perfumery, comes mainly from Colombia.

VANILLA BEANS

Two other products, which are not essential oils but are widely used as flavoring extracts, may be mentioned. These are vanilla beans and tonka beans. The original home of the vanilla bean is said to have been Mexico, and that country continues to be one of the chief producers, although the tiny colonists sent out to other tropical lands have established themselves so well that most of the world's supply now comes from Old World sources. In Mexico the vine grows both wild and cultivated. The State of Vera Cruz is the center of cultivation. The beans grow in pods, 6 to 9 in. long, and it is the carefulness observed in curing and drying these pods which determines the flavor of the commercial product.



AMERICAN UPLAND COTTON IN PIURA, PERU, LOCALLY KNOWN AS “EGIPTO”

The curing process consists of piling the pods in heaps for a few days, then exposing them to the sun, then wrapping them in a woolen blanket, and at night permitting them to sweat in air-tight boxes. They are then dried for about two months in the sun. Mexican vanilla is rated very high as compared with the product of other countries. In the West Indies several islands raise vanilla, and its cultivation in the French island of Guadeloupe has made it one of the colony's chief resources.

TONKA BEANS

Venezuela and the neighboring islands of Trinidad and Tobago are the chief source of tonka or tonquin beans, although the trees are also found in the Guianas and Brazil. These beans grow in long pods, which are gathered and dried until the pulp shrivels, when the shells are cracked and the seeds or beans are extracted. After being put through a process of preparation and drying they are exported to be used for various purposes such as scenting tobacco and snuff, fumigation, and use in sachet powders. They furnish coumarin, an essential ingredient of perfumes and flavoring extracts.

ANIMAL FATS

Of the animal fats the chief is of course the lard and tallow which form one of the important products of the meat-packing establishments of the River Plate countries and southern Brazil. These plants also turn out certain quantities of bone grease and bone oil, and the United States obtains from them large amounts of neatsfoot oil and stock. From the wool-growing countries Argentina and Uruguay come supplies of wool grease or lanolin. Brazil has developed the whaling industry to the point where whale-oil exports amount to \$45,000 or \$50,000 annually, besides which large quantities are consumed locally. The states of Pernambuco and Bahia are the chief centers of the industry, and the season usually lasts from April to August or September, when the Antarctic whales come north to find warmer waters. Turtle oil and alligator fat are possible products of Caribbean coast regions which have not yet received much attention.

CARNAUBA AND CANDELILLA WAX

Among the waxes of Latin America the one which occupies first place commercially is a product of Brazil—carnauba wax. It has a variety of uses. Candles, polishing pastes, varnishes and phonograph records are made from it and it is also used for cable coverings, waterproofing, etc. In 1919 Brazil sent 13,700,000 lb. of this wax, valued at \$5,000,000, to foreign countries, chief of which was the United States, which took 7,000,000 lb., and Great Britain, 3,200,000 lb. The wax is especially plentiful in the State of Ceara, in the northern part of Brazil. The leaves of the palm tree which furnish this wax are gathered during the months from September to March, from 2,000 to 4,000 leaves being required to supply 16 kilos of wax.

In Mexico an important wax called "candelilla" is obtained from a low-growing plant of that name which is found all over the northern part of the country. Many factories have been set up to extract this wax by boiling the plants in water to which sulphuric acid is added. The city of Monterey is one of the centers of manufacture. The wax is very hard and has a melting point of 150 to 175 deg. F., and can be bleached perfectly white. It is said to be more brittle than beeswax,

and dissolves in turpentine, chloroform, hot ether and benzine. It makes excellent candles, varnish and shoe polish, and may also be used for making phonograph records, insulation for electric wires, and plasters and ointments.

Beeswax comes from all parts of Latin America. Brazil exports very considerable amounts and the United States also receives small shipments from Ecuador, Mexico, Cuba and various other countries and islands. Ecuador reports a kind of palm wax which might be used in place of beeswax and for which local producers have requested inquiries from possible United States buyers.

Refining Chinese Bismuth Concentrates

BY ELTON R. DARLING

THE Chinese bismuth concentrates are yellow in color and vary in size from 4 to 100 mesh. They analyze about 58 per cent bismuth oxide, with 5 per cent of antimony and 0.14 per cent of arsenic, both expressed as the metals. The presence of antimony and arsenic renders the treatment of these concentrates for pure bismuth very costly.

The writer has been engaged upon researches whereby these two metals could be eliminated cheaply and the bismuth used for pharmaceutical purposes.

The following process gives satisfactory results:

The concentrates as received are reduced to about 80 mesh and dumped into vats, where they are extracted with warm hydrochloric acid solution prepared by the action of sulphuric acid upon a solution of sodium chloride. After extraction the whole is allowed to settle and the liquor drawn off into a second vat and this treated with metallic iron to precipitate the antimony and bismuth. The arsenic is not affected and remains in solution. The whole is then filtered and the resulting solution returned to the ore for a second extraction.

The gray precipitate containing the antimony and bismuth is washed well with water, spread out upon trays, and dried. The completely dried mass, in which the bismuth is in the form of hydrate, is then treated with a 15 per cent solution of hydrochloric acid; when the bismuth hydrate dissolves, the antimony, being insoluble, settles to the bottom. The solution of bismuth chloride is then drawn off and added to a large volume of water, which causes the precipitation of bismuth oxychloride. This is allowed to settle, the water drawn off and more fresh water added, the washing being repeated until the wash water is free from acid. The bismuth oxychloride is dried, mixed with charcoal as a reducing agent and with sodium carbonate, lime and fluorspar as a flux and reduced to the metal in iron crucibles.

Bromine in 1920

Bromine, which is derived from brines pumped from deep wells in Michigan, Ohio and West Virginia, was produced by eight firms in the United States in 1920. The output, according to the United States Geological Survey, was 1,160,584 lb., valued at \$745,381, a decrease of 37 per cent in quantity and nearly 40 per cent in value from the output in 1919. The quantity produced, however, was greater than in any year before 1918.

The average price per pound received by the producers rose from 13c. in 1910 to \$1.31 in 1916 and was 64c. in 1920, which is more than three times the average price in the year before the war.

The Use of Fluorides in Solutions for Nickel Deposition*

An Outline of the Experimental Work Leading to the Conclusion That Deposits of Nickel of Finer Structure and Higher Tensile Strength Are Obtained From Fluoride Solutions Than From the Corresponding Chloride Solutions

By WILLIAM BLUM†

IN CONNECTION with a process for the electrolytic reproduction of engraved printing plates, recently installed at the Bureau of Engraving and Printing under the supervision of the Bureau of Standards, it was necessary to secure for the printing surface nickel coatings which would be as hard as possible, but at the same time free from brittleness or a tendency to curl. In connection with this process the addition to nickel solutions of hydrofluoric acid or fluorides, recently recommended by E. G. Lovering, was investigated. The beneficial effect of such additions upon the physical properties of the deposited nickel was found to be so great that this type of solution was adopted and has been used successfully in the above-mentioned plant.

HISTORICAL

As the nickel solutions employed usually contain boric acid, we may assume that upon the addition of fluorides, fluoborates are formed. The use of fluoborate solutions for plating was first proposed by Leuchs,¹ who made experiments with several metals but not with nickel. In 1908 Kern and Fabian² employed a nickel fluoborate solution, from which they secured a thick deposit ($\frac{5}{16}$ in. = 8 mm.) having desirable physical properties. About this same time, O. P. Watts³ and his associates made a few experiments with nickel solutions containing fluoborates and also secured promising results. In 1912 they found that good deposits could be secured from nickel fluoride solutions containing free hydrofluoric acid. In the same year A. Hollard⁴ experimented with a nickel fluoborate solution for making electrotypes. So far as known to the author, however, no commercial applications of nickel solutions containing fluorine was made until recently, when E. G. Lovering,⁵ of Detroit, operated plating solutions containing in addition to the usual constituents—viz., nickel sulphate and boric acid—small amounts of hydrofluoric acid. He obtained such remarkable results that he designated hydrofluoric acid as the "magic fluid." Subsequently F. J. Liscomb⁶ published the results of a few experiments in which he employed solutions of nickel fluoborate and nickel-ammonium fluoborate, from both of which he obtained only fairly satisfactory deposits.

Publication and discussion of Lovering's results caused numerous electroplaters to try the use of hydrofluoric acid in nickel baths, with thus far somewhat contradictory results, owing in part, no doubt, to failure to define or control all of the conditions employed by them. Even though very marked effects are produced by the fluorides in the presence of boric acid, there is no reason to believe that such solutions form a panacea for all the ills of the plater. Just as the studies of cobalt plating several years ago led to important improvements in nickel plating, the investigation of fluoride nickel solutions may throw light on the behavior of the nickel solutions more commonly used, and may thereby lead to their improved operation.

GENERAL PRINCIPLES

If hydrofluoric acid is added in small amounts to a nickel bath, the acidity thus produced will cause an increase in anode efficiency and a decrease in cathode efficiency, and at least a partial neutralization of the hydrofluoric acid, to form either nickel fluoride, or, in case boric acid is present, a fluoborate. Since good nickel deposits cannot be secured from solutions which are appreciably acid, the solution must be operated for some time after the addition of hydrofluoric acid, or the bath must be neutralized, before satisfactory results are obtained. It therefore appears more logical to neutralize the hydrofluoric acid before adding it to the bath.

In order to produce baths of relatively simple composition the fluorine was first added in our experiments in the form of nickel fluoride, prepared by the solution of nickel carbonate in hydrofluoric acid. When commercial nickel carbonate in excess is treated with 5N hydrofluoric acid a solution is obtained which contains only about 80 per cent of the amount of nickel equivalent to the hydrofluoric acid used. It is evident, therefore, that in such solutions there is a tendency to form acid fluorides. With freshly precipitated nickel carbonate, neutralization is more rapid and more nearly complete, but in no case is a neutral solution obtained. This observation is in general accord with the experiments of F. H. Edminster and H. C. Cooper,⁷ who found that if hydrofluoric acid is neutralized with nickel carbonate the definite crystals obtained by several recrystallizations have the formula $\text{NiF}_2 \cdot 5\text{HF}$, although there is a tendency to form crusts having approximately the composition NiF_2 . For simplicity, we may assume that the solution contains nickel fluoride, NiF_2 , and a small excess of hydrofluoric acid.

If now boric acid in excess is added to such a solution, a precipitate, which probably consists of nickel hydroxide, separates, and the resultant solution contains

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¹German Pat. 38,193, May 13, 1886.

²*School of Mines Quarterly* (1908), vol. 29, p. 367. *Trans. Amer. Electrochem. Soc.* (1909), vol. 15, p. 464.

³Unpublished address delivered before the Chicago branch of the American Electroplaters' Society, Jan. 29, 1921.

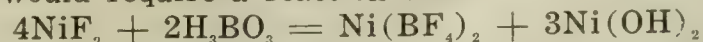
⁴*Bull. Soc. d'Encour* (1912), p. 24. *Brass World* (1912), vol. 8, p. 391.

⁵*Monthly Review*, American Electroplaters' Society, February, 1920.

⁶*Brass World* (1920), vol. 16, p. 311.

⁷*J. Am. Chem. Soc.* (1920), vol. 42, p. 1,419.

nickel in the ratio of approximately 1Ni to 4F. About the same ratio is obtained if the hydrofluoric acid and boric acid are first mixed and the resultant "fluoboric acid" is neutralized with nickel carbonate. It is difficult to assign a formula to the "fluoborate" which probably exists in such solution. If we assume the simplest formula for fluoboric acid—viz., HBF_4 —we would expect the formation of nickel fluoborate having the formula $\text{Ni}(\text{BF}_4)_2$ —i.e., with 1Ni to 8F. To produce such a compound by reaction between nickel fluoride and boric acid would require a reaction such as the following:



The reaction which actually occurs is apparently similar to this, but no doubt less simple, and the salt formed is a more complex fluoborate. Hollard⁸ used hydrofluoric acid and boric acid in proportions to yield a solution approximately 0.8N in HBF_4 and 0.2M excess H_3BO_3 , and agitated the solution for twenty hours with freshly precipitated nickel carbonate to secure complete neutralization, but did not record the nickel concentration of the resultant solution. As pointed out in a paper on lead fluoborate solutions⁹, there is a great need for study of the constitution of fluoboric acids and fluoborates.

In view of the uncertainty as to the constitution of the nickel fluoborates which are almost certainly present in these solutions, it is most satisfactory to express the composition of the solutions employed in terms of the amount of the constituents actually used in their preparation. Thus if a solution is stated to be 1.8N in nickel sulphate, 0.2N in nickel fluoride and 0.5M in boric acid, it was prepared by treating an amount of hydrofluoric acid equivalent to a final concentration of 0.2N, with an excess of nickel carbonate, and after all reaction had ceased, by adding the requisite amount of boric acid. This mixture was added to the nickel sulphate solution, and thoroughly mixed. After standing for several hours, the solution was filtered. By this method of preparation the solutions were made as nearly neutral as possible, as they were at all times in contact with nickel carbonate and nickel hydroxide. This procedure was employed at first because it was desired to obtain solutions containing no other metal than nickel. As will be explained later, it is far simpler to prepare solutions by the use of sodium fluoride, which solutions are very similar in behavior to those made from nickel fluoride.

METHODS OF ANALYSIS

For satisfactory experimentation or commercial application of plating solutions, it is essential to have reliable methods of analysis. In solutions containing nickel, fluorides and boric acid there is no difficulty in determining the nickel content by the usual electrolytic methods. The estimation of fluorine and of boric acid is, however, very difficult, and at present we know of no entirely satisfactory methods for fluorine, and no methods whatever for the boric acid in such solutions.

The determination of fluorine by precipitation as calcium fluoride is at best a tedious method, owing to the difficulty of retaining the calcium fluoride upon a filter. If calcium carbonate, or, as has recently been proposed, calcium oxalate,¹⁰ is precipitated along with the calcium fluoride, the precipitate may be retained on a filter, but the filtration and washing still require a long period. In order to apply such a method to the plating solutions

it would be necessary to remove the sulphate, and moreover the presence of boric acid would cause uncertainty in the composition of the final precipitate. These difficulties were found to be so great that after numerous attempts the gravimetric estimation of fluorine in these solutions was abandoned.

Approximate results have been obtained by a simple volumetric method which was first proposed by A. Greef.¹¹ It depends upon titration of the neutral fluoride with standard ferric chloride solution, which forms a precipitate having the formula Na_3FeF_6 analogous to cryolite. In order to repress the solubility of this salt, sodium chloride is added in large excess. Sodium sulphocyanate is used as the indicator and a layer of ether is employed to extract and concentrate the ferric sulphocyanate formed when the ferric chloride is present in slight excess. The end point is reached when a permanent faint pink color is produced in the ethereal layer. The details for the application of this method to nickel solutions have not yet been perfected, but the indications are that the method will be sufficiently accurate for plant control.

ESTIMATION AND CONTROL OF ACIDITY

Of even greater importance than the determination of the major constituents of a nickel-depositing solution are the estimation and control of the acidity, or, more strictly speaking, of the hydrogen ion concentration of the solution. In nickel deposition in general and especially in the accurate reproduction of engraved plates, the most common difficulties encountered are "pitting" and "cracking" or "curling." Even though there may be other contributing factors, it seems reasonably certain that the principal cause of such defects is excessive acidity of the solutions, or at least excessive liberation of hydrogen at the cathodes. In discussing the cause of pits it is necessary to distinguish between them and projections, which latter are usually initiated by the presence in the solutions of suspended conducting particles such as nickel and carbon derived from the anodes. Before any really conclusive evidence can be obtained, however, as to the cause and prevention of pitting and cracking, means must be secured for measuring and controlling the acidity of such solutions.

The hydrogen ion concentration of a solution may be expressed directly in the following form: $(\text{H}^+) = 10^{-x}$; which signifies that the actual concentration of hydro-

gen ions in the solution is $\frac{1}{1,000,000}$ normal. In order to avoid the use of the negative exponent, S. P. L.

Sørensen¹² employed the $\log \frac{1}{(\text{H}^+)}$ to which value

he applied the expression p_H . Thus in the above case $p_H = 6$. In using this method of expression it is necessary to bear in mind that a large numerical value for p_H represents a low hydrogen ion concentration or acidity, and *vice versa*. A detailed discussion of methods of measuring and expressing the hydrogen ion concentration will be found in a recent book by W. M. Clark.¹³

METHODS OF TESTING ACIDITY OF SOLUTIONS

Various methods for testing the acidity of nickel-plating solutions have been proposed and employed to

⁸Bull. Soc. d'Encour, 1912.

⁹Trans. Amer. Electrochem. Soc. (1919), vol. 36, p. 243.

¹⁰Edminster and Cooper, J. Am. Chem. Soc., 1920, vol. 42.

¹¹Ber. (1913), vol. 46, p. 2,511.

¹²Compt. rend. Lab. Carlsberg (1909), vol. 8, p. 1.

¹³"The Determination of Hydrogen Ions," Williams & Wilkins, Baltimore, Md., 1920.

advantage in plant control. The simplest is the testing of the solution with litmus and congo-red papers, which, it is frequently claimed, should both be turned pink by a solution in good operating condition—i.e., the solution should be acid to litmus and alkaline to congo-red. In measurements depending upon the actual titration of nickel solutions the most common indicator thus far employed is sodium alizarin-sulphonate. A solution is said to be satisfactory if a given sample requires a certain amount of acid or of alkali to produce a neutral (or some definite) tint with this indicator.

These two methods illustrate the measurement of two distinct factors in the acidity of such a solution—viz., the intensity and the quantity factor. The first method measures, at least roughly, the hydrogen ion concentration; the second determines the amount of acid or of alkali required to produce some definite hydrogen ion concentration. Either method may be useful, but both are necessary to a complete understanding of the behavior of such a solution during operation.

APPLICATION OF HYDROGEN ION MEASUREMENTS

The application of hydrogen ion measurements should prove very valuable in determining not only the optimum range of acidity for nickel deposition, but also the possible function of various additions, such as fluorides and boric acid, in regulating this acidity. In such measurements it is important to determine not alone the p_H of solutions of certain composition, but also the rate at which the p_H changes upon the addition of acid or alkali, since this rate determines the degree to which the solution will automatically compensate for any variation in anode or cathode efficiency. So far as acidity is concerned, the ideal nickel-plating solution is one which will within the desired working range have a relatively flat neutralization curve; in other words, it should be a well "buffered" solution. Much work remains to be done on this subject, as it will require the laboratory study of many solutions and the correlation of such results with the operation of corresponding baths over long periods. The observations thus far made by us are distinctly preliminary.

Since the hydrogen ion concentration of these solutions appears to be directly related to their behavior upon electrolysis, attempts were first made to measure this property by means of the hydrogen electrode. Even with pure nickel sulphate solutions, however, the results were not consistent or reproducible. Frequently values would be obtained which appeared to be definite, but with another electrode appreciably different values were secured. The results were still less reliable when the commercial plating solutions were thus tested. This latter difficulty is probably attributable to the presence in commercial solutions of small amounts of copper, iron or arsenic, which may "poison" the electrodes. The difficulty with pure nickel sulphate cannot be readily explained. The only conclusion that could be reached from hydrogen electrode measurements conducted at different times during the past several years is that normal nickel sulphate solution has a p_H value between 6 and 7—i.e., the hydrogen ion concentration (H^+) is between 10^{-6} and 10^{-7} —and that satisfactory plating solutions have a p_H value between 4 and 6.

"DROP METHOD" TEST FOR HYDROGEN ION CONCENTRATION

More satisfactory results have been obtained by measuring the hydrogen ion concentration with indicators,

using the "drop method" as proposed by L. J. Gillespie¹⁴ and also described in detail by W. M. Clark.¹⁵ In this method, instead of preparing hydrogen ion standards by the use of buffered salt solutions, tubes containing different fixed proportions of the given indicator in its acid and alkaline form are placed in pairs so that the color observed by transmitted light is that of a partly transformed indicator, corresponding to some known p_H . When the test solution is colored as with nickel solutions, it is necessary to include in each series of standards a third tube containing the nickel solution. A definite quantity of indicator is then added to a separate portion of the nickel solution, two tubes containing water are placed in series with it, and the resultant color is matched against the indicator color standards as above prepared. The indicators which have been found most useful in measurements upon nickel solutions are bromphenol blue, and bromcresol purple, which together cover the range involved—i.e., $p_H = 3.5$ to 7.0. At first methyl red appeared to be well suited for this purpose, since it is very sensitive in the region from $p_H = 4.0$ to 6.0; but careful measurements showed that

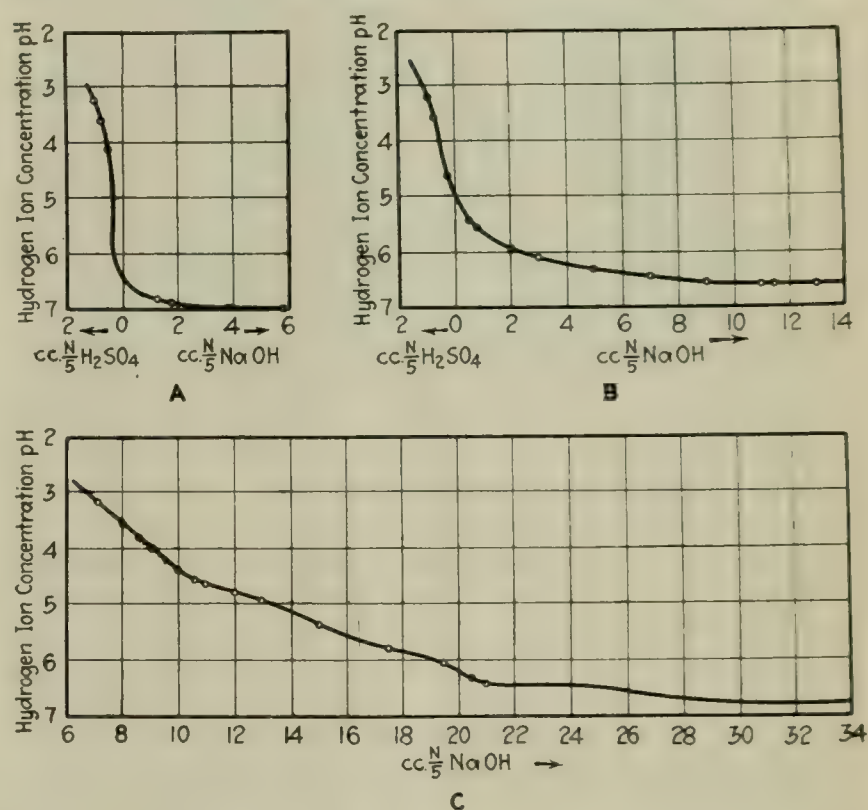


FIG. 1. HYDROGEN ION AND NEUTRALIZATION CURVES OF NICKEL SOLUTIONS

Based on colorimetric measurements upon 50 c.c. of solution. Initial composition:

- A: $NiSO_4 - N$.
B: $NiSO_4 - N$; $H_3BO_3 - 0.5M$.
C: $NiSO_4 - N$; $H_3BO_3 - 0.5M$; $HF - 0.1N$.

in nearly neutral nickel solutions anomalous results are obtained with this indicator, presumably because of some specific salt effect. Preliminary observations with indicators show that the p_H of normal nickel sulphate solutions is about 6.8, and that the addition of even very minute amounts of acid causes a great increase in acidity, that is, a decrease in p_H .

In Fig. 1, A is a typical "titration curve" of nickel sulphate—i.e., it represents the changes in hydrogen ion concentration produced by successive additions of acid or of alkali. This curve, based on measurements with indicators, has the same shape and approximately the same position as one which was obtained with the hydrogen electrode; in the latter case, however, the readings were somewhat uncertain and erratic. The large

¹⁴J. Am. Chem. Soc. (1920), vol. 42, p. 742.

¹⁵"The Determination of Hydrogen Ions," by W. M. Clark (Williams & Wilkins, 1920).

effect upon the hydrogen ion concentration produced by the addition of small amounts of sulphuric acid to nickel sulphate solutions indicates clearly why it is not practicable to deposit nickel from a solution containing only nickel sulphate, as even slight deficiency in anode corrosion will result in such a large increase in hydrogen ion concentration as to cause a low cathode efficiency and a poor deposit. Bennett¹⁶ and his associates found that the cathode efficiency in a "neutral" nickel ammonium sulphate solution was low, but that by the addition of small amounts of ammonia to the solution the cathode efficiency approached 100 per cent. They did not, however, make any measurements of the change in hydrogen ion concentration thus produced.

The effect of boric acid in maintaining a uniform slight acidity of a nickel bath is shown in Curve *B* of Fig. 1. Let us assume, as a first approximation, that a satisfactory nickel bath should have a p_H between 4 and 6 (actually the range may be much narrower). By comparison of curves *A* and *B*, it is seen that in 50 c.c. of a normal nickel sulphate solution it requires less than 0.5 c.c. of $N/5NaOH$ to change the p_H from 4 to 6, whereas, in the solution containing boric acid it requires about 2.5 c.c. of the alkali to produce the same change in p_H . This observation confirms the conclusion of L. D. Hammond¹⁷ that the principal function of boric acid in nickel baths is the maintenance of a uniform low hydrogen ion concentration. Upon reversal of the neutralization process—i.e., the addition of acid to a solution made slightly alkaline with sodium hydroxide—a curve of similar shape is obtained. If, however, nickel hydroxide has been actually precipitated by the alkali, there is a certain "lag" in its solution by the acid, which causes the solution at any stage to be more acid (a lower p_H) than corresponds to the true equilibrium. This lag is very much less if boric acid is present than in the simple nickel sulphate solution.

Curve *C* of Fig. 1 illustrates the effect of the addition of alkali to a nickel solution containing both hydrofluoric and boric acids. It is apparent that the reaction is complicated and that considerable further study will be required to explain the significance of each part of the curve. It is evident, however, that the solution is "well buffered"—i.e., the p_H does not change as rapidly upon the addition of alkali as it does in the pure nickel sulphate solution or in that containing only boric acid. To produce the same change as above considered—viz., $p_H = 4$ to 6—it requires about 10 c.c. of the 0.2*N* alkali—i.e., four times as much as in the solution with boric acid, and over twenty times as much as in pure nickel sulphate solutions. Whether this marked regulating effect of the fluorides or fluoborates is the principal cause of their effect upon the structure of the deposits must be determined by more exhaustive experiments.

It is significant that in all three curves the p_H at the point where nickel hydroxide begins to precipitate (and beyond which the p_H changes very slightly until all the nickel is precipitated) is about 6.8—i.e., nearly the same as the neutral point of nickel sulphate. This shows that when these solutions are neutralized by agitation with nickel hydroxide, they all reach the same degree of neutrality. A few experiments indicate that the same p_H is obtained by neutralizing the solutions with nickel carbonate.

EXPERIMENTS UPON THE OPERATION OF SOLUTIONS

Most of the experiments upon these solutions were carried out at the Bureau of Standards. Observations were also made upon solutions in operation at the Bureau of Engraving and Printing. Small-scale experiments were conducted in glass battery jars containing from 1 to 10 liters and in stoneware tanks with a capacity of about 30 liters. Within short periods there was practically no etching of the glass or stoneware by the solutions containing fluoborates. For continuous operation it is probably best, however, to line stoneware vessels with a bituminous coating, since it has been found that when lead fluoborate solutions are kept in stoneware for a year or more there is decided etching. For factory operation of these solutions both the stoneware and wooden tanks have been lined with bituminous material. There is no appreciable contamination of the solutions when kept in chemical glassware during analysis.

For purposes of comparison the fluoborate baths were usually run in series with a nickel bath similar to that recommended by O. P. Watts,¹⁸ but in order to permit a ready comparison between the function of the chlorine and fluorine, Watts' formula was slightly modified to yield definite normalities. See Table I.

TABLE I. FORMULA OF "CHLORIDE" SOLUTION. BATH NO. 2

		g/L	Oz./Gal.
Nickel sulphate.....	1.8 <i>N</i>	255	34
Nickel chloride.....	0.2 <i>N</i>	24	3.2
Boric acid.....	0.5 <i>M</i>	31	4.2

Corresponding "fluoride" baths were prepared, of which, however, the compositions are not strictly equivalent to that of the chloride bath, since, as previously noted, some nickel hydroxide separates out upon mixing nickel fluoride and boric acid. The constituents actually used in their preparation are shown in Tables II-A and II-B.

TABLE II-A. FORMULA OF "FLUORIDE" SOLUTION

		g/L	Oz./Gal.
Nickel sulphate.....	1.8 <i>N</i>	255	34
Nickel carbonate ¹⁹		12	1.6
Hydrofluoric acid ¹⁹ (50 per cent HF).....		8	1.1
Boric acid.....	0.5 <i>M</i>	31	4.2

TABLE II-B. FORMULA OF "FLUORIDE" SOLUTION

		g/L	Oz./Gal.
Nickel sulphate.....	2.0 <i>N</i>	281	37.5
Sodium fluoride.....	0.2 <i>N</i>	8.4	1.1
Boric acid.....	0.5 <i>M</i>	31	4.2

The solution given in Table II-A is prepared by adding the hydrofluoric acid cautiously to the nickel carbonate which has been previously mixed with water to the consistency of a thick cream. After effervescence ceases, the boric acid, first dissolved in warm water, is added, and the entire mixture is then added to the solution of the nickel sulphate. After thorough mixing the solution is filtered or allowed to settle.

The solution given in Table II-B is prepared simply by dissolving the three constituents in water. By using warm water, solution occurs more rapidly.

A few preliminary experiments were made with nickel fluoborate without sulphate and with solutions containing 50 per cent of the nickel as fluoborate and 50 per cent as sulphate; but the deposits obtained were less satisfactory than those with the above solution in which approximately 10 per cent of the nickel is present as fluoborate. Most of the studies were therefore

¹⁶C. W. Bennett, H. C. Kenny and R. P. Dugliss. *Trans. Amer. Electrochem. Soc.* (1914), vol. 25, p. 335.

¹⁷*Trans. Amer. Electrochem. Soc.* (1916), vol. 30, p. 103.

¹⁸*Trans. Am. Electrochem. Soc.* (1916), vol. 29, p. 125.

¹⁹Equivalent to 0.2*N* nickel fluoride.

conducted with the latter solutions. A few experiments with solutions containing only nickel sulphate and nickel fluoride yielded unsatisfactory deposits.

In general the solution to be studied was run in series with the "chloride" bath and with a copper voltameter (coulometer). In most cases deposition was produced upon polished steel plates which had been treated with sodium sulphide solution to permit subsequent separation of the deposited nickel.

Where physical tests of the deposits were to be made, the steel plates were surrounded with a shield of insulating material ("Formica") which served to reduce the current density and thickness over the entire surface.

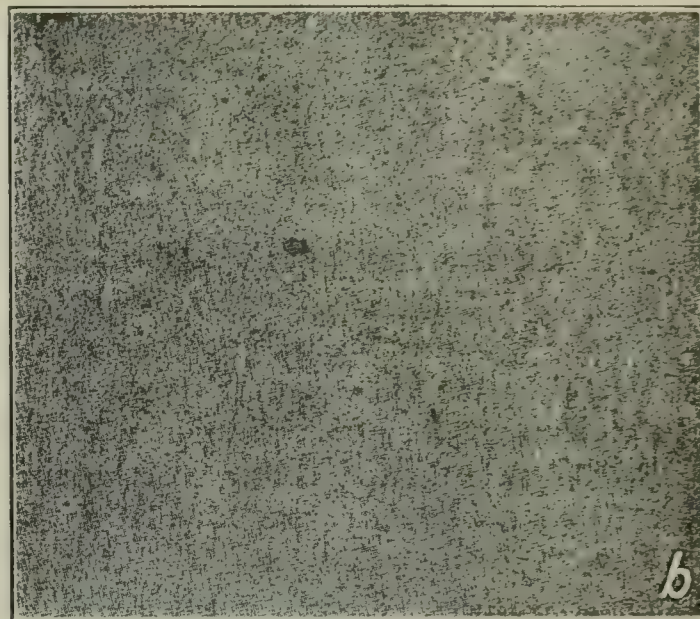
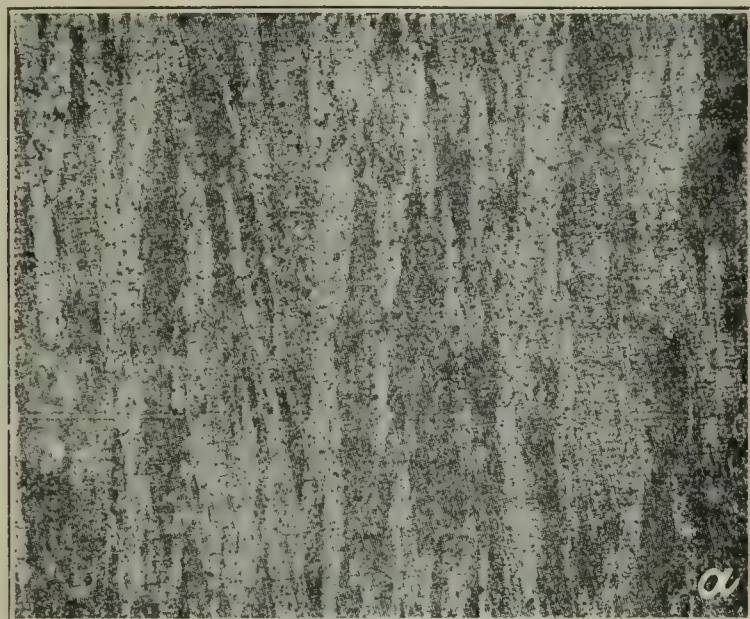
Through use of a shield it was also possible to employ entire higher average current densities than

The results obtained upon relatively thick specimens (about 0.75 mm. or 0.03 in.) are given in Table IV.

TABLE IV. PHYSICAL PROPERTIES OF DEPOSITED NICKEL

Expt.	Solution	Current Amp./ sq.dm.	Density Amp. sq.ft.	Ultimate Tensile Strength		Elongation in 2 in. (5 mm.) per cent
				Kg./sq cm.	Lb. sq in.	
1	Chloride No. 2	1	9	4,900	75,000	
2	Chloride No. 2	3	28	4,900	75,000	8.5
3	Chloride No. 3	5	47	5,600	80,000	11.0
4	Fluoride No. 3	1	9	7,000	100,000	
5	Fluoride No. 3	3	28	8,200	117,000	2.4
6	Fluoride No. 3	5	47	9,350	133,000	4.8

Accurate determination of the yield points was not found possible, but the few results obtained indicate that there is less difference in the yield point than in the ultimate tensile strength of the nickel from the two solutions. The data in Table IV show that there is a

FIG. 2. STRUCTURE OF ELECTRODEPOSITED NICKEL. $\times 100$

a—"Chloride" solution, 5 amp./sq.dm. (47 amp./sq.ft.). b—"Fluoride" solutions, 5 amp./sq.dm. (47 amp./sq.ft.)

otherwise, as under ordinary conditions the edges receive an excessive current density and become cracked or "burnt."

Unless otherwise noted, commercial "95-97 per cent" cast nickel anodes having an area approximately equal to the cathodes were employed. An analysis of one lot of these anodes²⁰ yielded the results given in Table III.

TABLE III. COMPOSITION OF NICKEL ANODES

	Per Cent
Nickel (+ cobalt).....	97.5
Carbon.....	1.50
Silicon.....	0.05
Copper.....	0.20
Iron.....	0.60
	99.85

In a few cases commercial anodes having almost the same composition, except that they contained 0.6 per cent of tin, were used, with no apparent difference in the operation of the baths.

PHYSICAL PROPERTIES OF DEPOSITED NICKEL

As our immediate interest was in securing deposits which would withstand severe abrasion, greater attention was paid by us to the physical properties than to the appearance of the deposits. Pending the development of a satisfactory method for measuring hardness, and especially the "abrasion hardness" of thin layers of metal, a few preliminary tensile tests were made²¹ upon the assumption that the results would at least indicate the relative hardness of samples of similar material.

²⁰By J. A. Scherrer, of this bureau.

²¹By L. B. Tuckerman, of this bureau.

great difference in the ultimate tensile strength of the deposits from the chloride and fluoride solutions, which difference is most marked in deposits produced at relatively high current densities. This difference can be readily observed by manual bending of the samples, when it will be found that the fluoride deposits are much stronger and more elastic than the chloride.

It has not been possible to secure any absolutely conclusive evidence of the relative wearing qualities (e.g., on a printing press) of the two grades of nickel, but all the evidence secured confirms the superiority of the fluoride deposit for this purpose.

That this difference in physical properties is accompanied by differences in crystal structure is evident

TABLE V. COMPOSITION OF DEPOSITED NICKEL

	"Chloride" Per Cent	"Fluoride" Per Cent
Nickel (+ cobalt).....	99.60	99.40
Iron.....	0.27	0.45
Copper.....	0.09	0.15
	99.96	100.00

from Fig. 2, from which it will be seen that the deposit from the fluoride is much finer grained than that from the chloride solution.

One of the most characteristic differences in the operation of baths containing chlorides and fluorides is the fact that much sludge is produced in the chloride solution, while the fluoride remains practically clear. Under these conditions we would expect a higher content of metallic impurities in the fluoride deposit than in the chloride, in fact the presence of such impurities has

been suggested as a cause of the finer crystal structure and higher tensile strength of the fluoride deposit. Analysis of the deposits²² yielded the results shown in Table V.

Even though there is a greater content both of copper and iron in the fluoride deposit (approaching closely that present in the anodes), it is at least doubtful whether these amounts of impurities could account for the difference in structure and physical properties, especially since they are present in at least comparable amounts in the chloride deposit. Further experiments are needed to determine whether the effect of the fluorides or fluoborates is specific, or whether similar effects may be produced by other substances.

EXPERIMENTS WITH HOT-ROLLED AND ELECTROLYTIC NICKEL ANODES

In view of the good anode corrosion in the fluoride solutions, and the almost complete absence of sludge, a few attempts were made to employ either hot-rolled or electrolytic nickel anodes.²³ These experiments indicated that the fluoride solution corrodes the rot-rolled anodes about as readily as it does the cast anodes, but that the corrosion of the electrolytic anodes is poor until the solution becomes so acid that a very low cathode efficiency is secured. Further work will be required to determine whether the commercial use of rolled anodes in these solutions will prove practicable and economical.

The rolled anodes used in these experiments had the composition given in Table VI.²⁴

In both the chloride and fluoride solutions it was found that the cathode efficiency for current densities up to 2 amp. per sq.dm. (19 amp. per sq.ft.) is above 99 per cent. At higher current densities the cathode efficiencies are slightly lower in the chloride than in the fluoride solutions. It is possible to use higher current densities in the fluoride than in the chloride solutions, without producing appreciable cracking or curling of the deposit. Thus on polished brass plates about 6 x 9 cm. (2.5 x 3.5 in.) good adherent deposits were obtained from both solutions at an average of 2 amp. per sq.dm. (19 amp. per sq.ft.), while at 4 amp. per sq.dm. (37 amp. per sq.ft.) the deposit from the fluoride was almost perfect, and that from the chloride was badly curled. These data are of only relative value, however, as the actual current density upon the edges, where cracking first occurred, was certainly much higher than the above values. The deposits referred to in Table V as secured at a current density of 5 amp. per sq.dm. (47 amp. per sq.ft.), were rendered possible only by the use of the shields.

As for the immediate purpose in view it was necessary to use wax for insulating purposes, the use of solutions at appreciably elevated temperatures was prevented. All of the experiments herein described were made with solutions at room temperature (20 to 25 deg. C., or 68 to 77 deg. F.). The effects of bath temperature upon the deposits will be included in the further investigations now in progress.

CONDUCTIVITY OF PLATING SOLUTIONS

One of the important factors in the operation of plating solutions is the conductivity, because an increase in conductivity not only represents an economy in power, but also leads to the production of smoother de-

TABLE VI. COMPOSITION OF HOT ROLLED-NICKEL ANODES	
	Per Cent
Nickel.....	98.50
Iron.....	0.64
Copper.....	0.17
Carbon.....	0.05
Manganese.....	0.35
	99.71

posits. In this respect the fluoride solution as above prepared is slightly inferior to the chloride as shown by the data in Table VII based on approximate measurements at 25 deg. C. (77 deg. F.).

TABLE VII. RESISTIVITY OF NICKEL SOLUTIONS		
No.	Composition	Resistivity Ohms per Cm. Cube
1.....	NiSO ₄ 2.0 N.....	20.5
2.....	NiSO ₄ 1.8 N NiCl ₂ 0.2 N H ₃ BO ₃ 0.5 M	19.8
3.....	NiSO ₄ 1.8 N NiF ₂ 0.2 N H ₃ BO ₃ 0.5 M	21.9
4.....	NiSO ₄ 1.8 N NiF ₂ 0.2 N H ₃ BO ₃ 0.5 M Na ₂ SO ₄ 0.5 N	17.2
5.....	NiSO ₄ 1.8 N NiF ₂ 0.2 N H ₃ BO ₃ 0.5 M MgSO ₄ 0.5 N	20.9
6.....	NiSO ₄ 2.0 N NaF 0.2 N H ₃ BO ₃ 0.5 M	19.9

Efforts were therefore made to increase the conductivity by the addition of sodium sulphate and magnesium sulphate respectively. It is interesting to note (Table VII) that the sodium sulphate has a greater effect upon the conductivity than has an equivalent amount of magnesium sulphate, though the change produced by this concentration of either is not sufficient to represent any great economic advantage. Unfortunately, there is no prospect for the development of a good nickel-depositing solution with a resistivity comparable with that of the acid copper bath (about 5 ohms per cm. cube).

A few experiments with solutions corresponding to Nos. 4 and 5 in Table VII showed that good deposits could be secured in them, within about the same range of current density, as in No. 3. No physical tests were made upon the deposits, but from simple bending tests they appeared to be somewhat "softer" than the deposits from No. 3. At the same time it was found that there was slightly less tendency for the deposits from Nos. 4 and 5 to crack and curl up than for the deposits from No. 3. The advantages observed were not sufficient, however, to justify a definite recommendation to add these "conducting salts" to the solution.

One of the chief objections to the use of solutions prepared like No. 3 is the danger and inconvenience of handling hydrofluoric acid. In our later experiments, therefore, a bath was prepared according to the formula of No. 6 (Table VII). The substitution in No. 3 of sodium fluoride for nickel fluoride, with the addition of an equivalent amount of nickel sulphate, should produce a solution exactly similar to that which would be secured by adding 0.2N sodium sulphate to No. 3. The value for the conductivity of such a solution and its behavior upon electrolysis indicates that such is the case. This bath has not been used by us on a commercial scale for so long a period as has No. 3, but the results thus far obtained are sufficiently promising to recommend its further application. Apparently, the de-

²²By J. A. Scherrer, of this bureau.
²³Furnished for this purpose by the International Nickel Co.
²⁴Analysis by J. A. Scherrer.

posits are slightly softer than those from No. 3, which may cause somewhat less resistance to abrasion. On the other hand, such deposits may be preferable in electroplating because they are more readily buffed. A bath of this character has been used by us for miscellaneous plating for a few months, and has given entirely satisfactory results.

CONCLUSIONS

When nickel or sodium fluoride is added to nickel baths containing boric acid, fluoborates more complex than those corresponding to the formula HBF_4 are probably produced. The fluorine content of such solutions can be determined approximately by titration with ferric chloride.

The effect of boric acid and hydrofluoric acid upon the hydrogen ion concentration and neutralization curve of nickel sulphate solutions has been studied, and their function in plating solutions has been suggested.

Nickel deposits produced in solutions containing fluorides have a finer structure and a higher tensile strength than those produced in corresponding chloride solutions. When prepared with anodes containing about 97 per cent of nickel, there is slightly more iron and copper in the fluoride deposits than in the chloride.

The anode corrosion in solutions containing fluorides

is good and the solutions produce less sludge than do corresponding chloride solutions. Attempts to use electrolytic anodes in such solutions at reasonably high current densities have not yet been successful, but the results with hot-rolled anodes are promising.

The use of fluorides in nickel solutions for electrotyping will probably increase the wearing quality of the printing surface. In electroplating, good deposits can be secured in the presence of fluorides at somewhat higher current densities than are ordinarily employed, and these deposits, while slightly harder to buff, show greater resistance to abrasion.

The use of the solution given in Tables II-A and II-B is suggested. These solutions may be used with an average current density of from 3 to 4 amp. per sq.dm. (28 to 37 amp. per sq.ft.) for producing adherent deposits in electroplating and 1.5 to 2 amp. per sq.dm. (14 to 19 amp. per sq.ft.) for making reproductions, as in electrotyping.

ACKNOWLEDGMENT

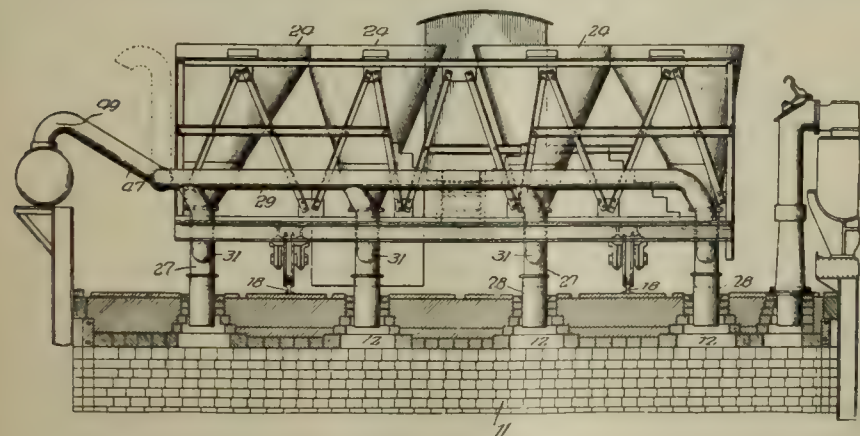
The author desires to express his appreciation for the assistance of his associates at the Bureau of Standards, especially W. E. Bailey, L. D. Hammond, H. E. Haring and M. R. Thompson, in conducting the experiments described in this paper.

Recent Chemical & Metallurgical Patents

American Patents

Complete specifications of any United States patent may be obtained by remitting 10c. to the Commissioner of Patents, Washington, D. C.

Coke-Oven Charging Car and Means of Discharging Smoke.—JOHN BECKER of Pittsburgh, Pa., has patented an improved device for charging coke ovens which also provides an effective means for taking care of the smoke ordinarily escaping into the open air at the time of charging. The charging car shown in the accompanying drawing permits the coking chambers of a battery of ovens to be charged independently of each other while at the same time the openings of the ovens are collectively connected to a fixed smoke main extending longitudinally along the battery. The smoke



incidental to the charging operation is conveyed from the coking chambers 11 through the openings 12. The charging car, consisting of the four funnel-shaped hoppers 24, can be moved across the several batteries of coking chambers on the tracks 18. The hoppers are normally closed by a slide located at the top of the chute 27. The smoke flue 29 is carried with the truck, and its branches 31 extend into the sides of the chutes. The action of recharging consists briefly in connecting the smoke flue with the main and then lowering the sleeves 28. The coal, which is charged from one or more

of the hoppers, causes the smoke to be delivered out of the other charging openings into the smoke flue 29 (1,376,313, April 26, 1921.) Another patent (1,376,314, April 26, 1921) provides a means for discharging the smoke into a gas-collecting main so that, if desired, the byproducts carried along with the gas can be recovered.

Process of Treating Brass Scrap.—OLIVER C. RALSTON has discovered that aluminum, iron and other metals which are electropositive to copper can be removed from brass scrap and related copper-bearing alloys by treating these materials with an aqueous solution of cupric chloride or with a weak hydrochloric acid solution into which chlorine gas is introduced. Starting with a brass scrap containing 35 per cent of zinc and 0.2 per cent of iron, the contents of these metals were reduced to 10 per cent and 0.05 per cent respectively, and the total loss of the charge did not exceed 48 per cent. (1,375,930; April 26, 1921.)

Refractory Material.—Carborundum refractory articles can be made satisfactorily by using a bonding material composed of zirconium and aluminum silicates. Carborundum constitutes at least 80 per cent of the mixture, which is held together by a bond consisting of 9 parts of zirconium silicate to 1 part of aluminum silicate. The principal advantages possessed by this bonding material are the long and higher vitrification range and its desirable surface reaction with the carborundum. (1,376,091; MINER L. HARTMANN, of Niagara Falls, N. Y., assignor to the Carborundum Co.; April 26, 1921.)

Alloys for High-Speed Tools.—Alloys consisting essentially of chromium, tungsten, cobalt, carbon and iron have been found to be especially useful for the manufacture of lathe tools and other instruments operated at great speed. These alloys, it is claimed, possess the requisite qualities of toughness, hardness and ductility in a high degree and would therefore be preferred to alloys which are so hard as to be brittle and easily broken or which are so soft that they will not withstand the great pressure under which they are operated. (1,376,056 and 1,376,062; JOHN F. WANDERSEE, ROBERT PERETTO, and THEODORE ALBRECHT, assignors to the Ford Motor Co.; April 26, 1921.)

Production of a Ferro-Silico-Magnesium Alloy.—An alloy to be used as a deoxidizing agent is prepared by adding magnesium to ferrosilicon, which has been heated to a semi-fluid state. Aluminum, nickel or other metals may be alloyed with magnesium and used as a substitute for it, provided they are added to the ferrosilicon in the same

manner. (1,376,113; GUSTAV PISTOR, ALBERT BEIELSTEIN, and ADOLF BECK, assignors to the Chemische Fabrik Griesheim-Elektron of Frankfort, Germany; April 26, 1921.)

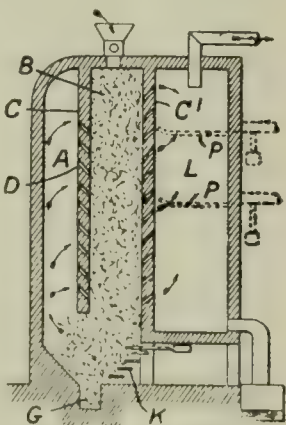
Nitrogen Fixation Process.—A method is proposed for producing compounds such as ammonia and the oxides of nitrogen by gas reactions within an electrolytic cell. Advantage is taken of the activity of electrolytic oxygen and hydrogen by bringing nitrogen into intimate contact with them at the time of their liberation. This is accomplished by the use of porous anodes and cathodes into which a stream of nitrogen is forced. (1,376,207; CHARLES B. JACOBS, assignor to E. I. du Pont de Nemours & Co. of Wilmington, Del.; April 26, 1921.)

British Patents

For complete specifications of any British patent apply to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Calcium Superphosphate.—A soluble calcium phosphate or a manure containing it in admixture with potassium sulphate is prepared by calcining alunite and passing the gaseous products into a tower or chamber containing phosphate with or without calcined alunite, water spray or steam being added if necessary. The calcination of the alunite may be effected in a closed retort at 700-900 deg. C. or in a furnace in which it descends over a number of hearths, the lower ones being externally heated to 700-900 deg. C. The reactions are completed on storing the product. According to the provisional specification, the gases arising from the calcination of alunite may be led over calcined alunite for the production of aluminum sulphate and alum; and a fertilizer containing soluble phosphate and potash is obtained by calcining as above described a mixture of alunite and insoluble phosphate. (Br. Pat. 158,293; A. MATHESON, London. April 13, 1921.)

Gas Producers.—In the continuous distillation of carbonaceous material by passing therethrough streams of hot gas, the volatile products are collected in a chamber provided with one or more outlets for gases, vapors and liquid distillates. The fuel may be fed continuously to the preheating chamber *B* of a producer provided with a grate *K* at the base, and ash is discharged continuously by a screw *G*. The producer gas passes into a distributing chamber *A* and through a louvered partition *D* into the fuel. The gases, etc., escape through a second partition *C'* into the collecting-chamber *L*, which may be divided by shelves *P* to fractionate the products. In one modification, three concentric chambers are used, and in another form, the producer is separated from the distillation chamber. (Br. Pat. 158,394; W. P. PERRY, London. April 13, 1921.)

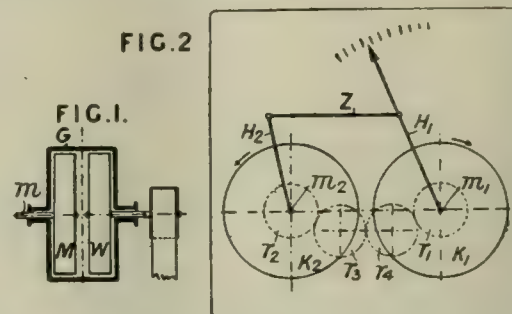


Dyeing Cellulose Acetate.—In dyeing fibers, threads or fabrics of cellulose acetate, the material is treated with ammonium thiocyanate prior to dyeing, or ammonium thiocyanate is added to the dye-bath. Instead of ammonium thiocyanate, sodium, potassium, calcium, etc., thiocyanates may be used. Examples are given of dyeing with acid wool dyes, basic dyes, substantive cotton dyes, and vat dyes. Mixed goods containing cellulose acetate and cotton, wool, silk, etc., may be treated by the process, either by cross-dyeing or by using a dye which the two fibers absorb in the presence of the thiocyanate. (Br. Pat. 158,340; BRITISH CELLULOSE & CHEMICAL MANUFACTURING CO., LTD., Westminster, and J. F. BRIGGS and C. W. PALMER, both of Spondon, near Derby. April 13, 1921.)

Catalytic Iron.—Pure iron, which is useful as a catalyst for the synthesis of ammonia, is prepared by treating ferric nitrate solution with just sufficient silver nitrate to precipitate any chloride present, filtering, evaporating the solution to dryness, partly converting the nitrate into oxide by gentle ignition, washing out the residual nitrate together with any oxidized sulphur product, and finally reducing the ferric oxide. An inert support, such as pumice or asbestos, may

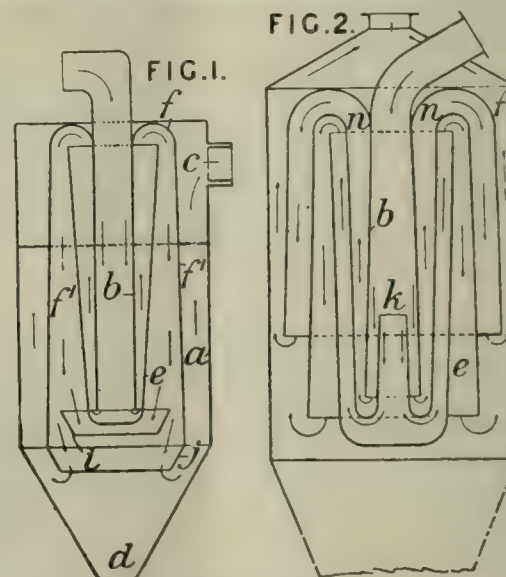
be added just prior to ignition; and a promotor may be incorporated with the catalyst by adding ammonium molybdate, potassium osmate, titanium nitrate, uranium nitrate or an alkali tungstate, to the purified ferric oxide before reduction. The product is preferably heated in pure ammonia gas. (Br. Pat. 159,960; NITRO-FIXATION SYNDICATE, LTD., and H. C. JENKINS, London, May 4, 1921.)

Gas Density Estimating Apparatus.—The density of a gas is determined by rotating a solid body in a chamber containing the gas and causing the current of gas thus set up to act on a second movable solid body which operates an indicating device. In the form shown in Fig. 1 the rotating member *W* is disposed in the chamber *G*, which also contains the member *M*, which is displaced by the gas current. The latter



member is mounted on a shaft *m* to which a pointer, etc., is connected. The form shown in Fig. 2 comprises two similar chambers *K*₁, *K*₂ respectively containing the gas to be tested and the standard gas such as air. The rotating parts are connected by gearing *r*₁ . . . *r*₄ so as to turn at equal speeds in opposite directions. The shafts *m*₁, *m*₂ carry arms *H*₁, *H*₂ connected by a link *Z*, and a pointer on the arm *H*₁ indicates the relative densities of the gases. (Br. Pat. 159,845; not yet accepted; G. KONIG DAHLEM, Berlin, May 4, 1921.)

Dust Collectors.—Relates to apparatus for separating dust from air and gases and of the type in which the separation is effected in stages within a vessel containing a conical hood, the air impinging upon the inner surface of the hood and having its direction changed and its velocity reduced as it passes through the vessel, and consists in the provision of additional conical hoods, within the vessel. As shown, the air-inlet pipe *b*, Fig. 1, communicates with the interior of the container *a* having an air outlet *c* which may be connected with a suction device, and a dust outlet *d*. A conical hood *e*



closed at its lower end encircles the inlet pipe, and a hood *f* having a conical depending skirt *f'* is fitted at the upper and open end of the hood *e*. Baffle-plates *i*, *j* are provided within and at the lower portion of the skirt to reduce the velocity of the air. In a modification, the cover at the lower end of the hood *e* is replaced by a dust-pipe extending through the lower portion *a'* of the container and closed by a removable cap. In another arrangement, the inlet pipe *b*, Fig. 2, is tapered, and the air current entering the container is subdivided by a hood *k*, having an open and upwardly extending central portion which communicates with a hood *e*. The subdivided air currents pass through passages formed in the container by means of hoods *f*, *n*, and finally unite before leaving. (Br. Pat. 160,100; R. BOBY, LTD., and M. JENNINGS, Bury St. Edmunds. May 11, 1921.)

Synopsis of Recent Chemical & Metallurgical Literature

Length Changes at Transformation Points.—Simple experiments showing the dilation of steel wires have been described by J. LEMOINE and M. GARVIN in *Revue Générale des Science*, April 15, 1920, p. 194. The accompanying figure shows schematically the results they have obtained. A 3.5 m. long, 1.5 mm. diameter nichrome wire was swung in a horizontal position between two supports and a 110-volt current passed through it. The wire elongates on heating so as to give a 25-cm. deflection. On cooling the wire regains the original horizontal position. A hard steel (piano) wire 1.2 mm. in diameter when treated in the same way expands during heating up to a deflection of about 15 cm. corresponding to the temperature of dark red, then

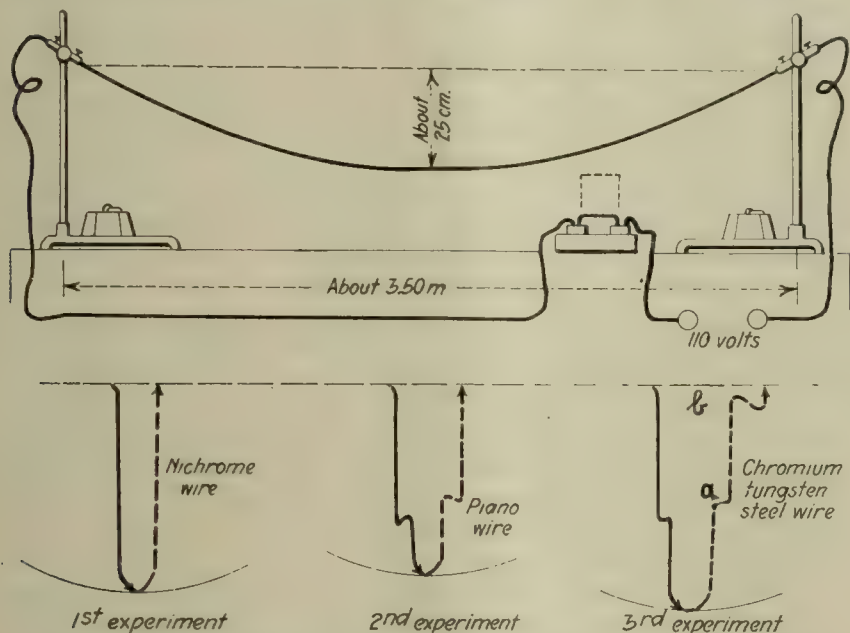


DIAGRAM SHOWING LENGTH CHANGES IN WIRES AT THEIR TRANSFORMATION POINTS

contracts a length corresponding to about 10 cm. deflection and finally elongates to about 20 cm. deflection at a temperature of cherry red. During cooling the wire contracts to a temperature below visible color, when it shows the phenomenon of recalescence and finally regains the original length. This experiment shows the well-known lag in transformation. A chromium-tungsten steel wire of the composition of high-speed tool steel, 3 m. long and 1.2 mm. in diameter, also gives instructive results. During heating a phenomenon similar to that for hard steel is observed, but at the temperature of bright red. During cooling two transformation points are observed. With slow cooling there would be only one transformation point corresponding to the first one at *a*; with rapid cooling there would also be only one, but this would correspond to that at *b*.

Research in Ceramic Decorative Processes.—The May *Journal* of the American Ceramic Society contains a clear analysis by FREDERICK H. RHEAD covering the fundamentals of research in ceramics. These fundamentals as outlined by Mr. Rhead consist of adequate resources, not only financial but mental and physical, which contribute to the success of the undertaking; a clearly defined purpose or program; efficient direction, experienced practical assistance, an adequate and well-planned equipment, and finally, educational facilities.

It will be generally conceded that the ideal condition will be that where the manufacturer and research director are in harmony as to the specific purpose of the activity. With the final program determined, working drawings would be executed and actual samples would be made. A competent director will commence work with as little disturbance as possible endeavoring to fit into the organization as it exists, while giving it new impetus. In this country we have archi-

fects, artists, draftsmen, sculptors and decorators of international reputation, and there is no practical reason why their interest should not be aroused and their services utilized.

As regards efficient direction, a progressive manufacturer with a knowledge of industrial possibilities should have little trouble in finding men capable of formulating and directing a program for the specific purpose in mind. The fact of the matter is that the average business man is afraid of the artist; calls him a freak; balks at his so-called temperament, entirely unconscious of the fact that the average business man is the most temperamental man in the world.

The art director and the director of artistic research must be an efficient executive with a sound knowledge of business principles, and the work of his department must be subject to the same rational business treatment and scrutiny and the same discipline accorded to the other branches of the activity.

It has just been stated that one man could not successfully carry out the work under discussion. An organization for the manufacture of artistic clay products may be compared to the symphony orchestra. Personal experience has shown that 35 per cent of the art director's time is spent in instruction. But it pays. An interested and enthusiastic working force is worth any amount of attention.

Speaking of adequate educational facilities, it might be suggested that the American Ceramic Society hold conventions where the program includes the general public. The various manufacturers would submit examples of their product; the school, examples of students' work. As far as possible each exhibit would be accompanied with a detailed classification of the process when school children are dabbling in pottery, when independent organizations such as the Apprentice Schools of Design and the Art Alliance are active in this direction. It is evidence of interest which could profitably be co-ordinated with the interests of the manufacturer.

If the American Ceramic Society is to establish a proper influence in the clay-working industry, the members as a body would be rationally sympathetic to those closely allied industries which in turn must be educated to an intelligent understanding of the tremendously important work being done by present-day industrial clay-working organizations. The work would be helped tremendously in this society if it were possible, at future conventions, to have a meeting of the heads of the various divisions. The decorative men need the assistance of the technicians, and both these groups cannot work without the practical men. And last, the manufacturer is an official whose attendance is absolutely necessary if the American Ceramic Society is to get very far with its program.

Recrystallization in Aluminum.—Prof. CARPENTER and Miss ELAM read a paper before the spring meeting of the British Institute of Metals on "Stages in the Recrystallization of Aluminum Sheet on Heating." They ascribe Brislee¹ and Anderson's² inability to detect crystalline structure in rolled aluminum to the fact that they examined the surface of the sheet. When cut, polished, etched and examined crosswise, laminar markings typical of drawn-out crystals were found. On reheating such sheet a long time at 220 deg. C., first evidence of structural change is shown in a general surface tarnish, a granular structure and a loss of definition at the original grain boundaries. After seventeen hours at 250 deg. C. and correspondingly shorter times at higher temperatures new white crystals appear at the old boundaries. Structural equilibrium attained after prolonged heating at such low temperatures gives crystals elongated in direction of rolling and showing high contrast in tarnish hues, the ones to grow first from less impure solid solutions having the lighter tones. Long heating at 450 to 600 deg. C. gives crystals less elongated and having but slight tarnish contrasts. Supplementary experiments on slightly worked 82:18 Al:Zn and α brass showed recrystallization in every case to start at grain boundaries, along twinning planes or in contact with a speck of insoluble impurities.

¹Trans. Faraday Society, 1917, vol. 12, p. 62.

²MET. & CHEM. ENG., 1918, vol. 18, pp. 172, 523.

Current Events

in the Chemical and Metallurgical Industries

Stanley Patent Bill Being Pushed

Every effort is to be made to obtain the prompt enactment by Congress of Senator Stanley's bill amending the Revised Statutes relative to patents which will require manufacture within continental United States of any article covered by a patent granted a foreigner.

In recommending the legislation to the Senate, the Committee on Patents pointed out that the War Department noticed in April that a large number of applications of patents were being filed by Germans. Many of these have been assigned to various German companies, including that of Krupp at Essen. An investigation by the War Department of 228 of these applications which related to ordnance disclosed the fact that all were assigned to the Krupp company.

The Secretary of War approves the legislation in that it prevents foreigners from obtaining United States patents for the sole purpose of protecting them against American manufacture of the articles covered by such patents. Secretary Weeks points out that under the present law foreigners enjoy the same protection and monopoly as to patent rights as do American citizens. In cases where patented articles are fully protected by the United States patents, it is of little consequence how high an import duty is placed on articles manufactured under such patents in foreign countries, since they are not manufactured in the United States and are necessary to the carrying on of our industries and must be imported regardless of the high tariff.

Secretary Weeks believes that the Stanley bill insures the foreign holder of the patent a reasonable return on his invention and at the same time insures the United States a domestic source of the product.

Gas and Fuel Symposium Planned

The processing of fuels and the chemistry of gas making will receive special attention at a symposium which is planned as a part of the New York meeting of the American Chemical Society next October. Plans for this occasion are just being perfected through the Division of Industrial and Engineering Chemistry of the society. C. H. Stone of the Rochester Gas & Electric Corporation will be chairman and R. S. McBride, engineer-chemist, Colorado Building, Washington, secretary of this session. The committee to work with these officers is soon to be designated by the division so that comprehensive plans may be formulated during the summer. Chemists and engineers interested in the project or having suggestions regarding papers which should form a part of the program should communicate with the secretary of the symposium. It is thought that a gas and fuel section of the A.C.S. may be formed as an outgrowth of this work, so that more attention may be given to the chemistry of fuels processing than is possible through the engineering and commercial organizations which are active in this field.

Scholarship to France for Wisconsin Engineer

A scholarship in the Metallurgic and Mining Institute of the University of Nancy, France, has been recently established for a University of Wisconsin student of engineering. The donor is Mme. K. de Billy, who established the scholarship in memory of her late husband, Edouard de Billy, a mining engineer and formerly French high commissioner to the United States. The scholarship is for 4,000 francs and is open to any student who has completed three years of engineering work and can pass the requirements for the University of Nancy. Unless a Wisconsin student qualifies the scholarship goes to some other American university.

Industrial Alcohol Legislation

The Committee on Rules of the House of Representatives was prepared at the time of this writing to report out a rule assigning a definite time for the consideration of the Volstead bill, to which manufacturers of industrial alcohol have taken exception. The Committee on the Judiciary, which reported out the bill, has insisted strenuously on its prompt consideration. Some displeasure has been indicated because the Committee on Rules did not act more promptly.

It is understood that the rule under contemplation will not preclude the offering of amendments on the floor of the House. If the House should vote down amendments looking to the liberalization of the control over industrial alcohol, the possibility of alterations by the Senate still exists.

The new prohibition commissioner has been sounded out and is known to be keenly aware of the necessity of placing no unnecessary obstacles in the way of the manufacture and use of industrial alcohol for non-beverage purposes. This is regarded as a very hopeful feature of the situation, since any law that may be enacted will leave a great deal to the discretion of the prohibition commissioner.

Du Pont Dye Plant Increases Production

The American dye industry is slowly recovering from the recent depression. Operations in the large dye works of E. I. du Pont de Nemours & Co. at Deepwater Point, N. J., are back on a six-day-a-week basis. This change went into effect on June 13 and applies to all departments in the plant. At the same time the management reduced the wages of all employees from 7 to 15 per cent. Salaries were reduced about 15 per cent when the bonus was discontinued on Feb. 1. Some of the older and more experienced operators, who have been out of work for several months, are being re-employed.

In most departments production is confined to dyes that the company has not hitherto manufactured, as the stocks on hand of the older staples are sufficient to meet the demand. In several instances special efforts are being made to manufacture those dyes for which the War Trade Board has issued import licenses. Until these dyes are manufactured in this country, it can hardly be said that the dye manufacturers are meeting all the demands of the dye consumers.

TNT Not Highly Sensitive

That TNT is not highly sensitive and is perfectly safe for industrial uses is a statement contained in a formal announcement by the Bureau of Public Roads. The announcement was prompted by the recent explosion of a bomb attached to an airplane at the Aberdeen Proving Grounds. Many of the reports of that accident conveyed the impression that TNT is a very sensitive explosive. The bureau points out that it has been distributing TNT to the state highway departments in large quantities for more than a year to be used for blasting purposes in highway construction and that during that entire period not a single accident has occurred. The Bureau of Public Roads points out that the accident at Aberdeen gives splendid proof that TNT is not a highly sensitive explosive. There were four 300-lb. TNT bombs attached to the airplane when the propeller struck the 50-lb. bomb which exploded. These bombs were intended to explode by impact. The force of the blow from the propeller was sufficient to detonate the one bomb but the explosion did not detonate the four 300-lb. bombs.

The success attending the use of TNT in road construction has led the bureau to undertake the distribution of picric acid, which is available in large quantities, to be used for land clearing.

Atlas Powder Company to Produce Refining Carbon

Many attempts have been made in the past sixty years to produce an efficient substitute for bone-char used in the refining of numerous products such as sugar, glucose, maltose, lactose, vegetable oils, gelatine, glue, alcohol products and other chemicals and pharmaceuticals. While the need for such a refining carbon has been growing more and more urgent, these attempts have not been commercially successful. Now after several years of research and tests, the Atlas Powder Co., Wilmington, Del., has drawn plans for a 6,000-ton plant to manufacture "Darco," a decolorizing and refining carbon which will be put on the market at a price to compete successfully with all other refining materials.

The principal reasons necessitating a bone-char substitute have been the constantly increasing price of this carbon of animal origin, due to the growing demand and inadequate supply. Refining carbons have been imported, but these expensive carbons cannot be used on a large scale without revivifying many times. Revivification has so far not been an easy and cheap process because of the considerable loss due to the large percentage of volatile fines contained.

The advantages claimed for "Darco" are that it is twenty-five to thirty times as efficient as bone-char, is rapid in action, and that it is so cheap that it may be used two or three times and then be discarded without the need of revivifying. There are no royalty charges added to its cost.

Heretofore chemists have focused their attention on particular raw materials from which decolorizing carbons were to be made, such as cinchona bark, rice hulls, corncobs, hydrolized wood waste, kelp, etc. While some of these carbons looked promising in the laboratory stage, the low yield in final product from the raw material and the cost of carbonization and subsequent washing made commercial production prohibitive. On the other hand the idea has also been proved mistaken that any kind of carbonaceous waste material, such as, for instance, the molasses residue in the manufacture of alcohol or the waste liquor in the paper pulp industry, would produce commercially efficient decolorizing carbon. The theory that any finely divided carbon would make a good decolorizing agent has not worked out.

This new development is the first attempt in this country by a large and well-known chemical manufacturing concern, such as the Atlas Powder Co., to undertake the manufacture of a decolorizing carbon. Because of the importance of efficient decolorizing, deodorizing and refining carbons in a large number of chemical industries, this project is receiving wide interest.

Fixed Nitrogen Laboratory to Be Transferred

The Fixed Nitrogen Research Laboratory will be transferred on June 30 from the War Department to the Department of Agriculture. With the laboratory the War Department will transfer the remainder of its appropriation for this type of research. The amount is approximately \$500,000.

The laboratory will be an independent unit of the Department of Agriculture and will be under the direction of Dr. Richard C. Tolman, who has been conducting it for the War Department. Dr. Tolman will report directly to the Secretary. He will have the assistance of an advisory committee to be made up of representatives of the agricultural bureaus having immediate interest in nitrogen matters.

Plans are being made so that the present appropriation will be sufficient to maintain the laboratory for two years.

Plastic Gypsum Commercially Available

Plastic gypsum made in accordance with the Bureau of Standards recommendations is now available commercially according to announcements. The principles on which this process were based were recently described in *CHEMICAL & METALLURGICAL ENGINEERING*¹ by Warren E. Emley, who discovered and has patented the improvements which make possible the preparation of calcined gypsum in a valuable plastic condition. Other companies are also reported to be building mills for the production of this product.

¹CHEM. & MET. ENG., vol. 24, p. 740, April 27, 1921.

Federal Regulation of Fertilizer Opposed

Senator Fletcher, of Florida, has presented to the Senate a resolution by Southern Commissioners of Agriculture protesting against federal regulation of the "sale and shipment of fertilizer in interstate and foreign commerce, to prevent the adulteration and misbranding thereof."

The resolution recites that it was actuated by the introduction of a bill in Congress to that end. This assumption is in error, however, as no bill has been introduced at this session of Congress which attempts such regulation of the fertilizer traffic. The Bureau of Soils frequently is accused of harboring an earnest desire for such legislation. The charge has been made that it takes advantage of the requests of Congress for information as to the fertilizer situation to bring forward arguments which make good propaganda for such legislation. So far as can be ascertained, however, Congress is not entertaining at this time any serious intention of legislation looking to federal regulation of fertilizers. There is some difference of opinion as to the effect on the fertilizer industry of the control which is proposed to exercise over the packers.

Obtaining Copies of Scientific Articles

Many scientists lack the library facilities which their work demands. They are compelled either to journey to distant libraries or to try to borrow books by mail. Often it is difficult for them to locate something that is badly needed, and again it may be impossible to borrow it.

The Research Information Service of the National Research Council is prepared to assist investigators by locating scientific publications which are not generally or readily accessible. It will also, as is desired, have manuscripts, printed matter or illustrations copied by photostat or typewriter. The cost of copying varies from 10c. to 25c. per page. No charge is made for this service unless an advance estimate of cost has been submitted and approved by correspondent. Requests for assistance should be addressed to National Research Council, Information Service, 1701 Massachusetts Ave., Washington, D. C.

Chemical Exhibit a Success

Members of Congress are practically unanimous in commending the chemical exhibit which was displayed in the office building of the House of Representatives by the National Research Council. The exhibit now has been moved where it will be on permanent display. The National Research Council has prepared a copy which is available for exhibition at any point throughout the country where there may be a demand for it.

Representative Longworth declares that members of Congress obtained more information concerning the chemical industry in a half hour at the exhibit than they would have received if they had read volumes.

Stamford Chemical Society Visits Testing Plant

On the afternoon of June 11 a party of members of the Stamford Chemical Society visited the research laboratory and small testing plant of Joseph H. Wallace & Co., at Webb's Hill, on the outskirts of Stamford, Conn. Interesting talks were given by Mr. Wallace, Mr. Greenwood and their research chemist, Mr. Stevens, on all phases of their process for producing high-grade paper pulp material with turpentine, fine oil and rosin as byproducts from the stump-wood of the Southern pine.

The process involves steaming the properly-sized wood chips for recovery of the turpentine and pine oils, treatment of the steamed chips with a fraction of the pine oils that has been found to be a good solvent for extraction of the rosin, and a steam distillation of the extract to recover the rosin and solvent. The treated chips then have a uniform composition and are in an ideal condition for transfer from the field plant to the paper pulp mill and treatment there with the mixed caustic soda and sodium sulphide solutions according to the regular routine of the sulphate process which is recommended by J. H. Wallace & Co.

A strong, high-grade paper can be uniformly produced by this method.

New Chemical and Oil Companies

During the month of May twenty-four companies with capitalization of \$50,000 or more were organized to manufacture chemicals, drugs, dyes and affiliated products. The total authorized capital of such corporations amounts to \$12,400,000, as compared with an indicated investment of \$9,390,000 for companies formed in this line in April. A year ago, May, 1920, the amount of capital involved in new companies in the chemical field totaled only \$3,392,500. During May, 1921, only two of the companies chartered had an authorized capital of \$1,000,000 or larger. For the first five months of the present year a total of \$62,300,000 in capitalization is shown in new companies formed to manufacture chemicals and affiliated products.

During the same month of May, 102 companies with a capital of \$50,000 or larger were organized to operate in different branches of the petroleum industry. The total capitalization is \$112,925,000, or the smallest aggregate for any month of the present year. During the preceding month, April, 110 companies were formed, with total authorized capital of \$227,470,000, while in May of a year ago 160 such concerns were organized, with an aggregate capitalization of \$200,350,000. Five companies were formed during May, 1921, with an authorized capital of \$10,000,000 or larger.

Ruling Scale by Light Waves

It is interesting to note that it is now possible to construct scales for the measurement of length directly from the fundamental wave lengths of light without the use of any intermediary standard. As an example of work of this sort which is now being regularly carried out, it may be mentioned that the Bureau of Standards recently completed the rulings on a 6-in. scale using light waves from a tube containing neon (wave length 5800 to 6600 Å) as the length standard. The work was done for the Brown & Sharpe Manufacturing Co.

Potash Outlook for 1921

Potash stocks in the United States are estimated by the Potash Producers Association to have been 50,000 tons K_2O on April 1. The 1920 consumption of fertilizer is given as 7,500,000 tons, a record for the industry. Figuring 3 per cent as the average potash content of 1920 fertilizer, 225,000 tons of K_2O was used. With lower fertilizer prices likely to prevail this fall and with the farms of the country still under-fertilized as a result of war shortages, a much larger consumption of potash in 1921 is predicted.

Would Modify Pulp-Wood Restrictions

All probabilities favor the ultimate passage of the Senate resolution providing for the naming of a commission to confer with the Canadian authorities in the hope of obtaining modifications of the Canadian restrictions on the export of pulp wood to the United States. These restrictive orders were made after the American mills had acquired pulp-wood holdings and rights in Canada.

Exposition at Portland, Ore.

Another step has been taken by way of preparation for the International Exposition to be held in Portland, Ore., in 1925. The Senate has passed a bill authorizing the President to invite foreign countries to participate in the exposition. The exposition is intended to celebrate the completion of the transcontinental and Pacific highways, the centennial of the invention of the electromagnet and to exemplify the development of hydro-electric energy.

Aluminum Solders

All tests on recent aluminum solders have been completed by the Bureau of Standards and circular 78, "Solders for Aluminum," will now be revised to include these tests. In spite of claims made by those interested, no solder for aluminum has yet been found which will withstand the corrosion test, although the fused zinc chloride solders withstand corrosion for the greatest length of time.

Patent Office Bill to Be Reported Out

Representative Lampert's bill providing for increased salaries in the Patent Office is to be reported out in the near future. It is known that there is no opposition to the measure in the committee. Prompt action by the House is expected. This bill failed at the last session because of the insistence on the part of Senator Norris, then the chairman of the Senate Committee on Patents, that the Senate decline to recede from its amendment which authorized the Federal Trade Commission to administer patents for Government employees.

Georgia Kaolins to Be Studied

The Georgia kaolins are to be the subject of a special study to be undertaken by the Bureau of Mines under a co-operative agreement with the Central of Georgia R.R. These white clays of Georgia have been used with some success in ceramic industries, and it is believed that means can be found for a very much more extensive use of them if economical methods can be found of ridding them of impurities.

Administration of War Minerals Relief Act

In all probability the administration of the war minerals relief act will be lodged in the future in a single individual. It is understood that Secretary Fall has tendered this position to Ira E. Robinson, of Grafton, W. Va. It is Secretary Fall's desire to wind up the settlement of all war minerals claims at the earliest possible moment. Since most of the work in this connection has been done, he believes that it will be unnecessary to continue the commission form of administration.

Reclaiming of Foundry Sands

A co-operative study of the problems encountered in the reclaiming of foundry sands is to be made by the Bureau of Mines and the American Foundrymen's Association.

Mme. Curie Given 50 Milligrams of Mesothorium

During the recent visit of Mme. Curie in Philadelphia she was presented with 50 milligrams of mesothorium by the Welsbach Company.

Book Reviews

A METALLOGRAPHIC STUDY ON TUNGSTEN STEELS, by Axel Hultgren. John Wiley & Sons, Inc., New York, 1920. Pp. 95; illustrated. Price, \$3.

This book is unusual in character in that it covers work which is ordinarily presented at meetings of technical societies or in technical journals. It describes the results of investigation of the transformations and structures of a number of tungsten steels under varying heat-treatments. There is, in addition, an appendix which comprises a critical review of the investigation of tungsten steels by Honda and Murakami,¹ but it is to be regretted that the original text was not rewritten following the author's first knowledge of these Japanese investigations.

The solubility of tungsten in austenite was found to be limited to certain tungsten proportions which decreased as the carbon content increased. Beyond this limiting composition there appeared a special constituent which, in the case of alloys carrying carbon corresponding to cast iron, was cementite; in high-carbon steels of over 0.7 per cent carbon, WC, but a metastable double carbide Z_2 appeared if stable conditions were not reached; in steels containing less than 0.7 per cent carbon, a double carbide designated Z_1 ; in low-carbon alloys, an iron tungstide.

It was found that Ar_1 in these alloys was raised approximately 10 deg. C. for each per cent tungsten and that the

¹This work was reviewed in CHEM. & MET. ENG., April 27, 1921, pp. 745-748.

eutectoid composition of the austenite was displaced toward lower carbon contents by about 0.05 per cent for each per cent tungsten. The pearlite transformation was retarded and this mechanical mixture was observed to be finer than that in carbon steels.

The lowering of the pearlite transformation on cooling from high temperatures (stabilization of the austenite) was marked and with certain combinations of composition, initial temperature and rate of cooling this change is entirely suppressed. So-called secondary ferrite was precipitated from the stabilized austenite at relatively low temperatures (providing the rate of cooling was not too slow) at temperatures of the low critical range found by earlier investigators.

A number of other conclusions are drawn and the relation of free carbides to magnetic properties of tungsten magnet steels is discussed and there is given a tentative Fe-W-C equilibrium diagram.

Presenting, as it does, the views of an investigator who has spent much time in the study of carbides in steels, the text should be of interest to anyone interested in the theory of a variety of commercial steels in which tungsten is an essential component.

H. J. FRENCH.

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A FRENCH-ENGLISH DICTIONARY FOR CHEMISTS.

By *Austin M. Patterson*, Ph.D. 384 pp., New York: John Wiley & Sons, Inc. Price \$3.

Chemists who have had occasion to use Dr. Patterson's "German-English Dictionary for Chemists" will welcome the arrival of this sister volume. The earlier book has proved itself an able assistant to the many readers, old and young, of scientific chemical German. The new volume, following the same general plan, promises to prove just as valuable to those who delve into *Comptes-rendus* or *Annales de Chimie*. French chemical literature, to be sure, covers a considerably smaller field than the German and to the beginner, at least, its translations offer fewer difficulties. There are, however, as the author points out, many obstacles such as idiomatic constructions and irregular verbs which can, at times, prove most troublesome. For the novice's benefit the introduction of the book contains many notes on chemical nomenclature and word derivations which should prove helpful in the use of the vocabulary. Our eccentric friends, French verbs, are appropriately introduced in a brief statement by Prof. Frank Vogel, of the Massachusetts Institute of Technology. The new dictionary is of convenient size and shape and its flexible green binding makes it easy to distinguish it from its German companion.

SIDNEY D. KIRKPATRICK.

Personal

CHESTER M. CLARK, formerly head of the corporation department of the constructing engineering firm of Stone & Webster, Boston, has recently been chosen treasurer of Arthur D. Little, Inc., Charles River Road, Cambridge, Mass.

Dr. C. E. CURRAN, formerly with the Mead Development & Engineering Co., Dayton, Ohio, is now at the Forest Products Laboratory.

J. R. DAVIES, for the past seven years in charge of the laboratories of the Calumet Baking Powder Co., Chicago, has been appointed assistant plant manager and chemical manager of the chemical works of the Calumet Baking Powder Co., Joliet, Ill.

Dr. G. J. FINK, formerly with the Hooker Electrochemical Co., Niagara Falls, is now associated with Dr. M. E. Holmes in the chemical department of the National Lime Association at Washington, D. C.

Captain WALTER GRAHAM has resigned from Government service at Washington, after making investigations of raw materials and blast furnace and steel works practice for the Fuel Administration, Army Ordnance Department, Bureau of Standards and the U. S. Tariff Commission, and

has moved to New York to engage in examination and reports on coal, iron and steel properties and operations. Captain Graham's present address is care of the Harvard Club, New York.

ROY A. HAYNES has been appointed the new federal prohibition commissioner to succeed John F. Kramer.

Dr. MAX HENIUS of the Wahl-Henius Institute, Chicago, Ill., has left for a visit to Denmark and northern Europe.

RICHARD LEWIS LLOYD, of the Dwight & Lloyd Sintering Co., Inc., was honored at the recent commencement of Washington University, St. Louis, with the degree of Master of Science. In conferring the degree Chancellor Hall referred to Mr. Lloyd as "A distinguished metallurgist, product of training in mining and metallurgy at this university in the early '90s; associated with important metallurgical processes; identified with many movements in smelting, especially copper smelting, where he had been instrumental in perfecting new methods in North and South America and in European countries; sharer in developing the well-known Dwight & Lloyd sintering apparatus; author of technical papers for engineering and mining journals and for technical societies."

RICHARD R. REES has resigned as metallurgist of the Neptune Meter Co. to accept a similar position with Neemes Bros., Inc., of Troy, N. Y.

Dr. RALPH E. RINDFUSZ, assistant to the president of the American Writing Paper Co., has been elected secretary of the company to succeed Michael N. Slotnick, resigned. In addition to his new duties as secretary, Dr. Rindfusz will continue as assistant to the president and will also retain general supervision of the department of chemical research, which will remain under the direct capable management of Dr. L. E. Roberts.

IRA E. ROBINSON, of Grafton, W. Va., has accepted the appointment to be war minerals relief commissioner. He already has entered upon his duties and is making a thorough review of the status of war minerals relief. Horace G. Pomeroy, a member of the commission under the preceding administration, has consented to remain in the service that he may be of any possible help to Mr. Robinson in acquainting him with the status of various matters pertaining to the commission's affairs. His resignation, however, will become effective June 30.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, June 20, 1921.

The past week has witnessed a slowing down of the recent increased activity in heavy chemicals. The more important items have been subject to irregular periods and the movement has reflected the cross-currents which characterize the consuming trade. The market fundamentally is very much brighter, as stocks in resale quarters have diminished without any corresponding increase in production. There were instances uncovered where spot stocks were actually scarce and advances have occurred where buying orders were executed. In most cases, however, buyers experienced some difficulty in obtaining supplies at apparently attractive prices. Various chemicals that have come under the license system have advanced and the general belief that others may be placed under that classification has prevented short selling and has tended to steady prices. Consumers still prefer to adhere to the conservative policy which has been so effective for the past year and most of the transactions have been limited to small lots. Trading of this caliber does not help conditions any too much and indicates that consumers are not reconciled to the idea that the market has touched bottom.

The decline in exchange rates has put a damper on any hopes of an early revival in export trade. The exchange has been keenly watched by leading chemical interests and

its peculiar action has caused considerable comment. There are many opinions expressed in chemical circles, but none seems really to understand the fundamental reason for the decline. Undoubtedly one of the principal factors is the position of speculators in foreign exchange. In January, 1921, sterling sold down to \$3.35 and then had a steady advance to \$4 in April. During this period a great amount of speculative buying of foreign moneys occurred in expectation of an early settlement of the German indemnity question. Now these speculative purchases are probably being liquidated. It is said that German bankers established over \$300,000,000 of credits in various countries when marks rose to a high level with the prospects that these credits could be used in the indemnity settlement that would eventually come. Now it is reported that Germans are transferring these credits into dollars and as a result are selling all exchanges. Still another important factor in the demoralization of sterling is the drawing down of foreign balances by American banks. There is a great deal of confusion in the foreign exchange market, but no apparent uneasiness and no evidence of any alarm.

IMPORTS

Imported soda ash has not been in as much demand as heretofore. Buyers have gradually eased up purchasing this commodity through fear of delayed shipments resulting from the general abnormal conditions in England. Some material was known to have been sold for July shipment, but under present conditions sellers are not pushing any new business. The placing of oxalic acid in the "synthetic organic chemical" list requiring a license for import has steadied that commodity and prices have been well sustained around the point recently established at the late advance. Odd lots of this material arriving rather late are held in bond and are a cause of great concern to holders. There were rumors current in trade circles that prussiate of soda was being placed on this license list and this had a steadying effect on values. There is enough caustic potash in dealers' hands both of domestic and foreign manufacture to keep prices rather irregular. Quinine, camphor and menthol have been quite firm of late and more confidence is expressed regarding prices. There have been no new reports of any imports of chlorate of soda and prices have ruled firm. Imported tartaric acid has shown its weak spots on account of lack of buying support.

DOMESTIC INQUIRY INCREASES

The domestic inquiry has shown a slight increase over the preceding week without resulting in any appreciable expansion in business. Basic prices on soda ash and caustic soda are lower, while the resale markets on both materials are stronger, with higher prices named generally on caustic. It is stated that producers have been placing more business recently. Small-lot trading in bichromate of soda has increased, with prices favoring sellers. Nitrite of soda seems to be in a more favorable position for an advance than at any other time this year. The greater portion of supplies is in hands that are not inclined to liquidate. It seems reasonable to assume that after carrying stocks for several months and now protected from foreign competition, buyers will pay higher prices when they attempt to replenish stocks. Business in general throughout the spring has been rather spotty and so far business during June has not been as good as in previous months. The probability is that the slowness is temporary and within a few weeks will have vanished. Manufacturers and dealers are looking forward beyond the immediate present and expect fall business to be active.

CHEMICALS

Resale lots of 76 per cent *caustic soda* of standard brand sold at \$4.15 per 100 lb. ex-warehouse N. Y. and it is doubtful if more than odd lots could be purchased below this figure. Outside makes were quoted at 4c. per lb. The export price for standard resale material is given at 4½c. per lb. Actual business was quiet, but offerings were rather limited and had a tendency to hold the market steady. Producers quoted contracts at 3½c. per lb., basis 60 per cent f.o.b. works, and 5c. per 100 lb. higher for single cars.

Higher prices were quoted for imported *prussiate of soda* on spot, and sales were recorded at 12½c. per lb. The former price of 12½c. was refused on firm bids in several directions. The demand for small lots was quite active and there are rather persistent rumors that this chemical will eventually be placed by the Treasury Department under the classification requiring license to import. Some sellers refuse to shade 2½c. per lb. on less than carlots for light *soda ash* in single bags ex-store. It is stated that cars could be purchased at \$2.15@2.20 per 100 lb., although the market looked decidedly firm under a continuance of light supplies. Resale lots in barrels are quoted at \$2.50@2.75 per 100 lb. according to quantity. Inquiries for home and export were quite numerous, with buyers always a trifle below sellers' views. Producers of *copper sulphate* have advanced their prices on a stronger copper market and are now quoting small crystals on a basis of \$5.62 per 100 lb. in carlots and large crystals at \$5.75 per 100 lb. Imported *citric acid* is quoted at 46c. per lb. spot, duty paid, with intimations that this price might be shaded on a firm offer for a round lot. The tendency of the market, however, has been firmer of late and it is asserted that holdings have been reduced through recent quiet buying. The general range was 46@47c. per lb.

Prominent sellers of *copperas* report a fair inquiry, with actual business rather spotty. Sales have been made at \$19@21 per ton, depending entirely upon grade, quantity and seller. Producers of *niter cake* are offering this chemical on a basis of \$5 per ton in bulk at the works. The call of late has been quiet and it is understood that a moderate accumulation of supplies exists. Sales of *oxalic acid* during the week were reported at 19@19½c. per lb., with some sellers quoting up to 20c. per lb. for prime material ex-warehouse. The tone of the market remains quite firm and many are convinced that any permanent buying movement would be readily reflected in the course of values. Producers of *sulphuric acid* state that contracts for the 66 deg. are being placed at prices ranging from \$18@20 per ton in tank cars f.o.b. works, the inside figure being named for large quantities. It is also stated that sales of the 60 deg. have been made down to \$11 per ton, although sellers as a rule are not eager to quote under \$11.50 for tank cars at the works. Sales of *oleum* are reported at \$21@23 per ton in tank cars. A good miscellaneous call for industrial purposes is reported, although new business has not shown any added activity since the turn of the month. Stocks of *muriate of potash* are quite heavy and holders are pretty well tired. Quotations are around \$50 per ton, but buyers have experienced no difficulty in finding lots at \$49 or even less. German *caustic potash* in the spot market is offered lower around 5@5½c. per lb., with shipment material offered at even lower figures. The demand is very slow and holders are willing to shade for sales. Shipment from Germany can probably be had as low as 4½c. per lb. Resale American material is pretty well cleared out of the market.

Quotations on the spot market for *fluoride of soda* are around 11½@13½c. per lb., according to seller and quantity. A marked increase in the purchases of Japanese refined *camphor* has been noted in the market during the week. Sales went through at 67, 68 and 70c. per lb. and the market then moved to 72c. for slabs in cases. Some sellers are bullish in their ideas and are quoting 74@75c. per lb. Small packings are held at 82@85c. per lb. Spot stocks are reported to be materially reduced. American refiners still adhere to the 80c. basis for bulk *camphor in barrels*. *Bromides* are in fair routine request. Prices are easy at 16@18c. per lb. for imported *potassium bromide*. *Sodium bromide* is held at 21c. per lb. with a greater interest from some consumers reported. American makers are holding *potassium bromide* at 24c. and *sodium* at 25c. per lb.

COAL-TAR PRODUCTS

The better tone in the coal-tar products market has kept up pretty well throughout the past week and is largely due to the gradual improvement in operations in textile mills, for reports in general have shown a better demand from actual consumers in domestic quarters, while from foreign

directions the demand shows a marked increase. Many of the more prominent sellers talk in a more cheerful tone and while shading is still possible in some quarters on firm business, prices all around are more firmly held. Business in dyes has been slowly improving and as a consequence intermediates are generally firmer. Producers of intermediates say there is a much wider call and some of the lesser active issues are also starting up and prices are noticeably stronger. Several comparatively strong resellers have shown an inclination to take up the weakest of the spot offerings in many items, especially *beta naphthol*. Prices throughout the market are firmer on this account coupled with the improved feeling among consumers. The situation in *benzene* has shown no change, but consumers are showing less interest. Makers' prices are unchanged at 27@33c. per gal. in tank cars and less, although they are able to offer only a little at these figures. Resellers have limited quantities to offer on the open market. The 90 per cent grade is quoted unchanged at 25@28c. per gal. The resale market in *naphthalene* was very quiet, with stocks still offered below 8c. per lb. Makers' prices are still unchanged. Most producers of H acid are quoting \$1.25 per lb., although offers from one source are heard lower at \$1.20 per lb. Buyers have virtually no interest and it is probable that as low as \$1.10 could be done with a firm order in hand. Technical *salicylic acid* is still in a weak position. Offers are heard around 19c. per lb., although some makers are quoting up as high as 22c. per lb. In the resale market offers of the U.S.P. are heard as low as 20c. per lb. Recent offers of *aniline oil* from resellers have been withdrawn to a great extent from the market and efforts to locate resale stocks were unsuccessful during the week. Makers are keenly competing for such business as comes into the market and price cutting is quite general. Quotations are given at 20@27c. per lb., according to maker, but it is known that no maker would turn down any real business at the 20c. level. The market on *beta naphthol* is quite firm at 38@40c. per lb., according to seller. Weak resale lots are being taken up by stronger holders and any business that has come into the resale market from consumers has met a firm price of 38c. per lb. Manufacturers' prices are quoted at 40@42c., but it is possible that they will meet the resale market at its present level.

WAXES

Trading in the market for *beeswax* was along routine lines, but with stocks practically light no selling pressure was in evidence and prices rule steady. African crude held at 16½@17c. per lb. Brazilian crude was offered at 24@26c. per lb., according to color, quantity and holder. Imports of beeswax in April were officially placed at 82,871 lb., which compares with 957,816 lb. for April a year ago. Imports for the ten months ended with April amounted to 1,909,735 lb., as against 3,205,102 lb. for the corresponding period a year ago. An unsettlement in shipment prices featured the market in *carnauba wax* and with supplies on hand more plentiful and the demand rather slow consumers showed no apprehension over the near future. No. 2 North Country was lowered on spot to 25c. per lb. Freer offerings of spot *Japan wax* sent prices to somewhat lower levels, and at the close the market stood at 17@17½c. per lb., round lot basis. Primary markets showed no important changes in the last week according to importers. The demand in general is quiet. Offerings of *montan wax* were noted at 6½@6¾c. per lb., the situation being easier on increased holdings. On forward business it was possible to do 5¾c. per lb. The decline in the export demand for *paraffine wax* is the principal cause in the unsettlement of prices. The domestic inquiry also remained subnormal and selling pressure has resulted in quite some price slashing, especially where round lots have been involved. According to official figures the exports of paraffine refined and crude for the month of April amounted to 9,939,611 lb., which compares with 35,874,485 lb. for April a year ago. Crude wax was offered at 2½@2¾c. per lb., according to melting point. Refined held nominally at 3¼c. per lb. for the 118-120 deg. melting point. There were sellers of the 130-132 deg. at 4¾c. immediate shipment, carlot basis.

The Chicago Market

CHICAGO, June 16, 1921.

Quieter conditions prevailed in the industrial chemical market during the past week and no large transactions were reported. Prices as a rule were quite firm with a few advances noted. Buyers are still averse to anticipating and what material that is moving is in small quantities for immediate consumption.

GENERAL CHEMICALS

Caustic soda is firm with spot supplies light. The solid 76 per cent is offered at 4c. and the ground at 4½@4¾c. per lb. delivered. *Soda ash* is very firm and holders show no disposition to shade the present price of \$2.60 per 100 lb. for barrels. *Aluminum sulphate* is in small demand and supplies are available at 2¼c. per lb. for ordinary lots. *Sal ammoniac* is firm and 8½c. per lb. was the best offer noted, while some factors are holding their supplies for 9c. *Barium chloride* is very quiet and ample supplies are available at \$75@\$85 per ton, according to the quantity. There is a fair demand for U.S.P. *epsom salts* and the price is unchanged at 3¼c. per lb. for barrels. *Formaldehyde* is dull and unchanged at 14½c. per lb. in barrels.

The *alcohol* market is extremely quiet, although as a rule prices are maintained. Denatured No. 6, 188 proof, is quoted by first hands at 33c. per gal. in five-drum lots and non-beverage 190 proof at \$4.85. Methyl alcohol is in limited request and holders are asking 80c. per gal. for the 95 per cent in drums.

Caustic potash is very unsettled and supplies of the 88-92 per cent are available at 7c. per lb. for single drums. This price could probably be shaded considerably with large business. *Potassium bichromate* is a little lower and small quantities are offered at 14½c. per lb. delivered. In contrast, *soda bichromate* is firmer and most holders have advanced their ideas to 9½c. for single casks. *Nitrite of soda* is very firm and 9c. per lb. was the lowest offer noted. There is a fair movement of *sodium bicarbonate* and prices are maintained at 2¾c. for barrels. *Glycerine* is in very poor demand and prices are easy with 15¾c. per lb. the lowest offer noted.

The list of acids is firm and quiet. The action of the War Trade Board strengthened the *oxalic acid* market and holders are now asking 20@21c. per lb. for first class goods. *Glacial acetic acid* is very quiet and the price is unchanged at 11@11½c. per lb., according to the quantity. Keener competition has forced the price on the 28 per cent material lower and supplies are available at 2½@2¾c. per lb. in barrels. The heavy acids are quiet with prices unchanged. Manufacturers quote 66 deg. *sulphuric* at \$19@\$20 per ton in tank cars f.o.b. works.

VEGETABLE OILS

This branch of the trade is very quiet, with little or no movement of stocks reported. *Linseed oil* is lower, with less than car lots held at 82c. per gal. for the boiled and 80c. for the raw.

NAVAL STORES

The leading factors describe this market as very slow with inquiries light. *Turpentine* is lower, with supplies available at 59c. per gal. in five-drum lots. There is practically no movement of *rosins* and the prices are unsteady. The WG is quoted at \$7.75 per 280 lb. for carload lots and \$8.75 for smaller quantities. *Rosin oil* is also quiet and easy at 60c. per gal. for single barrels.

The Iron and Steel Market

PITTSBURGH, June 17, 1921.

Each week the steel market shows that it is possible for it to become still duller. Since the slight increment in buying and in specifying against contracts that occurred in April there has been a progression downward in activity, and as July, proverbially the dullest month of the year in the steel market, is now close at hand, no revival in the very near future is expected.

The best guess as to the rate of steel ingot production

this week by the steel industry as a whole is that it is at about 23 per cent of actual capacity, with a probable error of one or two points either way, this comparing with rates slightly above 30 per cent in April and May. The present flow of orders and specifications is not sufficient to support such a production rate, so that further decreases are to be expected.

Mill costs are of course extremely high, on account of the very low operating rates. Many small plants have been closed for months, it being impossible to operate at all on the occasional orders that could be picked up. Larger mills make steel continuously at very low rates, or close steel-making departments entirely one or two weeks out of every three, finishing departments being operated as occasion requires. There will probably be some complete stoppages July 1, this being an old practice that became uncommon in recent years.

There is no prospect of steel demand increasing in the next few weeks, unless all precedents as to July being an exceptionally dull month are broken. The trade looks to the more distant future and in not a few quarters there are predictions that there will be a revival of some proportions in August. In other quarters it is doubted whether there will be any material improvement before October. Farmers are expected to become freer buyers after they have realized on their crops. The extreme inactivity of the railroads in the matter of making repairs and of buying all sorts of supplies is noteworthy and in some quarters there is a conviction that the railroads are carrying the policy too far for their own good.

STEEL PRICES

In the majority of steel products what are known as "April prices" continue to rule as the general market. One exception is wire products, which, as noted a week ago are down \$5 a ton. The market is altogether too dull to develop actual market prices, as there is scarcely any incentive to cut prices. It is the general belief that steel prices will be lower before there is anything like extensive buying, and the mills will hardly be averse to making reductions if more business can be obtained by such means.

The opinion apparently held by a majority of buyers, that there will be a general market decline by about Aug. 1, may, however, not be borne out. As to the extent of the decline, when a definite decline does occur, it is likely to be between \$5 and \$10 a ton. It would be idle to expect mills to reduce prices to the lowest level they may be able to reach in future, as they cannot get costs down as much as they can in a period of real activity. Using a weighted average of the prominent steel products, the April prices are about \$17 per net ton under the war control prices. Disregarding the advances made by independents in 1920, these advances coming off by the end of the year, there have been three general declines, in December, 1918, March, 1919, and April, 1921, not far from \$6 a ton each. A fair guess seems to be that the next decline will be as much or a little more. It must be remembered that there is such a gap between demand and productive capacity that the familiar course of the steel market can hardly be expected to be repeated, that course being for prices to decline to a low level, the mills to fill up and fall behind in deliveries and prices then to begin advancing.

PIG IRON AND COKE

Pig iron continues to show a declining tendency, but the yielding of prices is now very gradual, this being one of the indications that the market is beginning to scrape bottom. Basic iron is quotable at \$21 valley, against \$21.50 a week ago. Foundry remains at \$22.50 and bessemer at \$23.

Two contracts for Connellsville coke have been made in the past week, each for six or seven carloads a day, or 7,000 or 8,000 tons a month. One contract was with the Empire Steel & Iron Co., Catasauqua, Pa., for July, August and September at \$3 per net ton at ovens, the other being with the Colonial Iron Co., Riddlesburg, Pa., July to November inclusive, at \$3.15. The lowest contract price previously was \$3.25 or higher, several weeks ago, but for two or three weeks past the trade has understood that \$3 could be done on a short-term contract. Spot furnace coke has declined from \$3.25 to \$3.10 or \$3.15.

General Chemicals

CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots	Less Carlots
Acetic anhydride.....lb.	-	\$0.40 - \$0.45
Acetone.....lb.	\$0.12½ - \$0.12½	.13 - .13½
Acid, acetic, 28 per cent.....100 lbs.	2.50 - 2.75	3.00 - 3.25
Acetic, 56 per cent.....100 lbs.	4.00 - 4.25	4.50 - 5.50
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	9.75 - 10.00	10.25 - 10.50
Boric, crystals.....lb.	.13½ - .14	.14½ - .15
Boric, powder.....lb.	.15 - .15½	.16 - .16½
Citric.....lb.	-	.46 - .47
Hydrochloric.....100 lb.	1.50 - 1.65	1.75 - 2.00
Hydrofluoric, 52 per cent.....lb.	.12½ - .12½	.12½ - .13
Lactic, 44 per cent tech.....lb.	.10 - .11	.11½ - .12
Lactic, 22 per cent tech.....lb.	.04½ - .05½	.06 - .07
Molybdic, C. P.....lb.	4.00 - 4.50	4.50 - 5.00
Muriatic, 20 deg. (see hydrochloric).....lb.	-	-
Nitric, 40 deg.....lb.	.06½ - .06¾	.07 - .07½
Nitric, 42 deg.....lb.	.07½ - .07½	.07½ - .08½
Oxalic, crystals.....lb.	.19 - .19½	.19½ - .21
Phosphoric, 50 per cent solution.....lb.	.13½ - .14	.14½ - .18
Picric.....lb.	.20 - .25	.27 - .35
Pyrogallol, resublimed.....lb.	-	1.90 - 2.15
Sulphuric, 60 deg., tank cars.....ton	-	11.50 - 13.00
Sulphuric, 60 deg., drums.....ton	-	13.00 - 15.00
Sulphuric, 66 deg., tank cars.....ton	18.00 - 20.00	-
Sulphuric, 66 deg., drums.....ton	22.00 - 22.50	23.00 - 23.50
Sulphuric, 66 deg., carboys.....ton	-	-
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	22.00 - 23.00	-
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 - 26.00	26.50 - 27.00
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00	33.00 - 34.00
Tannic, U. S. P.....lb.	-	.90 - 1.00
Tannic (tech.).....lb.	.50 - .52	.54 - .57
Tartaric, crystals.....lb.	-	.29 - .30
Tungstic, per lb. of WO.....lb.	-	1.30 - 1.40
Alcohol, Ethyl.....gal.	-	4.80 - 5.00
Alcohol, Methyl (see methanol).....gal.	-	-
Alcohol, denatured, 188 proof.....gal.	-	.31 - .36
Alcohol, denatured, 190 proof.....gal.	-	.38 - .42
Alum, ammonia lump.....lb.	.03½ - .03½	.04 - .04½
Alum, potash lump.....lb.	.03½ - .04	.04½ - .04½
Alum, chrome lump.....lb.	.13 - .13½	.14 - .14½
Aluminium sulphate, commercial.....lb.	.01½ - .02	.02½ - .02½
Aluminium sulphate, iron free.....lb.	.03 - .03½	.03½ - .04
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07½ - .07½	.08 - .08½
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 - .32	.33 - .35
Ammonium carbonate, powder.....lb.	.08 - .08½	.09 - .10
Ammonium chloride, granular (white sal-amoniac).....lb.	.06½ - .06½	.07 - .07½
Ammonium chloride, granular (gray sal-amoniac).....lb.	.07½ - .08	.08½ - .08½
Ammonium nitrate.....lb.	.07½ - .07½	.08 - .08½
Ammonium sulphate.....100 lb.	2.50 - 2.75	2.80 - 2.90
Amylacetate.....gal.	-	4.00 - 4.25
Amylacetate tech.....gal.	-	2.50 - 3.00
Arsenic oxide, (white arsenic) powdered.....lb.	.06½ - .07	.07½ - .08
Arsenic, sulphide, powdered (red arsenic).....lb.	.11 - .11½	.12 - .13
Barium chloride.....ton	59.00 - 59.50	60.00 - 62.00
Barium dioxide (peroxide).....lb.	.19 - .20	.21 - .22
Barium nitrate.....lb.	.08½ - .09	.09½ - .10
Barium sulphate (precip.) (blanc fixe).....lb.	.04½ - .05	.05½ - .06
Bleaching powder (see calc. hypochlorite).....lb.	-	-
Blue vitriol (see copper sulphate).....lb.	-	-
Borax (see sodium borate).....lb.	-	-
Brimstone (see sulphur, roll).....lb.	-	-
Bromine.....lb.	.41 - .42	.43 - .45
Calcium acetate.....100 lbs.	2.00 - 2.05	-
Calcium carbide.....lb.	.04½ - .04½	.05 - .05½
Calcium chloride, fused, lump.....ton	24.00 - 25.00	26.00 - 27.00
Calcium chloride, granulated.....lb.	.01½ - .02	.02½ - .02½
Calcium hypochlorite (bleach'g powder) 100 lb.	2.15 - 2.25	2.35 - 2.50
Calcium peroxide.....lb.	-	1.40 - 1.50
Calcium phosphate, tribasic.....lb.	-	.15 - .16
Camphor.....lb.	-	.73 - .75
Carbon bisulphide.....lb.	.06½ - .07	.07½ - .08
Carbon tetrachloride, drums.....lb.	.10½ - .10½	.11 - .12
Carbonyl chloride (phosgene).....lb.	-	.75 - 1.00
Caustic potash (see potassium hydroxide).....lb.	-	-
Caustic soda (see sodium hydroxide).....lb.	-	-
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08 - .09	.09½ - .10
Chloroform.....lb.	-	.42 - .44
Cobalt oxide.....lb.	-	3.00 - 3.10
Copperas (see iron sulphate).....lb.	-	-
Copper carbonate, green precipitate.....lb.	.20 - .21	.22 - .23
Copper cyanide.....lb.	-	.50 - .62
Copper sulphate, crystals.....lb.	.05½ - .06	.06½ - .06½
Cream of tartar (see potassium bitartrate).....lb.	-	-
Epsom salt (see magnesium sulphate).....gal.	-	.85 - 1.00
Ethyl Acetate Com. 85%.....gal.	-	-
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.	-	.50 - .52
Formaldehyde, 40 per cent.....lb.	.13½ - .14	.14½ - .15
Fusel oil, ref.....gal.	-	3.00 - 3.25
Fusel oil, crude.....gal.	-	1.75 - 2.00
Glauber's salt (see sodium sulphate).....lb.	-	.16 - .16½
Glycerine, C. P. drums extra.....lb.	-	3.65 - 3.75
Iodine, resublimed.....lb.	-	.10 - .20
Iron oxide, red.....lb.	-	.10 - .20
Iron sulphate (copperas).....ton	19.00 - 20.00	21.00 - 22.00
Lead acetate.....lb.	-	.11½ - .13½
Lead arsenate, paste.....lb.	.09 - .09½	.10 - .11
Lead nitrate.....lb.	-	.15 - .20
Litharge.....lb.	.08½ - .08½	.08½ - .09
Lithium carbonate.....lb.	-	1.30 - 1.40
Magnesium carbonate, technical.....lb.	.09 - .09½	.10 - .11
Magnesium sulphate, U. S. P.....100 lb.	2.25 - 2.60	1.10 - 2.25
Magnesium sulphate, technical.....100 lb.	-	.75 - .77
Methanol, 95%.....gal.	-	.78 - .82
Methanol, 97%.....gal.	-	.14 - .14½
Nickel salt, double.....lb.	-	.15 - .15½
Nickel salt, single.....lb.	-	-
Phosgene (see carbonyl chloride).....lb.	-	-
Phosphorus, red.....lb.	.45 - .46	.47 - .50
Phosphorus, yellow.....lb.	-	.35 - .37
Potassium bichromate.....lb.	.11½ - .12	.12½ - .12½

		Carlots	Less Carlots
Potassium bitartrate (cream of tartar)	lb.	\$.35 - .40	\$0.30 - \$0.31
Potassium bromide, granular	lb.	.35 - .40	.16 - .25
Potassium carbonate, U. S. P.	lb.	.06 - .06	.06 - .07
Potassium carbonate, 80-85%	lb.	.08 - .10	.10 - .14
Potassium chlorate, crystals	lb.	.05 - .05	.26 - .28
Potassium cyanide	lb.	.05 - .05	.05 - .08
Potassium hydroxide (caustic potash)	lb.	49.00 - 50.00	2.75 - 3.00
Potassium muriate, 80% K.C.L.	ton		.10 - .12
Potassium iodide	lb.	.09 - .09	.33 - .34
Potassium nitrate	lb.	.31 - .32	.38 - .40
Potassium permanganate	lb.	.35 - .37	.25 - .26
Potassium prussiate, red	lb.	.24 - .25	1.50 - 1.75
Potassium prussiate, yellow	lb.		
Potassium sulphate (powdered)	per unit		
Rochelle salts (see sodium potas tartrate)			
Salammoniac (see ammonium chloride)			
Sal soda (see sodium carbonate)			
Salt cake	ton		32.00 - 33.00
Silver cyanide	cz.		1.35 - 1.38
Silver nitrate	cz.		.40 - .41
Soda ash, light	100 lb.	2.20 - 2.25	2.30 - 2.75
Soda ash, dense	100 lb.	2.45 - 2.50	2.60 - 2.75
Sodium acetate	lb.	.04 - .04	.05 - .05
Sodium bicarbonate	100 lb.	2.25 - 2.40	2.50 - 2.75
Sodium bichromate	lb.	.08 - .08	.09 - .10
Sodium bisulphate (nitre cake)	ton	5.00 - 5.25	5.50 - 6.50
Sodium bisulphite powdered, U.S.P.	lb.	.05 - .05	.05 - .06
Sodium borate (borax)	lb.	.06 - .06	.07 - .07
Sodium carbonate (sal soda)	100 lb.	1.90 - 2.00	2.10 - 2.40
Sodium chloride	lb.	.07 - .07	.08 - .08
Sodium cyanide	lb.	.22 - .24	.25 - .30
Sodium fluoride	lb.	.11 - .12	.12 - .13
Sodium hydroxide (caustic soda)	100 lb.	4.15 - 4.25	4.30 - 4.80
Sodium hyposulphite	lb.		.03 - .03
Sodium nitrate	100 lb.	2.90 -	3.00 -
Sodium nitrite	lb.	.07 - .07	.08 - .10
Sodium peroxide, powdered	lb.	.25 - .26	.27 - .30
Sodium phosphate, dibasic	lb.	.04 - .04	.05 - .05
Sodium potassium tartrate (Rochelle salts)	lb.		.26 - .27
Sodium prussiate, yellow	lb.	.12 - .12	.13 - .14
Sodium silicate, solution (40 deg.)	lb.	1.25 - 1.35	1.40 - 1.50
Sodium silicate, solution (60 deg.)	lb.	.02 - .03	.03 - .03
Sodium sulphate, crystals (Glauber's salt)	100 lbs.	1.50 - 1.75	2.00 - 2.25
Sodium sulphide, fused, 60-62 per cent (conc.)	lb.	.05 - .05	.06 - .06
Sodium sulphite, crystals	lb.	.03 - .04	.04 - .04
Strontium nitrate, powdered	lb.	.15 - .15	.16 - .17
Sulphur chloride, red	lb.	.07 - .07	.07 - .08
Sulphur, crude	ton	20.00 - 22.00	
Sulphur dioxide, liquid, cylinders extra	lb.	.08 - .08	.09 - .10
Sulphur (sublimed), flour	100 lb.		2.25 - 3.10
Sulphur, roll (brimstone)	100 lb.		2.00 - 2.75
Tin bichloride, 50 per cent	lb.	.18 - .19	
Tin oxide	lb.		.40 - .42
Zinc carbonate, precipitate	lb.	.16 - .18	.19 - .20
Zinc chloride, gran.	lb.	.11 - .11	.11 - .12
Zinc cyanide	lb.	.45 - .49	.50 - .60
Zinc dust	lb.	.12 - .13	.13 - .14
Zinc oxide, XX	lb.	.09 - .09	.09 - .10
Zinc sulphate	100 lb.	2.90 - 3.00	3.25 - 3.75

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude	lb.	\$1.10 - \$1.15
Alpha-naphthol, refined	lb.	1.25 - 1.30
Alpha-naphthylamine	lb.	.35 - .40
Aniline oil, drums extra	lb.	.20 - .27
Aniline salts	lb.	.26 - .29
Anthracene, 80% in drums (100 lb.)	lb.	.75 - 1.00
Benzaldehyde U.S.P.	lb.	1.50 -
Benidine, base	lb.	.85 - 1.00
Benidine sulphate	lb.	.75 - .85
Benzoic acid, U.S.P.	lb.	.60 - .65
Benzoate of soda, U.S.P.	lb.	.65 - .70
Benzene, pure, water-white, in drums (100 gal.)	gal.	.27 - .32
Benzene, 90%, in drums (100 gal.)	gal.	.25 - .28
Benzyl chloride, 95-97%, refined	lb.	.28 - .30
Benzyl chloride, tech.	lb.	.20 - .25
Beta-naphthol benzoate	lb.	3.50 - 4.00
Beta-naphthol, sublimed	lb.	.70 - .75
Beta-naphthol, tech.	lb.	.38 - .40
Beta-naphthylamine, sublimed	lb.	1.75 - 1.80
Cresol, U. S. P., in drums (100 lb.)	lb.	.16 - .18
Ortho-cresol, in drums (100 lb.)	lb.	.25 - .27
Cresylic acid, 97-99%, straw color, in drums	gal.	.70 - .80
Cresylic acid, 95-97%, dark, in drums	gal.	.65 - .70
Cresylic acid, 50%, first quality, drums	gal.	.45 - .50
Dichlorobenzene	lb.	.06 - .09
Diethylaniline	lb.	1.20 - 1.25
Dimethylaniline	lb.	.41 - .50
Dinitrobenzene	lb.	.26 - .28
Dinitrochlorobenzene	lb.	.20 - .30
Dinitronaphthalene	lb.	.30 - .40
Dinitrophenol	lb.	.35 - .40
Dinitrotoluene	lb.	.27 - .30
Dip oil, 25%, car lots, in drums	gal.	.40 - .45
Diphenylamine	lb.	.60 - .65
H-acid	lb.	1.20 - 1.30
Meta-phenylenediamine	lb.	1.15 - 1.20
Monochlorobenzene	lb.	.12 - .14
Monoethylaniline	lb.	1.75 - 1.85
Naphthalene crushed, in bbls.	lb.	.07 - .08
Naphthalene, flake	lb.	.07 - .08
Naphthalene, balls	lb.	.08 - .09
Naphthionic acid, crude	lb.	.70 - .75
Nitrobenzene	lb.	.12 - .15
Nitronaphthalene	lb.	.30 - .35
Nitro-toluene	lb.	.16 - .18
Ortho-amidophenol	lb.	3.10 - 3.20
Ortho-dichlor-benzene	lb.	.15 - .20
Ortho-nitro-phenol	lb.	.80 - .85
Ortho-nitro-toluene	lb.	.15 - .20
Ortho-toluidine	lb.	.20 - .25
Para-amidophenol, base	lb.	1.50 - 1.60
Para-amidophenol, I Cl.	lb.	1.75 - 1.80

Para-dichlorobenzene	lb.	.15 - .20
Paranitroaniline	lb.	.85 - 1.00
Para-nitrotoluene	lb.	.85 - .95
Para-phenylenediamine	lb.	1.80 - 2.00
Para-toluidine	lb.	1.25 - 1.40
Phthalic anhydride	lb.	.50 - .60
Phenol, U. S. P., drums	lb.	.11 - .13
Pyridine	gal.	2.00 - 3.50
Resorcinol, technical	lb.	1.75 - 1.85
Resorcinol, pure	lb.	2.25 - 2.30
Salicylic acid, tech., in bbls.	lb.	.19 - .22
Salicylic acid, U. S. P.	lb.	.20 - .25
Salol	lb.	.80 - .85
Solvent naphtha, water-white, in drums, 100 gal.	gal.	.25 - .28
Solvent naphtha, crude, heavy, in drums, 100 gal.	gal.	.14 - .16
Sulphanilic acid, crude	lb.	.30 - .35
Tolidine	lb.	.25 - .35
Toluidine, mixed	lb.	.40 - .45
Toluene, in tank cars	gal.	.25 - .28
Toluene, in drums	gal.	.28 - .31
Xylidines, drums, 100 gal.	lb.	.40 - .45
Xylene, pure, in drums	gal.	.40 - .45
Xylene, pure, in tank cars	gal.	.45 - .45
Xylene, commercial, in drums, 100 gal.	gal.	.33 - .35
Xylene, commercial, in tank cars	gal.	.30 - .35

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark	lb.	\$0.23 - \$0.25
Beeswax, refined, light	lb.	.25 - .27
Beeswax, white pure	lb.	.42 - .45
Carnauba, Florida	lb.	.58 - .60
Carnauba, No. 2, North Country	lb.	.25 - .26
Carnauba, No. 3, North Country	lb.	.16 - .17
Japan	lb.	.17 - .17
Montan, crude	lb.	.06 - .06
Paraffine waxes, crude match wax (white) 105-110 m.p.	lb.	.03 - .03
Paraffine waxes, crude, scale 124-126 m.p.	lb.	.02 - .02
Paraffine waxes, refined, 118-120 m.p.	lb.	.03 - .03
Paraffine waxes, refined, 125 m.p.	lb.	.04 - .04
Paraffine waxes, refined, 128-130 m.p.	lb.	.04 - .05
Paraffine waxes, refined, 133-135 m.p.	lb.	.05 - .05
Paraffine waxes, refined, 135-137 m.p.	lb.	.05 - .06
Stearic acid, single pressed	lb.	.09 - .09
Stearic acid, double pressed	lb.	.09 - .09
Stearic acid, triple pressed	lb.	.10 - .10

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl.	280 lb.	\$5.20 -
Rosin E-I	280 lb.	5.80 - 6.00
Rosin K-N	280 lb.	6.50 - 6.70
Rosin W. G.-W. W.	280 lb.	6.80 -
Wood rosin, bbl.	280 lb.	6.25 -
Spirits of turpentine	gal.	.62 -
Wood turpentine steam dist.	gal.	.60 -
Wood turpentine, dest. dist.	gal.	.58 -
Pine tar pitch, bbl.	200 lb.	6.75 -
Tar, kiln burned, bbl. (500 lb.)	bbl.	11.50 -
Retort tar, bbl.	500 lb.	11.50 -
Rosin oil, first run	gal.	.36 -
Rosin oil, second run	gal.	.38 -
Rosin oil, third run	gal.	.43 -
Pine oil, steam dist., sp.gr. 0.930-0.940	gal.	1.80 -
Pine oil, pure, dest. dist.	gal.	1.50 -
Pine tar oil, ref., sp.gr. 1.025-1.035	gal.	.46 -
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla.	gal.	.35 -
Pine tar oil, double ref., sp.gr. 0.965-0.990	gal.	.75 -
Pine tar, ref., thin, sp.gr. 1.080-1.960	gal.	.35 -
Turpentine, crude, sp. gr. 0.900-0.970	gal.	1.20 -
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990	gal.	.35 -
Pinewood creosote, ref.	gal.	.52 -

Solvents

73-76 deg., steel bbls. (85 lb.)	gal.	\$0.41 -
70-72 deg., steel bbls. (85 lb.)	gal.	.39 -
68-70 deg., steel bbls. (85 lb.)	gal.	.33 -
V. M. and P. naphtha, steel bbls. (85 lb.)	gal.	.30 -

Crude Rubber

Para-Upriver fine	lb.	\$0.16 - .17
Upriver coarse	lb.	.09 - .09
Upriver cauchoo ball	lb.	.11 - .12
Plantation—First latex crepe	lb.	.14 - .14
Ribbed smoked sheets	lb.	.12 - .12
Brown crepe, thin, clean	lb.	.15 - .15
Amber crepe No. 1	lb.	.17 - .17

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls.	lb.	\$0.08 - \$0.09
Castor oil, AA, in bbls.	lb.	.10 - .10
China wood oil, in bbls. (f.o.b. Pac. coast)	lb.	.13 - .13
Cocoonut oil, Ceylon grade, in bbls.	lb.	.10 - .10
Cocoonut oil, Cochinchina grade, in bbls.	lb.	.11 - .11
Corn oil, crude, in bbls.	lb.	.07 - .07
Cottonseed oil, crude (f. o. b. mill)	lb.	.05 - .05
Cottonseed oil, summer yellow	lb.	.07 - .08
Cottonseed oil, winter yellow	lb.	.08 - .08
Linseed oil, raw, car lots (domestic)	gal.	.76 - .76
Linseed oil, raw, tank cars (domestic)	gal.	.70 - .70
Linseed oil, in 5-bbl lots (domestic)	gal.	.79 - .79

Olive oil, Denatured.....	gal	\$1.40	—	\$1.60
Palm, Lagos.....	lb.	.06	—	.07
Palm, Niger.....	lb.	.05 ¹ / ₂	—	.05 ¹ / ₂
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.05 ¹ / ₂	—	.06
Peanut oil, refined, in bbls.....	lb.	.10	—	.10 ¹ / ₂
Rapeseed oil, refined in bbls.....	gal.	.88	—	.90
Rapeseed oil, blown, in bbls.....	gal.	.94	—	.95
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07 ³ / ₄	—	.....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.05 ³ / ₄	—	.....

FISH

Light pressed menhaden.....	gal.	\$0.40	—	\$0.41
Yellow bleached menhaden.....	gal.	.42	—	.....
White bleached menhaden.....	gal.	.44	—	.....
Blown menhaden.....	gal.	.80	—	.....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	15.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	.....
Blanc fixe, dry.....	lb.	.05	—	.05 ¹ / ₂
Blanc fixe, pulp.....	net ton	50.00	—	60.00
Casein.....	lb.	.09	—	.12
Chalk, domestic, extra light.....	lb.	.05	—	.05 ¹ / ₂
Chalk, domestic, light.....	lb.	.04 ¹ / ₂	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04 ¹ / ₂	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	30.00
China clay (kaolin), imported, lump.....	net ton	15.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	20.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	.....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07 ¹ / ₂	—	.08
Graphite, Ceylon chip.....	lb.	.06	—	.06 ¹ / ₂
Graphite, high grade amorphous crude.....	lb.	.02 ¹ / ₂	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05 ¹ / ₂
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	.....	—	10.00
Quartz (acid tower) 1 ¹ / ₂ @ 2 in., f.o.b. Baltimore.....	net ton	.....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	.....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.70	—	.....
Shellac, orange superfine.....	lb.	.73	—	.74
Shellac, A. C. garnet.....	lb.	.54	—	.55
Shellac, T. N.....	lb.	.69	—	.70
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	35.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$35.00—50.00	
Carborundum refractory brick, 9-in. { less than carlot	1,000	1250.00	
..... { carlot lots	1,000	1100.00	
Chrome brick, f.o.b. Eastern shipping points.....	net ton	75—90	
Chrome cement, 40—45% Cr ₂ O ₃	net ton	45—50	
Chrome cement, 40—45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	.....	55
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	40—50	
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	40—50	
Magnesite brick, 9-in. straight.....	net ton	90	
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	100	
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	110	
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	45—55	
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	45—55	
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	45—55	

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00 — \$225.00	
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.14 —	.....
Ferrochrome per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.15 —	.....
Ferromanganese, 76-80% Mn, domestic.....	gross ton	75.00 —	81.00
Ferromanganese, 76-80% Mn, English.....	gross ton	75.00 —	81.00
Spiegeleisen, 18-22% Mn.....	gross ton	30.00 —	32.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50 —	.....
Ferrosilicon, 10-15%.....	gross ton	42.00 —	45.00
Ferrosilicon, 50%.....	gross ton	70.00 —	75.00
Ferrosilicon, 75%.....	gross ton	140.00 —	145.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45 —	.50
Ferroumium, 35-50% of U, per lb. of U content.....	lb.	6.00 —	.....
Ferrovanadium, 30-40% per lb. of contained V.....	lb.	5.00 —	6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$8.00 — \$10.00	
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.40 — .45	
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.40 — .45	
Coke, foundry, f.o.b. ovens.....	net ton	4.00 — 4.50	
Coke, furnace, f.o.b. ovens.....	net ton	3.00 — 3.25	
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00 — 16.00	
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	12.50 —	.....
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	18.00 — 20.00	
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 ¹ / ₂ —	.01 ¹ / ₂
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.25 —	.....
Manganese ore, chemical (MnO ₂).....	gross ton	55.00 — 60.00	
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55 —	.60
Monazite, per unit of ThO ₂ , c.i.f., Atlantic seaport.....	unit	30.00 —	.....
Pyrites, Spanish, fines, c.i.f., Atlantic seaport.....	unit	.14 —	.14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.14 —	.14
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12 —	.13
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15 —	.....
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75 — 3.00	
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00 — 3.25	
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50 — 2.50	
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25 — 2.50	
Vanadium pentoxide, 99%.....	lb.	12.00 — 14.00	
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.50 —	.....
Zircon, washed, iron free.....	lb.	.03 —	.....

Non-Ferrous Metals

New York Markets

Copper, electrolytic.....		12.85—13.00	
Aluminum, 98 to 99 per cent.....		28.00@28.5	
Antimony, wholesale lots, Chinese and Japanese.....		5 ¹ / ₂	
Nickel, ordinary (ingot).....		41.00	
Nickel, electrolytic.....		44.00	
Monel metal, spot and blocks.....		35.00	
Monel metal ingots.....		38.00	
Monel metal, sheet bars.....		40.00	
Tin, 5-ton lots, Straits.....		30.00	
Lead, New York, spot.....		4.35—4.40	
Lead, E. St. Louis, spot.....		4.20	
Zinc, spot, New York.....		4.80	
Zinc, spot, E. St. Louis.....		4.40—4.45	

OTHER METALS

Silver (commercial).....	oz.	\$0.58 ¹ / ₂	
Cadmium.....	lb.	1.00—1.25	
Bismuth (500 lb. lots).....	lb.	1.50@1.55	
Cobalt.....	lb.	4.00	
Magnesium (f.o.b. Philadelphia).....	lb.	1.25	
Platinum.....	oz.	75.00	
Iridium.....	oz.	180.00@200.00	
Palladium.....	oz.	70.00	
Mercury.....	75 lb.	46.00—47.00	

FINISHED METAL PRODUCTS

		Warehouse Price	
		Cents per Lb.	
Copper sheets, hot rolled.....		21.25—21.50	
Copper bottoms.....		28.75—29.00	
Copper rods.....		20.00	
High brass wire.....		17.25	
High brass rods.....		14.25	
Low brass wire.....		18.75	
Low brass rods.....		18.75	
Brazed brass tubing.....		27.50	
Brazed bronze tubing.....		32.25	
Seamless copper tubing.....		22.00	
Seamless high brass tubing.....		20.00	

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.25@9.50	9.25	9.50
Copper, heavy and wire.....	8.25@8.50	8.50	8.50
Copper, light and bottoms.....	7.25@7.75	7.50	7.25
Lead, heavy.....	3.25@3.50	3.25	3.25
Lead, tea.....	2.25@2.35	2.25	2.25
Brass, heavy.....	4.25@4.50	4.50	5.00
Brass, light.....	3.25@3.50	3.25	3.50
No. 1 yellow brass turnings.....	4.25@4.50	4.25	4.50
Zinc.....	2.00@2.50	2.00	2.25

Structural Material

The following base prices per 100 lb. steel or structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.60	\$3.23	\$3.23
8 ft steel bars.....	2.50	3.00	3.13
Soft steel bar shapes.....	2.50	3.13	3.13
Soft steel bands.....	2.85	3.83	3.78
Plates, 1/2 to 1 in. thick.....	2.50	3.30	3.23

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

Construction and Operation

Alabama

MOBILE—The Mobile Paint Mfg. Co., 62 South Commerce St., recently organized with a capital of \$50,000, has acquired a 3-story building and will equip the structure for the manufacture of paints, colors, etc. It is proposed to develop an output of 2,000 gal. of material per day. W. A. Benson is manager.

BIRMINGHAM—The Atlas Machine & Foundry Co. has plans under way for the erection of a 1-story addition, 65 x 100 ft., estimated to cost about \$10,000.

Arkansas

HOT SPRINGS—The Silver King Mining Co., 306 Citizens' National Bank Bldg., is planning for the installation of a new mining plant at its silver properties at Silver, Ark., totaling in excess of 1,000 acres. The machinery is estimated to cost about \$200,000. It is planned to develop a large production. J. W. Kelly is president.

EL DORADO—The Arkansas Royalty Co., recently organized with a capital of \$100,000, has preliminary plans under way for the erection of a new oil refinery on a local site. Lee Miles is president; E. E. King is secretary and treasurer.

California

SANTA CLARA—The Homer-Knowles Pottery Co., has broken ground for the construction of its proposed new local plant, estimated to cost in excess of \$100,000 with equipment.

SAN MATEO—The proposed new plant to be erected here by the Illinois-Pacific Glass Co., Fifteenth and Folsom Sts., San Francisco, is estimated to cost close to \$1,000,000, including machinery. The city, through the Chamber of Commerce, has been asked to donate a site. The initial plant will give employment to about 600 operatives.

LOS ANGELES—The Union Oil Co. has taken bids for the erection of a new laboratory building in the Wilmington district. It will be constructed in conjunction with a new administration building, estimated to cost about \$300,000.

Colorado

DENVER—The Producers' & Refiners' Corp. has disposed of a bond issue of \$3,000,000, and a portion of the proceeds will be used for plant extensions and improvements. A new skimming plant will be constructed in the vicinity of Casper, Wyo., estimated to cost about \$400,000, including a new pipeline from the company wells in the Salt Lake field to this location. F. E. Kistler is president.

Connecticut

MERIDEN—The C. E. Schunack Co., manufacturer of paper boxes and containers, has awarded a contract to the H. Wales Lines Co., Holyoke, Mass., for the erection of a 2-story addition, 42 x 46 ft., with 1-story extension, 14 x 42 ft. Ground will be broken at once.

Florida

STUART—Walter J. Lloyd and associates are organizing a company with capital of \$300,000 for the establishment of a local tannery and fertilizer manufacturing plant, handling shark, porpoise skins, etc. A building has been acquired, heretofore used as an ice-manufacturing plant, and machinery will be installed at an early date. J. B. Sisco is in charge of plant improvements and equipment.

TAMPA—The Southern Bottle Mfg. Co., 402 Curry Bldg., recently organized with a capital of \$150,000, has awarded a contract to Oatley & Jones, Tampa, for the erection of a new local plant for the manufacture of glass bottles, jars, etc. It will be 1-story, 60 x 150 ft., with wing extension, 40 x 102 ft. The machinery installation will cost about \$25,000, including

a 6 to 8 ring furnace. J. F. Jones is president; and R. L. Rundell, secretary and treasurer.

Kentucky

ASHLAND—The East Kentucky Oil Association is considering the erection of a new oil refinery on a local site.

Louisiana

NEW IBERIA—The Charles Boldt Paper Mills Co., Cincinnati, O., is completing the erection of its new local mill, representing an investment of close to \$1,000,000, and will soon begin production for the manufacture of paper board products.

Maryland

FREDERICK—The O. J. Keller Lime Co. has awarded a contract to the McClintic-Marshall Co., Pittsburgh, Pa., for the construction of its proposed new lime manufacturing plant. Richard K. Meade, 13 East Fayette St., Baltimore, is engineer.

BALTIMORE—The American Sugar Refining Co., 117 Wall St., New York, N. Y., has filed plans for the erection of a new brick and steel filter plant at Woodall and Clement Sts., 80 x 203 ft., for its new local sugar refinery. Stone & Webster, Inc., 120 B'way, New York, is contractor.

BALTIMORE—The Baltimore Copper-smith Co., 1914 Aliceanna St., manufacturer of copper and brass specialties, is planning for enlargements in its plant. Gustav Larsen is president.

Massachusetts

HOLYOKE—The Whiting Paper Co. has awarded a contract to the Casper Ranger Construction Co. for the erection of an addition to the machine department at its No. 2 Mill, to cost about \$14,000.

CAMBRIDGE—The George Lawrence Co., Lansdowne and Green Sts., has filed plans for the erection of a new 1-story, brick and concrete plant for the manufacture of steel springs for automobile service, estimated to cost about \$30,000. George M. Davis & Sons, Cambridge, have the building contract.

INDIAN ORCHARD—The Chapman Valve Mfg. Co., Pine St., manufacturer of heavy-duty gate and other type valves, has broken ground for the construction of its new 1-story foundry, 50 x 275 ft., with two wings, each 20 x 28 ft., to be equipped for the production of iron castings.

WESTFIELD—The Strathmore Paper Co., Mittineague, Mass., is reported to be negotiating for the purchase of the paper mill of the Crane Paper Co., Westfield, with consideration involving about \$500,000. Upon acquisition the mill will be used by the new owner as a branch plant.

Michigan

DETROIT—The Fraser Paint & Varnish Co. is said to be planning for the rebuilding of its plant destroyed by fire May 24, with loss estimated at about \$100,000, including equipment.

Missouri

KNOB NOSTER—The Johnson County Brick Co., recently organized with a capital of \$125,000, has commenced the rebuilding of its local brick manufacturing plant. New kilns, both of up-draft and down-draft type, will be constructed with aggregate capacity of about 500,000 bricks. The daily output at the plant will average 40,000 finished bricks. At a later date machinery will be installed for the manufacture of hollow tile products. S. C. Garrett, Warrensburg, Mo., is secretary and manager.

New Jersey

NEWARK—The United Butchers' Fat Rendering Co., Jersey City, N. J., recently organized with a capital of \$150,000, has acquired property on Doremus Ave., Newark, adjoining the chemical works of the Butterworth-Judson Corp., and heretofore held by that company. The site will be used for the erection of a new plant for the manufacture of fertilizer, tallow, glue and kindred products, utilizing the fat, hides, etc., of cattle. Plans for the new plant will be placed under way at an early

date, and machinery acquired. Robert H. Bayerl, 302 Jackson Ave., Jersey City, is president.

NEWARK—E. I. du Pont de Nemours & Co. have filed plans for the erection of additions to their chemical works on Vanderpool St. to cost about \$29,000, including alterations and improvements in laboratory and other buildings.

New York

NEW YORK—The Sinclair & Valentine Co., 611 West 129th St., manufacturer of lithographing inks, etc., has awarded a contract to the Vought Construction Co., 133 East 44th St., for the erection of a new 3-story plant addition, 73x125 ft., on 129th St. near B'way.

BUFFALO—The Niagara Gas Corp., recently organized to take over the artificial gas works of William J. Judge, has made application to the Public Service Commission for permission to build a new gas plant to be used for service at Buffalo and at Cheektowaga.

GLENS FALLS—The International Paper Co., 38 Broad St., New York City, has broken ground for the erection of its proposed new hydro-electric power plant on Sherman Island, near Glens Falls, to cost in excess of \$1,500,000. It will be used for paper mill service in this section.

Ohio

CLEVELAND—The Sterling Brass Co., 4610 St. Clair Ave., has completed plans and will take bids at once for the erection of a new 2-story brass foundry and machine shop, 145x200 ft., at St. Catherine and 93d Sts., to cost about \$100,000 with equipment. Allen Sogg, Hippodrome Bldg., is architect and engineer. S. L. Will is head.

CANTON—The Canton Brick & Fireproofing Co., recently organized with a capital of \$1,500,000 to take over a number of brick and kindred plants, will soon break ground for the erection of a new brick and tile plant at Midvale, O. A branch line has been constructed from the Baltimore & Ohio R.R. to the site. Dr. W. A. Demuth, New Philadelphia, O., is president.

Pennsylvania

PHILADELPHIA—The Philadelphia Paper Mfg. Co., River Road, Manayunk, has filed plans for the erection of a new 2-story, reinforced-concrete building at its plant, 100x180 ft., to cost about \$200,000.

PALMERTON—The New Jersey Zinc Co. is increasing production at its local works and has reinstated about 100 operatives after a number of weeks of idleness. A reduced wage scale has been placed into effect.

JEANNETTE—George R. West, recently resigned as president of the Westmoreland Specialty Co., Grapeville, Pa., has organized a new company to be known as George R. West & Sons, to operate a local glass-manufacturing plant. An existing building has been secured and machinery will be installed for the production of fine glassware products. Charles H. and George L. West are also members of the new organization.

ALLENTOWN—The Allentown Copperas Co., a subsidiary of C. K. Williams & Co., Easton, Pa., manufacturer of mineral colors, paints, etc., is planning for the rebuilding of the portion of its plant destroyed by fire June 9, with loss estimated at about \$35,000. Robert Miller is local manager.

Tennessee

KNOXVILLE—The Knoxville Fertilizer Co., recently organized, is planning for the establishment of a new local plant for the manufacture of acid phosphate and kindred products. The initial plant is estimated to cost about \$150,000. Hanson L. Dulin is president and James W. Dean secretary and treasurer.

NASHVILLE—The Victoria Oil & Refining Co. is said to be planning for the immediate rebuilding of its distilling plant recently damaged by fire, with loss of about \$25,000.

Texas

SWEETWATER—The United States Gypsum Co., 205 West Monroe St., Chicago, Ill., is perfecting plans for the erection of its proposed new plant at Sweetwater, estimated to cost close to \$1,000,000 with machinery.

Virginia

NORFOLK—The F. S. Royster Guano Co. has arranged for a bond issue of \$2,500,000, the proceeds to be used for operations, proposed extensions, financing, etc. The company specializes in the manufacture of chemical fertilizers and affiliated products. F. S. Royster is president.

BRISTOL—The Iron City Stove & Foundry Co., recently reorganized with a capital of \$10,000, is planning for extensions in its foundry and other plant departments to include the installation of new machinery. E. H. Wilkinson is president.

West Virginia

CLARKSBURG—The Eagle Convex Glass Specialty Co., Box 525, recently organized with a capital of \$50,000, has acquired a local building and will install machinery for the manufacture of convex glass products, including clock faces, portrait glass, etc.; considerable beveling equipment will be installed. F. Aucremanne is president and manager.

New Companies

THE AMERICAN METALLURGICAL CORPORATION, of Boston, Mass., has been incorporated with a capital stock of \$50,000, to engage in the metallurgical business. Officers are: Harry O. Breaker, of Winthrop Center, Mass., president; Kristian A. Juthe, of Newton Center, Mass., treasurer; and John R. Hanmer, 201 Devonshire St., Boston.

THE VAYCIDE CHEMICAL CORP., Birmingham, Ala., has been incorporated with a capital of \$60,000 to manufacture chemicals and chemical byproducts. George B. McVay, Jr., Birmingham, is president and treasurer; M. D. McVay is secretary.

THE CONSOLIDATED SILVER MOUNTAIN MINES CO., Spokane, Wash., has been incorporated with a capital of \$150,000 to operate silver mines and refining works. The incorporators are W. E. Seelye, Charles Tanner and H. A. Manchester. The company is represented by McCarthy, Edge & Lantz, Paulsen Bldg., Spokane.

THE LOS ANGELES-BROWNWOOD OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$250,000 to manufacture petroleum products. The incorporators are C. C. Loomis, F. R. Miner and S. S. McKinney. Lloyd Wright, 208 Currier Bldg., represents the company.

THE CORTLAND GRINDING WHEELS CORP., Chester, Mass., has been incorporated with a capital of 8,000 shares of stock, no par value, to manufacture abrasive materials. Charles J. Ayer, Plymouth, Mass., is treasurer; Ralph S. Spooner and E. Bertram Pike, Chester, are directors.

THE STETSON CHINA CO., Room 1535, 1537 South State St., Chicago, Ill., has been incorporated with a capital of \$100,000 to manufacture crockery and earthenware. The incorporators are Lewis B. and Joseph Stetson.

THE D. L. & D. CORRUGATED PAPER PRODUCTS CO., New York City, has been incorporated with a capital of \$75,000 to manufacture corrugated paper specialties. The incorporators are J. and A. Wolf, and M. R. Schner, 7 Dey St.

THE IMPERIAL LEATHER CO., INC., Lynn, Mass., has been incorporated with a capital of \$10,000 to manufacture leather products. F. A. Fleith is president, and Augustus S. Crovo, 93 Crest Ave., Beachmont, treasurer.

THE GREEN BAY TURPENTINE CO., Bushnell, Fla., has been incorporated with a capital of \$16,000 to manufacture turpentine and affiliated products. J. F. Lambert is president, and J. H. McKnight, Bushnell, secretary and treasurer.

THE DRAYTON TUNNEL KILN CO., Brazil, Ind., has been incorporated under Delaware laws with capital of \$300,000 to manufacture tunnel kilns for ceramic and other kindred service. The incorporators are William Drayton, Walter J. Kissler, Brazil; and E. Edward Dean, Indianapolis, Ind.

THE U-RUB-IT CHEMICAL CO., Philadelphia, Pa., has been incorporated with a capital of \$100,000 to manufacture chemicals and chemical byproducts. The incorporators are William T. Conwell, W. L. Henderson and William F. Vogel, Philadelphia. Thomas Conwell, Lewes, Del., represents the company.

THE GRAND CHEMICAL PRODUCTS CO., Grandville and Grand Rapids, Mich., has been incorporated with a capital of \$30,000 to manufacture chemicals and chemical byproducts. The incorporators are R. A. Caldwell, Grandville; Claude M. Connor and Stanley L. Barnett, Grand Rapids.

THE SUBURBAN OIL CO., Pasadena, Cal., has been incorporated with a capital of \$75,000 to manufacture petroleum products. The incorporators are J. C. Cook, William W. and K. D. Butterfield. The company is represented by Ticknor, Carter & Webster, Pasadena.

THE HERCULES EXPLOSIVES CORP., New York City, has been incorporated with a capital of \$4,000,000 to manufacture powder, dynamite, explosives, etc. The in-

corporators are R. H. Dunham, T. W. Bacchus and W. M. Annette. The company is represented by White & Case, 14 Wall St.

THE RICH SQUARE BRICK CO., Rich Square, Tex., has been incorporated with a capital of \$400,000 to manufacture bricks and other burned clay products. J. R. Connell, Rich Square, is president.

THE KANGAROO POLISH CO., Newton, Mass., has been incorporated with a capital of \$50,000 to manufacture polishes and kindred specialties. Robert G. Shaw 2nd, Newton Square, Mass., is president and treasurer; Albert N. Lyon and Warwick Henderson are directors.

THE MURDO OIL CO., Park and Division Sts., DuQuoin, Ill., has been incorporated with a capital of \$50,000 to manufacture refined oil products. David B. Levy, Murphysboro, Ill., is the principal incorporator.

THE GUARANTEE PRESTO-WATER CHEMICAL CO., Nashville, Tenn., has been incorporated with a capital of \$50,000 to manufacture chemicals and chemical byproducts. The incorporators are John H. Grant and Walter H. Moppin, Nashville.

THE VARSITY GLASS PRODUCTS CO., Pasaic, N. J., has been incorporated with a capital of \$35,000 to manufacture glass specialties. The incorporators are Henry J. Fixsen, Henry S. Hubschmitt and Frank M. Griswold. James H. Penn, 816 Main Ave., represents the company.

THE HUNTINGTON SUPERIOR OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$200,000, to manufacture petroleum products. The incorporators are W. J. Little, Allen Janes and A. P. G. Steffes. The company is represented by Randall, Bartlett & White, 605 California Bldg., Los Angeles.

THE STANDARD FERTILIZER CO., Centerville, Tenn., has been incorporated with a capital of \$480,000 to manufacture fertilizer products. A. H. Grigsby is president, H. H. Campbell vice-president and C. A. Betts secretary and treasurer, all of Centerville.

THE RECTOR OIL & REFINING CO., Rector, Ark., has been incorporated with a capital of \$75,000, to manufacture refined oil products. The incorporators are C. W. Weideman and W. H. Simmons, Rector.

THE CONSOLIDATED LEATHER CO., 468 Frelinghuysen Ave., Newark, N. J., has filed notice of organization to manufacture leather products. The company is headed by Philip Frank, 270 West End Ave., and Henry Frank, 970 Park Ave., both of New York City.

THE NEW JERSEY CRAYON CO., INC., Paterson, N. J., has been incorporated with a capital of \$10,000 to manufacture wax crayons, chalk, etc. The incorporators are Arthur V. V. Livingston and J. M. Camagni, 21 Bridge St., Paterson.

THE MARDEN-WILD CORP., Boston, Mass., has been incorporated with a capital of \$50,000 to manufacture oils, dyestuffs and kindred products. Frank W. Marden is president, and Prescott F. Wild, Winchester, Mass., treasurer.

THE GENERAL REFRACTORIES CO., Philadelphia, Pa., has been incorporated with a nominal capital of \$5,000 to manufacture firebrick, furnace linings and other refractory products. The incorporators are John R. Sproul, Chester, Pa., son of Gov. Sproul; Burrows Sloan, Ardmore, Pa.; and James H. France, Philadelphia.

THE NEW ENGLAND-TEXAS OIL & REFINING SYNDICATE, INC., Springfield, Mass., has been incorporated with a capital of \$1,000,000 to manufacture refined oil products. Charles N. Hawkes is president; and Frederick L. Haskins, Springfield, treasurer.

THE WESTERN PIPE & STEEL CO. OF ILLINOIS, INC., Room 7, 154 West Randolph St., Chicago, Ill., has been incorporated with a capital of \$100,000 to manufacture steel products. The incorporators are Frederick T. Hoyt, John R. Lenfesty and Reuben W. Newton.

THE TAFT CENTRAL OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$250,000 to manufacture petroleum products. The incorporators are E. L. Mason, A. Richardson, Los Angeles; and C. C. Montgomery, 811 Washington Bldg., Pasadena, Cal.

GEORGE MANN & CO., INC., Providence, R. I., has been incorporated with a capital of 250 shares of stock, no par value, to manufacture chemicals and chemical byproducts. The incorporators are George Mann and George F. Waters, Fall River, Mass.; and Edward G. Fletcher, Providence.

THE NEWPORT MFG. CO., 2555 North Crawford Ave., Chicago, Ill., has been incorporated with a capital of \$5,100 to manufacture chemical specialties. The incorporators are Aaron T. Rubin and Edward M. Seymour.

THE AMERICAN KAOLIN CO., Vincennes, Ind., has been incorporated with a capital of \$250,000 to operate clay and kaolin properties. The incorporators are P. L. Donie, J. A. Kapps and W. T. Bessonette, Vincennes.

THE NICHOLSON SUPPLY CORP., Fredericksburg, Va., has been incorporated with a capital of \$30,000 to manufacture mineral and vegetable oil products. The incorporators are C. O'Connor Goolrick, Fredericksburg; and George B. and Arthur D. Nicholson, Pittsburgh, Pa.

THE BRINTEX CHEMICAL CORP., New York City, has been incorporated with a capital of \$10,000 to manufacture chemicals and chemical byproducts. The incorporators are J. L. Diamond, J. L. Carty and P. J. McMahon, 87 Nassau St.

THE ROCKVILLE IRON FOUNDRY CO., Rockville, Conn., has been incorporated with a capital of \$50,000 to manufacture iron and steel, brass and bronze castings. The incorporators are S. and H. C. Murlless, Rockville; and A. L. McCarthy, Hartford, Conn.

Capital Increases, Etc.

THE GEORGIA SOAP CO., Jackson, Ga., has filed notice of increase in capital from \$500,000 to \$1,000,000.

THE CENTRAL GLASS CO., Louisville, Ky., has filed notice of increase in capital from \$1,000,000 to \$1,250,000.

THE AMERICAN LACQUER CO., Stratford, Conn., has filed notice of increase in capital from \$20,000 to \$100,000.

THE HOLMAN SOAP CO., 3104 Fox St., Chicago, Ill., has filed notice of increase in capital from \$150,000 to \$300,000.

THE DATNER OIL & REFINING CO., Detroit, Mich., has filed notice of change of name to the Detroit Oil & Refining Co.

THE DU PONT AMERICAN INDUSTRIES, INC., Wilmington, Del., manufacturer of chemicals, dyes, composition products, compounds, etc., has filed notice of increase in capital from \$50,000,000 to \$75,000,000.

THE BRADLEY-WISE PAINT CO., 650 Santa Fe Ave., Los Angeles, Cal., has filed notice of increase in capital from \$50,000 to \$150,000. H. C. Bradley is secretary.

THE AMERICAN COATING MILLS, INC., Elkhart, Ind., manufacturer of coated paper products, has filed notice of increase in capital from \$1,200,000 to \$1,400,000.

THE STANDARD OIL CO. OF INDIANA, Indianapolis, has increased its capital from \$100,000,000 to \$140,000,000.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY'S summer meeting will be held at Canton, Alliance, Sebring and East Liverpool, Ohio, July 25 to 27. Headquarters will be at the Hotel Courtland, Canton, Ohio.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

AMERICAN INSTITUTE OF CHEMICAL ENGINEERS is holding its spring meeting June 20 to 24 at Detroit. Industrial excursions will be made to Ann Arbor, Saginaw, Midland and Bay City.

AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.

CHEMICAL & METALLURGICAL ENGINEERING

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Assistant Editors
CHESTER H. JONES
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Managing Editor

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Investment Of Work

CONSERVATIVE financial men recognize that these days are opportune for the investment of money in securities or materials, and particularly so in certain classes of industries which are thought to be liquidated. In other words, the person or firm having had foresight enough to conserve surplus cash may now take it into the markets and receive in exchange the commodities needed for the future in greater ratio of commodity to dollar than can possibly exist in times of business prosperity. This investor believes from past experience that depressions and periods of industrial affluence come in cycles and that it is sound thinking to expect good times in the next swing.

No brief is here supported for those salesmen, writers and other amateur optimists who distill elusive, vaporous expressions to create a general opinion that business is good and the depression is over when such obviously is not the case. The true business optimist accepts conditions as they are today and proceeds to invest with a firm faith in the future revival of economic activity and consequent increase in the value of materials purchased for cash or effort during the restricted period. Certainly no one can think that we are entirely gone to the dogs and that happy days will never come again.

These are elementary facts well known to financiers, but too seldom considered by the salaried individual in connection with the investment of his personal effort. Working for a salary is plainly conducting a business of producing a certain economic good which is marketed with the employer. The market varies with business cycles the same as for other commodities. In financial crises, with the buying power of the medium of exchange—dollar, piaster, tical or what not—increasing coincidently with the decrease in the value of goods while the salary remains fixed, the employee is getting a larger return for his efforts. A great majority of technical men enjoy this position now, notwithstanding individual observations to the contrary. It is, then, the day of the salaried man.

If the technical worker is content to accept this good fortune and continue delivering the same amount of work for the increased pay, well and good. He remains with the majority a fair, average individual. He is acceptable as an employee, but scarcely sought after. For as the value of the dollar increases, so personal effort is at a premium. It is difficult even now to find excellent men available for employment. They are too badly needed and too well appreciated in present affiliations to be released. A price must be paid to secure them. They are in demand because they have invested work.

Increased work, work as a vocation and as an avocation, merits and receives just recompense, and in this

world at that. The chap who is a work eater stands forth well toward the spotlight in periods when most men hold a dormant, almost paralyzed attitude toward commercial activity. The market is right for the investment of effort and the wise ones will develop every dyne, not merely to hold the job but rather for the accretion of personal wealth in the final accounting.

Responsibility Holds the Better Man

NOT long ago the president of a concern employing engineers and highly trained salesmen, with main offices in the East, was asked by a friend for the name of his district office manager, and was surprised to learn that there was no manager of the Western territory. Each man in that office reported directly to his particular department head at the home office. The nature of the work was such that there was little in common among the different departments. The men in the district office were of the type that could be relied upon to work with one another on those matters that might call for co-operation among departments. A chief clerk acted in details of stenographic help, supplies, etc., but without authority over the various units. The plan continues to operate successfully.

Examination of the district offices of many highly organized industrial companies reveals the fact that the individual efficiency of the better grade employee is markedly lower than might be supposed. When men worthy of responsibility are made to feel the yoke of servitude, they become reconciled to drawing the pay check and taking it easy. Servants in the Orient can prepare a meal, it is true; but one must draw the water, another carry the wood, another watch the fire, etc. The average efficiency of the total is about 10 per cent.

The other method of organizing intelligent men places the full responsibility for a field upon one man. He is checked by results alone. If he does not come up to the scratch, another replaces him. Very soon the right one is found, and this fellow sticks. He enjoys the weight of the work, the freedom of action unharassed by petty rules, lives his job all the working hours of every day and dreams of it at night.

Admittedly army organization and discipline is fine—for the military establishment where accountability for execution of definite orders accomplishes the result. Technical men are thinkers, and can see that the policy of the concern which hampers freedom of thought and action by such organization is wrong, and if they work for such a company they wilt under the management. They will come to work only for the daily bread.

The president above mentioned has developed a wonderful industrial concern thus based on the highest American business ideals. He employs the best men in his line. He knows that responsibility holds the better man.

Courage a Byproduct Of Research

MANY times these columns have called attention to the manifold advantages to industry of a well-planned and well-executed research program. It requires a serious business depression to show plainly that a business, a corporation or an organized industry which has seriously investigated its technical problems in a scientific manner is also unafraid of the future. That is a point which engineers and executives will do well to mark. Of course it takes a certain amount of commercial foresight, mental courage and common sense to build up an adequate research department and maintain it despite market fluctuations and objections of myopic penny-hounds always present somewhere in the directorate. Such admirable qualities will undoubtedly be a sound foundation for sanity during perilous times, but more than that, the organization will be stout hearted because it *knows*; others can only fear. It knows what its product is, what it will do, where it is best adapted for use, how to make an excellent and uniform product—undoubtedly such a company is getting a lion's share of the orders, and is setting the house in order for a future demand which is just around the corner.

Perhaps these thoughts would find readier acceptance by giving a concrete instance. This can the more readily be done, since it will supply the motive for a brief reminder of the work of the American Malleable Castings Association. In the words of their genial consultant, Prof. TOUCEDA, it happened that when business slackened various members realized that the time was opportune to take up matters that were pending, but which owing to pressure of work they had been unable to take up sooner. It really seems that all got the same idea at the same time, both in connection with research work they desired done and alterations needed at their plants. So despite the fact that the steel industry is operating at 20 per cent capacity, automobile construction is at a low ebb, practically no railway rolling stock is being built and the farmer is too poor to buy harvesters, the malleable iron men who *know* are going ahead with needed improvements and fundamental research.

What would have happened ten years ago? Competition was then of the cut-throat variety, the lowest bidder often executing work for much less than his total cost, had he only known it. The result, most easily seen and most impressive to the owners, was a dwindling surplus, despite a continuously debased plant; the growing use of only the rawest of immigrants and the shipment of any junk which possibly might be accepted on the contract.

Under these circumstances some of the most capable men in the industry came together from time to time for interchange of ideas, and their first move was the employment of an expert to devise a uniform accounting system. This enabled those plants, at least, to avoid ruinous quotations. But deeper down, it was discovered that the reckless disregard of quality had convinced the ordinary consumer that malleable iron was not only lacking in dependability, but the best of it was of very low strength. Everyone was buying steel castings or forgings—if they came out poor it was ascribed to ignorant manufacture; malleable was condemned as being constitutionally unfit.

With such an outlook, the association resolved to

engage competent technical help and give him all available resources to find out what was the matter with American malleable and to show how the defects could be cured. Barring a few notable exceptions, such foundry investigations were unknown; rule of thumb was plenty good enough. Yet to the credit of the association it should be said that it has consistently backed Prof. TOUCEDA in his recommendations, irrespective of cost, and has made no statement of progress unless it had been shown to be backed by incontestable data.

A full statement of the various steps taken during the past eight years which have resulted in a veritable industrial renaissance would deserve many pages, and has been presented to the technical world elsewhere. It may be summarized by saying that whereas the best of the malleable iron then made had a strength of 40,000 lb. per sq.in. with 5 per cent elongation, the average of all test-bars from the association for the year 1920 broke at 52,000 lb. per sq.in. with 13.3 per cent elongation.

This is one way of appraising the advantage of their research to the quality of their product. In the first paragraph it was attempted to show the effect on the stamina of the industry as a whole. Evidently, some kind of organized research gets results, and pays!

Petrified

Wool Fat

THE plea for greater scholarship in chemistry on the one hand and the demand for a more widespread sensing of chemistry on the other have sometimes borne curious fruits. In order to discover the frequent errors in scientific statements made by newspapers we have occasionally intimated that it would be a good thing if the editors of our dailies were to establish communication with someone who could pilot them over the charted seas of science when they want to enlighten their readers. A correspondent from the Massachusetts Institute of Technology sends us a clipping from the *Boston Traveler* of March 10 which indicates that that paper aspires to follow the advice, and yet we fear that, to put it in Irish, their chemist is the kind of a chemist that a chemist isn't. The quotation reads:

"Question: What kind of oil or fat is lanolin?"

"Answer: Lanolin is wool fat or wool grease in a petrified condition."

Prof. CIAMICIAN has referred to coal as the fossil energy of the sun, and we might even indicate lanolin as the hydrogenated juices of the sheep—although this would not be an enlightening or happy description. But the statement that it is "petrified" discourages us in our search for scientific scholarship in the revelation of the *Traveler's* chemist.

In answer to the call for broad, general training for chemists we learned lately of a requirement of a great institution bearing a Frinch name that demands proficiency in the history of Ireland as a requirement for the degree of Chemical Engineer. We might get the idea if the aspirants for the degree were prospective pharmacists hoping to learn how to cure snake-bites, for ST. PATRICK was truly a great pioneer in the prophylaxis of this most distressful evil. Then there was ROBERT BOYLE, who made chemistry the profession of a gentleman, and he was a son of the Earl of Cork. But he lived and wrought in England, while science never has seemed to find much of a welcome in Ireland. Perhaps—and we consider this idea to be no less than an inspiration!—the purpose of the course in Irish

history is to prepare young chemical engineers to succeed in politics. We need more scientific vision in politics, and the Irish seem to have a peculiar gift in the direction of getting into office. It is not altogether clear to us how the study of Irish history develops the art, but if it does, then let all the lads who would be chemical engineers be after studying the history of Ireland so as to make them Congressmen and Sinators.

The Lime Industry Looks to Research

RESEARCH was the keynote of the lime industry's nineteenth annual convention, the third since the organization of the present National Lime Association. Almost without exception the speakers pointed out the value of research in all phases of the association's activities—the determination of fundamental data, improvements in limekiln construction and in the technology of lime burning, the development of new markets and the extension of old ones through the application of data obtained from conscientious scientific studies.

Much of the time-consuming organization work has been completed and the association, representing 124 lime producers, is now able to carry out a definite program of research and educational work through the central office staff and the three technical departments—chemistry, construction and agriculture. The following extract from President CHARLES WARNER'S report is an excellent example of the manner in which the problems are being attacked:

Take, for instance, the problem of developing the best type of quick-hardening lime plaster and mortar. This question is of great importance to the construction field. It has been attempted more or less superficially and spasmodically by many manufacturers as well as in some of the past efforts of your association staff.

Under past efforts the problem has not been suitably solved for the broad welfare of the industry. It has not been until within the fiscal year just closing that we have been able to lay a broad plan for its study, utilizing fellowships at the Bureau of Standards and elsewhere for taking hold of particular phases of the problem with the intention of gradually bringing all these lines together into a broad basic report that will throw the fullest light on the proposition.

To get at this problem there are four major lines of study and research that have to be undertaken, and each of these four major divisions fans out into numerous sub-studies and minor researches:

First—The effect of burning, grinding and hydration in various combinations and in conjunction with other ingredients to locate any refinement in manufacturing processes that may stimulate hardening in the finished product.

Second—The study of any hardening materials which of and by themselves and upon addition to lime will harden the mixed product.

Third—Since carbon dioxide is the ingredient first naturally employed in the normal hardening of plasters and mortars, but, limited by the slow effect and small quantity of this gas found in normal atmosphere, it becomes necessary to determine all materials, such as charcoal, which might absorb carbonic gas in quantity yet hold it so loosely that upon admixture with lime and water a quick release of the carbonic gas would produce rapid carbonization and hardening throughout the mass.

Fourth—It is within the bounds of possibility that we can locate a chemical compound which upon addition in small quantities to lime will immediately establish in the lime an entirely new hardening characteristic and solve our problem in that fashion.

With such a forward-looking spirit of co-operation, we can confidently expect some remarkable developments in the lime industry. The industry and its leaders are to be congratulated.

Steel Production In 1920

WITH the production of steel ingots now running at the rate of about 12,000,000 gross tons a year, and prospects that the rate will drop below 10,000,000 tons in July, the official statistics of production in 1920 appear, showing that in that year 40,881,392 tons of ingots was produced. Even that was not a record production, however, for the honor belongs to 1917, with 43,619,200 tons. The 1917 production did not represent the capacity existing in the year, for while there was a surplus of orders there were physical difficulties in the way of full operation. Capacity has since increased, moreover, so that the 1920 production was decidedly short of the capacity, being hardly as much as 80 per cent. It was a year of difficulties. At the opening, when the iron and steel strike, inaugurated Sept. 22, 1919, was just over, there was some labor shortage and a great deal of labor inefficiency, while there was some shortage of coal and coke, following the outlaw strike in the coal industry. On April 1, when the steel industry had largely recovered from these troubles, the outlaw railroad strikes began, bringing about a shortage in transportation that lasted for months, or until shortage of orders began to affect some of the mills, late in September.

The production of rolled steel in 1920 was 30,970,297 tons, in the form in which steel received its last hot rolling, the total being therefore made up of rods, sheets, skelp, plates, shapes, bars, etc., forging billets and semi-finished steel that was exported. Production of rolled iron was 1,377,566 tons and production of steel castings was 1,251,542 tons.

The year 1920 was fourth best in steel ingot production, but third best in rolled steel, because 1918 was a year of heavy production of shell steel ingots, liberally cropped, and rolled steel did not make its usual percentage showing in relation to ingots. While third best in rolled steel in general, the year made a new record for production of structural shapes, with 3,306,748 tons, and as there was no large tonnage used in freight-car building there was evidently heavier consumption in construction work than would be assumed by those who held that construction work was much restricted in 1920 by high costs. Production of wire nails was only 3 or 4 per cent short of production in the two better years, 1916 and 1917, while wire-rod production was off 11 per cent from the tonnage of 1916, when there was a special demand for rods in connection with defense against submarines and the making of barb wire for land defense. The wire nail production suggests that there was a very fair degree of building activity in progress during 1920.

On the whole, the distribution of steel in the various finished products was not far from normal in 1920. There was no extremely light demand and no extremely heavy demand for any particular product, except in the case of automobile sheets, and the strain there was not in sheet-rolling capacity, but in pickling capacity. It is true the production of rails was only 2,604,116 tons, or 35 per cent less than the record production of 3,977,887 tons, made in 1906, while production of rolled iron and steel as a whole was 65 per cent greater in 1920 than in 1906, but the disappearance of rails as the dominant finished steel product is now an old story. Rails were passed by both wire rods and structural shapes in 1914 and have not come back in any subsequent year.

Presentation of the Gibbs Medal to Mme. Curie

Report of the Meeting of the Chicago Section, American Chemical Society, June 14, 1921,
When the Willard Gibbs Medal Was Presented to
Mme. Marie Sklodowska Curie

THE Chicago Section of the American Chemical Society met Tuesday, June 14, 1921, to present the Willard Gibbs Medal, founded by William A. Converse, to Mme. Marie Sklodowska Curie.

Her presence in America was the best occasion for the American people in general and for the American scientists in particular to show their appreciation of the great work she has accomplished and is still doing in the chemistry of radioactivity. The presentation of one gram of radium by the President of the United States, a gift of the women of America, the honorary degrees bestowed by leading American universities, the presentation of the Gibbs Medal and the hearty welcome she met everywhere are a few of the means at our disposal to express our esteem and appreciation for the greatest of woman scientists.

Marie Sklodowska, the granddaughter of Polish peasants and daughter of a professor of physics and chemistry, was born in Warsaw in 1867. After finishing the schools in her native city she spent a few years there as a private tutor and then went to Paris, where after three years she obtained the degree of bachelor of science in mathematics and physics. She then continued to work in the laboratories of Professors Becquerel and Curie, and soon after published the results of work accomplished under the guidance and by collaboration of these great French scientists. In 1895 she married Prof. Curie, and until 1906, when Prof. Curie died, they both undertook most successful researches on radioactive elements and radioactivity which aroused the interest of all scientists.

The steps followed in the work leading to the discovery of radioactive elements and in the solution of problems on radioactivity are best outlined by Mme. Curie herself in her address accepting the medal.

Mme. Curie is still a hard worker, and only a few days before sailing for this country she presented a new memoir before the French Academy of Sciences on Gamma Rays and Emissions of Heat by Radium and Mesothorium (*Comptes rendus*, pp. 1022-1025, April 25, 1921).

It might be mentioned here that Miss Irène Curie, one of her two daughters, is also a scientist of note, having already published a series of contributions for the advancement of chemistry, the latest being her study on the atomic weight of chlorine (*Comptes rendus*, pp. 1025-1028, April 25, 1921).

Mme. Curie has been twice honored with the Nobel prize. She is professor at the Faculty of Sciences and director of the Radium Institute in Paris.

At the meeting of the Chicago Section of the American Chemical Society the American chemists, physicists, geologists, astronomers and physicians joined to present their appreciation for the medalist through their respective spokesmen, H. N. McCoy, R. A. Millikan, T. C. Chamberlain, E. B. Frost and W. A. Pusey, while Prof. W. Lee Lewis of Northwestern University acted as toastmaster.

Address by Dr. W. Lee Lewis

In 1910 one of the most modest and retiring members of an unusually modest and retiring organization—namely, the Chicago Section of the American Chemical Society—after a long and faithful service to our section, made it possible for that section to pay its glad homage to those who have wrought immortally in our science. I refer to William A. Converse.

In attaching the name of Willard Gibbs, our greatest American chemist, to this token, it was established forever on an exalted plane of worthiness.

This is the occasion of the eleventh presentation of the Willard Gibbs Medal, the second time it has been presented to a distinguished European.

The list of those who have received this medal attests how well it has served its high purpose: Svante Arrhenius, Theodore W. Richards, Leo H. Baekeland, Ira Remsen, Arthur A. Noyes, Willis R. Whitney, Edward W. Morley, William M. Burton, William A. Noyes, F. G. Cottrell and tonight Mme. Curie, the first woman recipient.

Through all times men have sought to symbolize their gratitude for Greatness, or for what Emerson says might be better called Completeness, in a spiritual manner. The victor in the Greek games was given not an object of great worth but a wreath of wild olives. The prized guerdon of those old days of chivalry and knight errantry was a ribbon or a flower. Coins and medals are struck to commemorate national victories. Similarly the swastika, the cross, the flag of a nation, the wedding ring, the loving cup, the lotus flower, the phoenix, stand for values in human life which are not intrinsic.

In that spirit we are gathered tonight.

We have asked Drs. H. N. McCoy, R. A. Millikan, T. C. Chamberlain, E. B. Frost and W. A. Pusey to address us on some of the far-reaching consequences of the discovery of radium.

Address by Dr. Herbert N. McCoy, "For Chemistry"

The advance of every science is made over stepping stones of great discoveries. Let me illustrate by brief reference to a few of the most notable examples in chemistry.

Priestley's discovery of oxygen in 1774 and Lavoisier's prompt explanation of the rôle of this element in the burning of substances led to the proof that matter is indestructible. This fact is the basis of the most fundamental law of chemistry. Lavoisier's monumental work inspired the famous French chemist Wurtz to write many years ago: "Chemistry is a French science, founded by Lavoisier of immortal memory."

The electrolytic isolation of metallic sodium by Davy in 1810 not only led at once to the separation from their compounds of half of a dozen new metals but foreshadowed the development of the whole science and art of electrometallurgy.

In 1828, Wöhler's preparation of urea from ammo-



PHOTOGRAPHS OF MME. CURIE AND HER DAUGHTER, POSED ESPECIALLY FOR "CHEMICAL & METALLURGICAL ENGINEERING," IN MME. CURIE'S LABORATORY

niun cyanate disproved the hitherto universal view—a view strongly supported by religious dogma, be it remembered—that compounds of carbon obtained from animal and vegetable sources could be produced only through the agency of vital forces. The almost unlimited possibilities indicated by Wöhler's discovery have been amply realized. Today the number of known synthetic organic substances is over 100,000. Perkin's preparation of the first coal-tar dye, mauve, was of course a consequence of Wöhler's work. The thousand or more artificial dyes of today represent only the elaboration of Perkin's discovery.

The periodic system of Mendeléeff and of Meyer gave a system of classification of inestimable value and also furnished the first clear proof that the elements are closely interrelated.

The application of thermodynamics to chemistry in the early '70s by Willard Gibbs gave us the phase rule and served as the most important single contribution to the foundation of the science of physical chemistry. Gibbs' papers are a source of inspiration and information not yet exhausted, nearly five decades after they were written. The medal to be awarded tonight is a memorial to this illustrious chemist.

Van't Hoff's theory of solution, published in 1887, and its corollary, the ionic hypothesis, simultaneously announced by Arrhenius, served for three decades as the foremost stimulating idea for chemical and biological research.

The discovery of radium twenty-three years ago is in every way worthy to be classed among the typical great discoveries just mentioned, and we are assembled tonight to do honor to the discoverer.

IMPORTANCE OF THE DISCOVERY OF RADIUM

It is by the developments that arise from a discovery that its true importance is to be judged. If these are epoch-making and if the discovery has been the result of acute scientific insight, prophetic imagination and patient and skillful experimentation, then we are bound to acclaim the greatness of the discovery. Judged by all these facts, the discovery of radium measures up to the high place it has been accorded.

The early history of our science very plainly shows that the rapid growth of chemical knowledge was in no small measure due to the innumerable attempts of alchemists to transmute the baser metals into gold.

While two and one-half decades ago it was rank chemical heresy to admit the possibility of the transmutation of the elements, yet more than one chemist of repute had a feeling that the last word on this topic had by no means been spoken.

The advent of radium threw a clear new light on this most fascinating subject and led to revelations of a wholly unexpected nature. It seems appropriate, therefore, on this occasion briefly to review the current conception of the nature of matter and to point out the advances that have been made toward the solution of

the chemists' and physicists' most difficult problem—the transmutation of elements.

The discovery of radium revealed to science a well nigh unbelievable group of phenomena. We read in our journals that radium emits light and heat, that its rays penetrate light-proof paper and produce photographs like those of X-rays, that in the presence of radium air is ionized—that is, it is made a conductor of electricity. Then came the astounding statement that atoms of radium explode and that material fragments are shot out with velocities fifty thousand times that of a rifle ball; that these fragments are positively electrified atoms of the element helium; that particles of negative electricity (electrons) fly off with velocities that would enable them to travel around the earth between two ticks of a watch; that radium produces a sort of transcendent X-ray that can penetrate the armor plate of a battleship. Add to all this the fact, soon established beyond controversy, that radium produces continuously a radioactive gas, the emanation, unquestionably a new element, and it must be admitted that the like of such news never had been heard before.

Taken at their face value, all the above assertions about radium meant, first, that one element changed into other and different elements, and second, that energy in the form of heat and light were created from no known source. Here was indeed a most amazing difficulty, for the first of these tenets violated one of the basic laws of chemistry—the impossibility of transmutation—while the second was equally careless of the most fundamental principle of physics—the impossibility of creating energy.

We now know that the physicists were right. Energy is not created by radium. It already exists as the internal energy of the atom itself and is only liberated in radioactive change. The chemists, on the other hand, were wrong, since it was soon proved beyond a shadow of doubt that helium and emanation—both elements—are formed from the element radium. Chemists were then forced to admit that radioactive changes accomplish transmutation of the elements.

STRUCTURE OF THE RADIUM ATOM

Of what, then, is an atom composed, and what is its structure? Plainly, an atom is not a tiny, hard, structureless and indivisible bit of material, differing in nature from one element to another. Small as it is, the atom is highly complex. In structure it may be likened to our solar system on a miniature scale. After all, why not? Great and small are but relative terms. What is our earth compared with the sun, nearly a million times bigger and 93 million miles away? And what in turn is our great sun but one faint star of the myriads that fill the universe? Let your imagination have full sway and see an atom of radium as it might appear if magnified to a diameter of a hundred yards.

In the center, a nucleus the size of a cherry. Surrounding this, eighty-eight electrons each the size of a pea. Let the peas be arranged in eleven groups of eight each, so that each pea of the outer eight is 50 yd. from the central cherry and 20 yd. from its neighbor of the same group. Let the inner groups be equally spaced from one another and from the central cherry.

The nucleus has a positive charge equal to the charges of the eighty-eight negative electrons. The whole system is held together by electric forces of attraction and repulsion. The small compact electropositive nucleus, in turn, is apparently made up of eighty-eight single

units of the primitive material of the universe—positive electricity. Atoms of other elements are similarly constituted, but simpler, since the atom of radium is one of the very largest. The hydrogen atom consists of a single unit nucleus and one electron, while the helium atom, the next larger, has two electrons.

Atomic systems in general are stable, but in the case of some of the largest and most complex ones, like that of radium, something occasionally goes wrong and the atom disintegrates with a violence a hundred thousand times as great as that of the explosion of an equal mass of TNT. The fragments of the explosion of a radium atom are an atom of helium, an atom of emanation and electrons. This in brief, is the picture furnished by the disintegration hypothesis proposed in 1903 by Rutherford and Soddy.

This modern conception of an atom gives a clear insight into a great variety of chemical matters. Take, for example, the explanation of chemical union. All chemical and most physical properties of an atom depend upon the electrons surrounding its nucleus. Let us assume that the outer ring of an atom can lose or gain one or more electrons. An atom of elementary sodium, let us say, has a strong tendency to lose an electron, and an atom of chlorine, on the other hand, has a tendency to take up an extra electron. If we bring the elements together, they react violently, as we know, and produce sodium chloride—common salt. All the characteristic properties of each element has disappeared. Why? Because the sodium metal owes its metallic properties and its intense reactivity to the tendency of each of its atoms to lose one electron. The terrific effect of chlorine is solely due to its power to extract electrons from any source capable of giving up electrons. In each molecule of salt we have a sodium atom minus one electron and therefore positively charged, associated with a chlorine atom plus one electron, which gives it a negative charge. The two parts of the molecule hold together by reason of the electrical attraction between positive and negative charges. The older explanation of the union was that chlorine has a strong affinity for sodium. But this is all wrong. If Smith lends Jones \$10 and you see Smith continually dogging Jones, is it because of the love or affinity of Smith for Jones? Not at all. Smith is attracted only by the \$10 he lent Jones!

The valence of an element is the number of electrons its atom can lose or gain in chemical reactions.

ISOTOPIC ELEMENTS

The nucleus is the seat of mass and likewise of radioactive changes. In addition to positive electricity, the nuclei of the larger atoms contain a few electrons. In some cases two different nuclei have the same excess positive charge, but one nucleus has a greater number of positive units and a correspondingly greater number of electrons than the other. The result is most astonishing. These different nuclei hold exactly the same numbers of external electrons. Chemically, the atoms are identical. But their nuclei are different and in consequence they differ in atomic weight and in the nature of their radioactive changes, if they are active.

Prior to the discovery of radium it was never suspected that atoms having different mass could be chemically identified. Among radioactive elements many cases of this kind are well known. For example mesothorium, a perfectly definite radioactive element of atomic weight 223.4, is completely identical in chemical properties with radium of atomic weight 226, so much

so that once the two are mixed they cannot be separated. If it had not been for their radioactivity, in which they differ widely, they never would have been recognized as distinct elements. Elements of this sort are called isotopes. Isotopes have the same net nuclear charge and therefore the same number of external electrons. Among radioactive substances many isotopes are known.

But is it not only among radioactive elements that isotopes exist. Thanks to the researches of Aston, of Harkins and of Dempster, we now are learning that several of the most familiar elements, such as chlorine, magnesium and mercury, are isotopic mixtures.

TRANSMUTATION OF NITROGEN

Although radioactive changes involve transmutations of elements, it must not be forgotten that such processes are spontaneous and completely independent of all physical and chemical conditions. Man is apparently unable to start, stop, hasten or retard any radioactive change. Still in recent years chemists have often seriously considered the question: Can atoms not naturally radioactive be disintegrated or transformed? This indeed is the old problem of alchemy in a more modern setting. About ten or twelve years ago Ramsay thought he had answered the question in the affirmative in the supposed change of copper into lithium under the influence of the rays of radium emanation. But the critical repetition of the experiment by Mme. Curie proved that the lithium found came from other sources.

Recognizing clearly that only the most intense force can possibly penetrate to the nucleus of an atom and so disrupt it, Rutherford made the attack on the problem of the transmutation of nitrogen with the most powerful means known to science—the helium nuclei shot out by the radioactive element thorium C. Their velocity is 14,000 miles a second. When one of these finds an atom of nitrogen directly in its path, it goes straight through the field of outlying electrons, assaults the citadels of the nitrogen nucleus and knocks out fragments. In some cases these are nuclei of hydrogen atoms, in other cases nuclei of a hitherto unknown sort three times as large. What then does this mean in less technical terms? Simply this: This element nitrogen, which is not radioactive, has been transformed into hydrogen and a new element. This is a real transmutation of a common element. Such a transmutation is of purely scientific interest at present. But who dares discount the future?

Atomic disintegration involves two principal things—the production of new kinds of elements and the liberation in part of the internal energy of the atom. The amount of the latter is startlingly great. For example, the atomic energy of a single ounce of one of the heavier elements like lead or uranium is equal to that of ten tons of coal. If it ever becomes possible in future to induce the disintegration of ordinary elements, the value to humanity will come in greater measure from the limitless stores of energy thus placed at man's command than from the possible production of precious metals.

VALUE OF THE DISCOVERY OF RADIUM

I have tried to point out some of the epoch-making developments that have taken place in our science as the result of the discovery of radium. These are some of the fruits of Mme. Curie's work. For the world in general the use of radium in medicine has an even greater human interest. If there had been no scientific achievements the gift to medicine of this powerful thera-

peutic agent would alone entitle this discovery to take an exalted position. When we add to all this the fact that the discovery has given to chemical technology an industry which in America has an annual output worth \$4,000,000, there is but one conclusion: The discovery of radium is the most conspicuous single chemical event of this generation.

All honor to the illustrious discoverer, Mme. Marie Sklodowska Curie.

Prof. R. A. Millikan's Address, "For Physics"

On an occasion which is so rare as this—namely, an occasion on which Mme. Curie is delivering the only address which she makes on this trip to America—I am sure you do not wish me to take any time in giving out words even from the standpoint of physics or from the standpoint of America. I shall therefore do nothing more than to express my delight and that of my fellow physicists in paying our tribute of respect and honor and admiration to one who has contributed to all our sciences, one whom I am proud to say has the title of Experimental Physicist in a university of Paris and one whose discovery has touched not only physics but also chemistry, astronomy, geology and, what is much more important, philosophy. The opening up of the mind of man to the possibilities of this world, due to the discovery of radium, is certainly a philosophical event of immense importance. It seems to me therefore that this occasion tonight is one which represents the word "co-operation" in an unusual way. It represents the co-operation among all the physical sciences, which is to be, I think, the watchword of the decade upon which we are now entering. It also represents co-operation in the mission of bringing forward the progress of civilization by the progress of science, through the magnificent effort by the women of this country in assisting Mme. Curie with the great resources which we happen to have.

Prof. T. C. Chamberlain's Address, "For Geology"

I cannot tell you very well the contribution which the discovery of radium and of radioactivity has made to geology without telling you a little of the struggle through which it has been passing, for it is the contribution of radium and radioactivity to the relief of our difficulties that constitutes its essential contribution to our science.

In the closing years of the last century some of the very fundamental ideas of earth's science seemed to be slipping away, as the severer tests of the dynamics of our planet were brought to bear upon them. It was relatively easy for our forefathers to tell us how matter might be gathered into a globe and how that globe might have some sort of revolution, but it proves to be quite another thing to tell us how matter could be gathered together in a series of globes that should revolve in relation one to another and to their controlling sun in the very peculiar and singular way in which our planets act.

Hypothesis after hypothesis was brought up and tested and failed. It was amended and tested again and failed, and so on, until at length a hypothesis quite distinct from the others in its dynamic qualities was found which seemed to meet the rigorous requirements.

Then it was necessary to test this new hypothesis on other accounts to see if there did not lurk within it somewhere a fatal deficiency such as had been found in the others. One of the first of these tests to present

itself was the question of "adequacy of heat." The old hypothesis had started with the fiery beginning and a surplus of temperature. The new hypothesis was that of an earth built up slowly, very slowly, small particles coming in in such a way as to lose the heat of the impact before it was communicated to the body of the earth, and so the earth grew up like an ash bed—cold, or relatively cold. Whence, then, the heat indicated by volcanic action and other sources? Whence, then the great heat that we supposed to reside in the interior of the earth?

DISCOVERY OF RADIUM SOLVES MANY GEOLOGIC PROBLEMS

It was in this stage of solicitude when there came information of the wonderful heat-producing powers of radioactive substances, and so at once there came joy and satisfaction from this new discovery. There was no longer any question about the adequacy of heat in the earth or the moon or in any of the bodies that had encompassed radioactive substances in their formation. On the contrary, a difficulty of precisely the opposite source arose. Just as soon as the examination of the surface of the earth had reached an adequate stage it was found that the radioactive material, though very minor in its quantitative amount, was very effective in its heat-producing power. If the center of the earth, if the whole body of the earth, were permeated by radioactive substances as plentifully as the accessible portion, the annual product of heat would be very much greater than the earth is giving forth at the present time. And so there followed the almost necessary inference that the earth must be growing hotter all the time and must have been growing hotter all the time.

Now this conclusion is directly opposed to the geological evidence, and the geological evidence is strong. How, then, is this difficulty, this enforced difficulty, to be met? The only obvious way is to suppose that the radioactive substance is concentrated toward the surface and the quantitative value of its heat-producing power was such that less than one-hundredth of the thickness of the earth's crust would contain a sufficient amount of radium to produce all the heat that the earth is giving forth from the interior annually.

Now, according to the inherited concepts of the interior of the earth, it was once at least in a fluid condition. Some have held that it still is largely fluid. But the radioactive material, being of the heaviest order, ought to have concentrated in the center and not at the surface.

Here was a radical difficulty, but this gave us no trouble, because we had previously abandoned the whole concept of a fluid earth and a fluid interior, and substituted for it a very different concept, a concept which rested upon the stress conditions of the interior. There exists three million times as much static pressure in the center as at the surface, and, besides that, there is a whole group of pulsating stresses in operation due chiefly to outside sources and whose resultants were ten times, or thereabout, as great in the deep interior as at the surface. Thus it is obvious that if there were spots all through the earth possessing a liquefying agency, it would follow as a consequent mechanical condition in so fast and in so far as these little spots became liquid, or the local adjacent region became liquid. Then these would be squeezed to the surface, carrying the little heaters with its own currents of liquefaction. Here, then, was a mechanism peculiarly well adapted to pick

up and bring to the surface every radioactive substance in the interior of the earth and lodge it at the surface. Dr. Boulliet, who has written a fine work on geology and radioactivity, borrows this hypothesis and very discreetly says nothing about the difficulty of the old theories.

During the last half of the last century we were sorely belabored by Lord Kelvin and many other great and able physicists and some astronomers, because, as they said, we drew too largely on the bank of time. They had studied long and intently the heat energy of the sun and had found it adequate only to maintain the present output of the sun's heat for twenty or thirty million years, or some such period. They assured us that we were extravagant and must restrain ourselves, and so, bowing to these apparently strong arguments, we were under duress. But radioactivity has completely changed this attitude, and now there is no question about the possible adequacy of the energy in the sun or in the stars or in the earth to maintain the activities which we actually observe.

Radioactivity has brought to us another very precious instrument of great power, an instrument by which we may measure epochs and eras with an accuracy, I think, far greater than before. Geologists have studied the rate of physical and life processes of all sorts and have attempted from these to form some estimate of the age of the various formations and the age of the earth, but these are subject to serious question, because we live in an age just after a great organic revolution by which mountains tipped over and continents emerged. Radioactivity, by the rate of its decomposition, has given a mode which is entirely independent of these conditions. It gives a time measure four, five, six times as great perhaps as the geological methods, but in my judgment these are more nearly accurate than our older methods. So, singularly enough, the discovery of radium and of radioactive processes gives us one of the most needed means for measurement of time.

The discovery of radium and radioactivity has come to us at critical times and has brought us joy and satisfaction, given us instruments of power, and conferred upon us a benefit it is difficult for us to estimate.

E. B. Frost's Address, "For Astronomy"

Mr. Frost stated that there is no group of scientists that has greater interest in the discovery of new elements than astronomers—particularly astro-physicists.

He cited the case of helium, which has so remarkable a relation to radium, and outlined the conditions under which two astro-physicists, a Frenchman and an Englishman, working independently during the solar eclipse of 1868, one in India and the other in England, each detected the presence of a never before identified slender beautiful line in the spectrum of the edge of the sun. A new element was thus discovered, which, they guessed, came very close after hydrogen in the series of chemical elements, and they even surmised some of its properties. But it was only after twenty-seven years that helium was identified in terrestrial sources.

Nebular Orion, shining with its peculiar bluish green light, and spread over enormous space, emits light from which the astro-physicists have identified a gas they call nebulum. The speaker hoped that some day some discoverer with the skill of Mme. Curie would find that gas in some of the products of the earth.

Referring to radium, he stated that it has been something of a disappointment to find that there is no spectroscopic evidence of the presence of radium in the sun.

The work of the speaker on the identification of radium emanations in the solar sphere has not proved successful; some lines have been identified, but the intensities do not match, and some lines which should be there have not been detected. Thus the astro-physicists, when conservative and cautious, are not in a position to identify conclusively the presence of radium in celestial bodies.

Dr. W. A. Pusey's Address, "For Medicine"

I am glad to testify to our indebtedness to the honored guest of this evening for the discovery of radium, because its biological effects are no less interesting than its other amazing qualities. These biological effects were discovered very soon after concentrated radium salts had been produced by Mme. Curie, and tradition has it that it occurred when Prof. Curie himself, carrying radium in his pocket, discovered that it produced a sore. It was not very long after this that the study of these biological effects began and they led to extraordinary results. If the surface of the skin, which is the easiest living tissue to study, is exposed to radium, there is no change for eight to ten days. Where the reaction is slight it is confined to reddening. If the exposure has been longer or more intense, blisters occur on the surface. If it is carried beyond this point, the tissues of the skin are destroyed and in its maximum effect deep ulcers are formed.

The phenomena as studied under the microscope are not less interesting. First, in the mildest degree there is an inflammation; when carried a little further, certain cells are damaged that first show a disturbance of function, then a disturbance of structure, and then, if it is carried beyond this, absolute destruction of certain of the cells. These cells look as though they had been bombarded and broken into fragments. Other cells at this stage of the process will be able, if the process does not go too far, to be restored to normal, but a loss of certain sensitive cells takes place. If the process is carried to its maximum, you get complete destruction of all tissues, everything down to and including bone.

Radium has no effect on dead skin, no more than ordinary light. These phenomena, as they are produced by radium and X-rays, are absolutely unique.

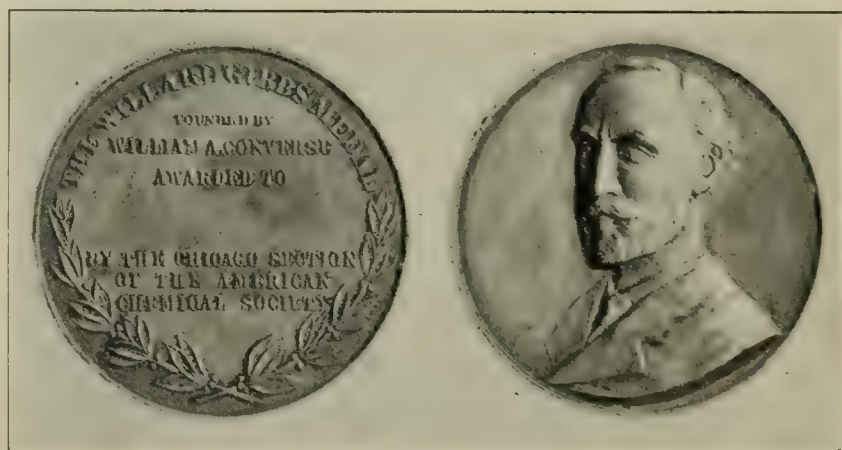
Their application to medicine lies in the fact that radium has a selective effect upon the tissues. Certain diseased tissues are readily damaged. Young cells and those which are highly differentiated and whose functions are special are particularly sensitive to the effects of radium. Through the utilization of this variation in sensibility to the effect of radium we have been able to do very much with radium in the treatment of disease. It has given us new methods of great convenience and effectiveness in handling some diseases we could handle before and it has given us methods in handling some diseases we could not successfully handle before. It has given us a new means of attack on cancer. It has not solved the cancer problem, it has not taken the place of surgery, but it has given us a means of controlling many cases of cancer that we could not control, and of alleviating some cases and of saving patients from the terrors of operations in others.

The work, as you may well imagine, is but in its beginning. Nobody can tell what the effects of radium on therapeutics is going to be, but even at the present time medicine owes a great debt to the discoverer of radium, and we are glad to do homage to Mme. Curie as one of those rare people who have discovered valuable new agents for the attack upon disease.

Dr. Lewis then introduced Prof. Julius Stieglitz of the University of Chicago, Dean of the American Chemical Society, Chicago Section, who was chosen to convey to Mme. Curie the Gibbs Medal.

Presentation of the Medal by Prof. Stieglitz

In choosing the name of our medal of honor the Chicago Section of the American Chemical Society sought to commemorate the work of the man whom we considered the greatest chemist America has ever produced, Willard Gibbs, the pioneer in physical chemistry. The first medal was bestowed upon Svante Arrhenius, a pioneer in the field of ionization, who developed a theory which for twenty or twenty-five years cleared up a great mass of what otherwise would appear as unconnected complicated facts. Great as were the discoveries of Gibbs and of Arrhenius, even greater, Mme. Curie, were the discoveries, the contributions to science which you have made, for you turned the key to the lock behind which the deepest and most fundamental secrets of nature were kept, the secrets of the subatomic world. We who lived in the time when atoms were considered whole and unchangeable can best appreciate the tremendous wonder of what has been accomplished in the last twenty-five years through the discoveries which you developed and through which you led the world of physics and chemistry. The story of the tracing of the pinhead of radium through a ton of pitchblende and other ores is more interesting, more profoundly moving, than any story of conquest on the face of the earth. It is a story of unflagging courage, of persistent self-sacrificing effort, and in gratitude for your work the Chicago Section of the American Chemical Society has asked me to present to you, as a token of its esteem and reverence, this medal, the Willard Gibbs Medal of 1921.



THE WILLARD GIBBS MEDAL

May you take it and esteem it, you and yours, in the same way as do those who are giving it to you, as homage to your courage, to your self-sacrifice and to one of the most lasting and greatest achievements in science which we have to commemorate in our generation. This is your medal, Mme. Curie, from the Chicago Section of the American Chemical Society.

Address of Mme. Curie

I wish to thank the American Chemical Society for having expressed its appreciation of my work by bestowing upon me the Gibbs Medal. I consider it an honor to be present at a meeting of the society which has elected me to membership several years ago. It is also a satisfaction to me to meet here Prof. Millikan, Prof. McCoy, and others whose work in atomic science and in radioactivity I know and highly appreciate.

It was the wish of the society that in this address I

should speak of my early work and give you a short account concerning the discovery of radium. It would be a great pleasure for me to do so, and I think that Prof. McCoy has already given you a view of the various developments of the new science of radioactivity.

The work was begun in the year 1897. At that time Prof. Curie and I were working in the laboratory of the School of Physics and Chemistry in Paris. I was engaged in the study of the uranium rays, which had been discovered two years before by Prof. Henri Becquerel. Becquerel found that uranium salts emit continuously special rays very different from ordinary light, but similar in some properties to X-rays. These rays are able, like X-rays, to make an impression on a photographic plate through an envelope of black paper protecting it from ordinary light, and these rays may also produce conductivity of air, they may produce a discharge, because the air which the rays are penetrating has acquired a force called ionization.

This property of uranium, emitting rays which are similar to those in the X-ray tube, was of course a very strange property and it was natural for me to try to know what it was. The first thing to do was to find a good method for measuring the intensity of those rays. These could be measured by the rate of discharge of an electroscope under suitable conditions, but I preferred a method which seems to me more accurate and rapid, consisting in measuring the same conductivity and ionization by a compensation method using an electrometer. I shall not describe this in detail, because it has been given in several of our publications.

Those measurements were very reliable. Tested in such a way, the property of radiation by uranium proved a very regular one, a steady one. What was more, it was proved that it belonged to all the compounds of uranium in every state and increased with the amount of uranium in the compound. And so I was compelled to come to the conclusion that the emission was an atomic property of the element uranium. This property of matter consisting in the emission of rays has been called radioactivity.

A HUNT FOR RADIOACTIVE ELEMENTS

Then the second question I asked myself was whether the element uranium was the only one possessing the property of radioactivity. In order to settle that I undertook an extensive examination of all kinds of elements and their compounds to ascertain if there was any other element which would possess atomic radioactivity. The only one I found was thorium. Radioactivity is high in both uranium and thorium, but this is their only common characteristic. Those two have the greatest atomic weight, but otherwise they have no particular analogies.

In my general examinations of so many chemical products, I had taken not only the pure elements and their compounds, but also some natural products, ores and minerals, and it is then that I came face to face with quite unexpected facts. I expected, of course, that all minerals containing uranium and thorium—and very often the same minerals contain both elements—would be radioactive, but it seemed also from my point of view that none of them ought to have as much radioactivity as pure uranium or thorium oxide. But what I found was quite different! I found several minerals that had stronger radioactivity than the oxides of thorium and uranium, the ratio being as high as four in the case of one sample of pitchblende. In order to explain this

abnormal behavior of minerals, I admitted that in those minerals was contained some new element with an atomic radioactivity much stronger than that of uranium and thorium and which could be present in the minerals only in a very small proportion, because they were not detected in the analysis of the minerals. This particular hypothesis has been verified by the discovery of polonium and radium by Prof. Curie and me.

Prof. Curie and I then started a common work for the separation of that new element. We were guided in our work by chemical analysis of the mineral accompanied by measurements of radioactivity. As some products on analysis proved more and more radioactive, we knew that we had succeeded in concentrating the new element, and during the year 1898 we were able to establish the existence of at least two new radioactive elements which were called, the first polonium, being separated with the bismuth, the other one radium, being separated with the barium.

Our purpose was to get these elements in a pure state, because if that could not be done chemical science would not have accepted our statements about the new elements. The difficulty was that the quantity of polonium and radium in the mineral was so exceedingly small. I considered it equal to about 1 per cent in quantity, but now we know that the quantity of radium which really is present in uranium ore is not even one part of a million in a good ore and the quantity of polonium is even much smaller. So that to get a quantity of radium one is obliged to work up huge quantities of ore, a very difficult task for a laboratory.

LACK OF EQUIPMENT, HELP AND MONEY

It must be said also that at the time we did not even have a good laboratory, a good chemical laboratory. We had a place to do some work and we had at our disposal a kind of shed which was not a laboratory at all, only a shed—no chemical arrangements where we could try to do the necessary work for the separation.

The second difficulty was that at the beginning we had no help of any kind and no money. That was also a very difficult condition under which to do that work, and it is just because the conditions were so difficult that the work was not done as quickly as it could have been done under other conditions.

The separation of radium, of course, could have been done within a period of several months, or at least less than a year, but it took us really four years to get the radium completely pure. Even at that time we could not buy pitchblende in sufficient quantity, but we had the idea that radium must be concentrated in the residues of the pitchblende after the extraction of uranium, and we contrived to get a certain quantity at the factory of the Austrian Government, where pitchblende was treated for the extraction of uranium. These residues had no value at that time and were thrown away, but this was the ore that we used. We succeeded in treating quantities up to 50 kg., but it is very difficult to do this kind of work with this quantity in a laboratory. We were obliged to give up doing it that way and to try to get the rough treatment done elsewhere and only the end of the work on the concentrated product was done in the laboratory.

It is not necessary to explain all the details of the work. It is sufficient to say that the proceeding was just the same as that that would be needed to extract barium from pitchblende, because radium belongs to the barium group. The work was centered on the ex-

traction of radium, because this was easier than getting polonium.

The radium extracted with the barium forms a barium-radium salt in which the concentration of radium is indeed exceedingly small. I do not think it could have been determined by ordinary means of chemical examination at that time. It could be deduced only by measurements of radioactivity.

In order to concentrate the radium in that barium-radium salt I devised a method of fractional crystallization. I found that if a solution of barium-radium-chloride is allowed to crystallize, the radium percentage in the barium-radium salt is several times greater for the crystals than for the solution. On that principle a regular working scheme can be established, leading to a very satisfactory separation of radium and barium by a sufficient number of crystallizations, if only the quantity of radium is not too exceedingly small. The crystallization of bromide may also be used with some advantage.

I myself did the numerous crystallizations that were wanted to produce the first pure radium. It was in the year 1902 that I succeeded for the first time in getting nearly 100 mg. of pure, very pure, radium chloride. The purifications by concentration have been all the time accompanied by measurements of radioactivity on the one side, by spectroscopy, and by determinations of the atomic weight of the matter present in the salt. That is also an ordinary chemical matter.

As the concentration in radium was increasing new lines appeared in the spectrum, while the barium lines weakened and disappeared, and the mean atomic weight of the metal, determined by the same method which is used for barium, increased to a limit which I determined to be 226. The atomic weight of barium from which we had started was, as is well known, 137.

So at last the end had been reached, and established without doubt that radium was a new chemical element in the same meaning as every chemical element is. We held the absolute proof that radium is a new chemical element and that the initial hypothesis was justified. These results also have been corroborated by many other scientists.

SEPARATION OF RADIUM METAL

Later I was also able to separate the radium in the metallic state. This was a still more difficult work, because radium is an element which decomposes water very strongly, and I also had a very small quantity of radium. It was always only those 100 mg. which have served.

The separation of radium in the metallic state has been done in the same way as it is done with barium, because the elements are so similar. The groundwork was prepared by the use of an electrolytic solution of radium chloride. After reduction this has been heated in very pure hydrogen, the mercury distilled away and in that way the radium metal has been left as a white metal, like barium. That work is extremely dangerous to the safety of radium, which, as you know, is a very precious material. This experiment has never been repeated by any one else in the world so far as has come to my knowledge.

You may see that the conditions in which this work has been done were from many points of view not easy conditions. Later they have improved. The laboratory which I have now is a new laboratory very much better equipped than ever before. Now I believe that my work

will be made even more efficient and more thorough by the interest which your country has so generously given.

The special interest of radium is, as you know, in the intensity of the rays, which is more than a million times greater than the intensity of the uranium rays. It is because of that that the effects of radium rays are so important.

Particular attention has been given, as you have been just told, to the physiological effects of the rays and which were discovered for the first time, as you have heard, in France. It was also in France that the first work of radium therapy was started, which is also sometimes called Curie therapy. This made necessary the production of radium, and so the supply of radium has been provided by factories of which the first has been also started in France.

The first radium came from France, but now America is the biggest producer. Many grams of radium are manufactured every year from the great quantities of Colorado carnotite. The methods used for the extraction of radium are always nearly the same as those which have been devised in our laboratory. All of these methods and all the ways and means and details of the preparation have been already published by Prof. Curie and by myself, for the benefit of science and humanity.

Radium is now a commercial product, but the quantities for sale are not controlled by its weight. It is much more convenient for a substance which is so precious and sold generally in small quantities, to control these quantities by the measurement of the intensity of radiation made under proper conditions, and particularly by comparison with the radiation of a known quantity of radium. So a number of the scientists of different countries decided that it was necessary to have an international standard of radium to make reliable measurement in all countries, and I was intrusted with the preparation of that standard. That was done in the year 1911, when the international standard of radium was prepared in the shape of a small glass tube containing 22 mg. of very pure, anhydrous radium chloride prepared for the determination of the atomic weight. This international standard is deposited at the International Bureau of Weights and Measures near Paris, and it is used only for comparison with secondary standards to be deposited in national institutes in the different countries.

RAYs FROM RADIUM

During the years when all this chemical investigation was going on, a great deal of work was also devoted to the study of the rays. This work has been done not only by us but by many other scientists, among them Henri Becquerel, Prof. Rutherford, Villard and others. Three kinds of rays have been identified and designated as the alpha, beta and gamma rays. These letters correspond exactly to the three sets of rays which are to be found in an X-ray tube. That is indeed a very curious coincidence.

The alpha rays are positive rays. We know now that they are atoms of helium, carrying a positive charge and traveling with a great velocity, one-twentieth of the velocity of light. The beta rays are not atoms, but electrons—that is, particles nearly 1,800 times smaller than the mass of hydrogen atoms and carrying a unit charge of negative electricity. The speed may come very near to the velocity of light and of course is greater than the speed of the alpha rays. The third, which are gamma rays, are not corpuscular, they are an electro-

magnetic vibration similar to light and to X-rays, but having a much greater frequency.

The penetrating power of the rays varies greatly. The alpha rays have a very small power of penetration and are very easily absorbed even by an ordinary sheet of paper. The beta rays may travel through several millimeters of aluminum, and the gamma rays may even penetrate much more dense material, like lead.

TRANSFORMATION OF RADIOACTIVE ELEMENTS

I have already told you that besides radium many other radioactive elements have been discovered, and in all cases the same method of chemical radioactive analysis has been used.

The emission of the rays is followed by a transformation of the element. Having expelled either the alpha ray, which is a helium atom, or the beta ray, which is an electron, the atom is changed into an atom of a different kind. These transformations go on until another element is obtained, which is no more radioactive. The theory of these transformations is a very important achievement of Rutherford and Soddy.

For any radioactive element the proportion of atoms destroyed in a given time always remains the same. The time required for the destruction of half of the atoms is a characteristic constant of the element and is called the period. The shorter this period the shorter is what is called the average life of the element. If this average life is very long, the element may still exist in the earth even if its formation has taken place before the actual constitution of the earth's crust—that is, more than a thousand million years ago. This is the case of uranium and thorium. All the other radioactive elements, including radium, have rates of disintegration too large to enable them to survive geological time and they are present in the minerals only because they are continuously produced by a chain of transformations beginning either at uranium or at thorium.

These chains are named "families" and all members of the family are present in the ancient minerals of uranium and thorium. In these minerals a state of equilibrium has been reached. Radium, for instance, is a product of the disintegration of uranium, and the period being 1,600 years, the quantity accumulated in the ore is a little more than three parts of radium to ten million parts of uranium.

We find the element may be more easily found and isolated if its average life is longer than if its average life is shorter. The quantity of polonium is 5,000 times smaller, polonium being also a product of the series starting from uranium, but with a period of only 140 days, and this explains why we could succeed in isolating radium but not polonium. I even can have the hope that polonium will be isolated in the very near future. The most we have had, and then only once, was a tenth of a milligram of polonium, and several milligrams of some material with which it was mixed, and that was a material which was extremely radioactive, much more radioactive than radium. Of course it was not pure polonium, and the purification has not been effected.

In the series from uranium we have a long-lived radio element, ionium, discovered in this country by Prof. Boltwood and known for being the direct parent of radium. It is an intermedium between uranium and radium. It was produced from uranium and that element could be isolated if only it could be quite free of thorium. To the same series belong actinium, discovered in France by Dr. Debierne. In the same family we

find short-lived radioactive gases or emanations and of the products of their transformations. Radium emanation is the most important, because it has been isolated in the pure state and because it has received an important medical utilization. Even if it is short-lived, it nevertheless has been isolated and because it is a gas it is easier separated. Its spectrum has been obtained and determined in the pure state. It can be separated from radium and for several purposes its use is more convenient than that of radium.

In the thorium family we find mesothorium and radiothorium, both produced in reduction plants as by-products in the winning of thorium. They are also used for many purposes. We have also thorium emanation, which is a radioactive gas.

The end products of both families are helium and at least two kinds of isotopic lead.

The radioactive elements are long-lived or short-lived, and the chemist must consider the evidence to determine whether their life be long as uranium, or if it should be very short, as that of some emanations or some product of their transformations. Every substance of that kind is an element and has definite chemical properties. For that reason it has been possible to introduce these elements in the periodic classification. In Mendeléeff's table all the radioactive elements, which are more than thirty in number, occupy ten places, beginning with lead and finishing with uranium. Of course there are only ten places but there are more than thirty elements. The explanation for this is to be found in that several elements occupy the same place, and these are elements which are called isotopic, having such very similar chemical properties that they can't be separated. From the chemical point of view this classification is entirely satisfactory, because the properties of the elements are just these which can be expected from an element belonging to that special place. The first place, which was a new place, has been occupied of course by radium. No one element was at that place at that time. After the discovery of radium it fitted very exactly in the periodic classification where it belongs by its atomic weight and by its properties. Of the other radioactive elements several came in places which were already occupied by other elements—for example, lead, or uranium, or thorium.

CHEMISTRY OF RADIOACTIVE ELEMENTS

In this way we establish what may be called the chemistry of radio elements. It is a specialized chemistry, but though chemistry in its designation, as far as the means of investigation are concerned, it is all very special chemistry, entirely different from the chemistry of the ordinary elements. The methods of investigation are not at all the same. The quantities of radioactive material are so extremely small that they are absolutely beyond determination by any mechanical method which does not depend on electrical measurements. Quantities of radium which may be detected, for example, are less than a ten-thousandth of a milligram, which is not approached by any mechanical method of measurement. It is because of that that we always measure our radioactive substances by its radioactivity and do not try to weigh it. Therefore this study could be in a way called the chemistry of what is invisible. It is an expression which could be applied to a great part of this chemistry which has been started by the discovery of radium and polonium and achieved by the joint work of distinguished scientists of all the world.

National Lime Association Convention

New Features in Kiln Construction—Chemical Control the Key to Kiln Efficiency—Modern Plant at Rockland, Me.—Standardization—Research—Lime in Water Purification—The Plasticimeter—Chemical Department Accomplishments and Plans

THE third annual convention of the National Lime Association was held at the Hotel Commodore, New York, June 15 to 17. The program covered all phases of the association's activities—lime production problems, extending the use of lime in the construction, agricultural and chemical fields, and details of association work.

NEW FEATURES IN LIMEKILN CONSTRUCTION

Richard K. Meade read a very interesting paper on new features in limekiln construction.¹ These developments were visualized by a set of lantern slides showing kilns in which the steel shell was replaced by reinforced concrete, the application of hand stokers to shaft kilns, and the installation of rotary kilns at the Eastern Potash Corporation's plant near New Brunswick, N. J. This plant will have a capacity of 1,000 tons of lime a day, limestone being obtained from extensive deposits in Sussex Co., N. J., near McAfee. The lime will be used to treat greensand for the production of caustic potash and a residue which will be used in the manufacture of high-grade building brick.

CHEMICAL CONTROL THE KEY TO KILN EFFICIENCY

W. D. Mount called attention to a fact which is perhaps not generally appreciated—namely, that the alkali manufacturers using the ammonia soda process are among the most important producers of lime. With the best high-grade calcium stone about 1.2 tons of limestone is required per ton of soda ash. In 1918 the production of alkali in this country was equivalent to 2,500,000 tons of soda ash. Using a conservative ratio of 1.3 tons of limestone, this amount of soda ash would call for 3,250,000 tons of limestone or 1,625,000 tons of lime. The commercial production of lime in 1918 was 3,204,000 tons, from which it will be seen that the lime used by the alkali manufacturers was equal to one-half of that burned for commercial purposes.

It is therefore of interest to consider the methods of lime burning employed in this industry. Being part of a great chemical industry, every phase of this work is under complete chemical control.

The limekilns are usually quite high in proportion to the diameter, ranging from 60 to 70 ft., with an internal diameter from one-sixth to one-seventh of the height. They are operated under induced draft, and coke is used as fuel, being charged direct with the stone. Extreme care is taken in adjusting the ratio of coke to stone and also in the sizing of each—a 6-in. cube represents the normal maximum size for the stone and a 2½-in. cube for the coke. The correct ratio of coke to stone is determined by analysis of the coke and adjustment of the burden (coke to stone ratio) until the maximum volume per cent of CO₂ is obtained consistent with a well-burned lime. The gases are analyzed hourly and

temperatures are measured by recording pyrometers. Since both the lime and the CO₂ are used in the process close chemical control is absolutely essential in order to maintain the efficiency of subsequent operations and also to keep down costs.

With a high-calcium, free-burning stone and with coke low in sulphur and containing less than 8 per cent ash, fuel ratios as high as 1 ton of coke to 12 or 13 tons of stone are not uncommon monthly averages. These figures may be compared with the theoretical data for a kiln operating under ideal conditions—that is, cold at top and bottom, continuous discharge, fuel burned in direct contact with the stone, perfect heat conservation.

Taking the heat of decomposition of CaCO₃ as 775 B.t.u. per lb., 1 ton of limestone will require 1,550,000 B.t.u. The average temperature of the stone as charged will probably approximate 50 deg. F. and its specific heat 0.22, hence the temperature range is $1904 - 50 = 1,854$ deg., and the heat required to bring the stone to the decomposition temperature is $1,854 \times 2,000 \times 0.22 = 816,000$ B.t.u. The total heat required is thus 2,366,000 B.t.u. One ton of coke will yield on burning 29,000,000 B.t.u., or enough heat to decompose 12.26 tons of stone under ideal conditions.

It will be noted that results obtained by the alkali manufacturers as regards fuel economy are apparently in excess of those indicated under the ideal conditions assumed. However, it may be pointed out that the stone charged will probably average 95 per cent CaCO₃, and that the decomposition is only about 95 per cent complete, so that we have $13 \times 0.95 \times 0.95 = 11.73$, indicating a kiln efficiency of 96 per cent.

MODERN PLANT AT ROCKLAND, ME.

George B. Wood, president of the Rockland & Rockport Lime Corporation, described the company's new plant which is nearing completion at Rockland, Me.

The plant comprises a battery of six Mount kilns with two Morgan mechanical producers centrally located. Provision has been made for the subsequent erection of two additional kilns at each end to make a future battery of ten. The kilns are 10 ft. outside diameter and 75 ft. high above foundations. The top 20 ft. of the kiln is unlined and holds a reserve storage of 45 tons of rock, which is charged through an air-tight charging bell operated by compressed air. Air for combustion is drawn from the bottom of the kiln through the hot lime below the fires, preheating the air before meeting the gas and thoroughly cooling the lime before it discharges from the kiln. The lime discharges continuously through an annular opening at the bottom of the cooling cone onto a slowly revolving circular table. The speed of the table determines the rate of discharge and may be regulated for each kiln independently through the simple shift of a lever.

A conveyor carries the lime to the storage and packing building, where it is first run over a bar grizzly to separate the fines. The lump lime is then sorted by

¹Some of the features were covered by Mr. Meade in the series of articles which appeared in CHEM. & MET. ENG., vol. 23, p. 841, Oct. 27, 1920; p. 873, Nov. 3, 1920; p. 929, Nov. 10, 1920.

hand into selected lump lime and common lime. Four 500-ton overhead steel storage bins keep the lime in first-class condition until ready for shipment or packing.

STANDARDIZATION

The luncheon address on Wednesday was delivered by Dr. S. W. Stratton, director of the Bureau of Standards. He spoke on the relation of standardization to Government research and industrial development.

Standardization is essential to the intelligent use of materials, and the development of specifications or standards of quality is particularly important in this connection. Before the process of standardization can begin a set of definitions must be formulated and accepted by all concerned. Then in making the specifications it should be borne in mind that three groups are involved: Those who make the materials, those who use the materials and those who made the specifications. No one of these groups should attempt to draw up specifications without consulting the others. In bringing together the user and the manufacturer, the Bureau of Standards has found that many of the disputes which arose over matters of sentiment or tradition could be solved conclusively in the laboratory.

THE BUSINESS OUTLOOK

On Thursday the luncheon address was given by Wallace A. Booth, vice-president, Guaranty Trust Co., New York City. Mr. Booth reviewed recent developments in this country and abroad and from this very comprehensive survey of factors influencing business drew the conclusion that the prospect for a steady return to normal conditions is decidedly more hopeful than it was a year ago.

DEPENDENCE OF MODERN INDUSTRY ON RESEARCH

Dr. Arthur D. Little discussed the dependence of modern industry on research, with special reference to the lime industry. He introduced the subject by a very entertaining summary of the wide variety of forms in which calcium carbonate is found in nature—the transparent calcite or Iceland spar used for optical purposes, marble, pearls, and the great limestone, chalk and coral formations which are due to countless millions of minute organisms, particularly foraminifera, globigerina, and the coral polyps.

Turning to lime manufacture, Dr. Little pointed out that the industry was already indebted to science for more than 60 per cent of its market. Many of the problems which still confront the lime burner will be solved by science. Improved kiln design is dependent upon the application of physico-chemical principles, and the quality of the product must be controlled by chemical and physical tests. Different lines of the same chemical composition exhibit wide variations in their physical characteristics. Thus some high-test limes are found to be only 80 per cent available when used for causticizing; in making bleaching powder one lime may absorb 25 per cent more chlorine than another of the same chemical composition, and similar variations are found in practically all of the applications of lime. For certain purposes the little-understood property of plasticity is of prime importance, and Dr. Little called attention to the work that was being done on this subject by Warren E. Emley at the Bureau of Standards and Prof. Bingham at Lafayette.

The progress which has been made in kiln construction is an excellent example of the practical value of

research. Old-style kilns produced probably not more than 2 tons of lime per ton of coal, while the ratio in modern kilns is greater than 6:1.

LIME IN WATER PURIFICATION

Certain phases of the use of lime in water purification were taken up by C. Arthur Brown of the American Steel & Wire Co. Eighteen years' experience with the lime:ferrous sulphate method of water purification has convinced Mr. Brown that this application is capable of considerable extension. At present about 120 municipal water-purification plants in the United States consume 55,000 tons of lime per annum. It is estimated that between 30 and 40 per cent of the water-purification systems in the country could use lime profitably. Projecting the consumption curves forward, this would mean a demand for 346,000 tons of lime in 1931. However, an approach to this figure can be attained only through an educational campaign designed to increase public appreciation of the value of soft water for domestic purposes.

PLASTICIMETER

Since 1910 the Bureau of Standards has experimented with many types of apparatus for the measurement of plasticity and twenty-one different machines have been built. The latest step in this evolution was demonstrated by Warren E. Emley. This plasticimeter gives a numerical result and is thus more suitable for obtaining comparable records than the Carson blotter test.

Sufficient water is added to the sample to make a good workable mix. A cylinder of the mixture $1\frac{1}{2}$ in. high x 3 in. in diameter is placed in the machine between a specially prepared base plate having a definite absorptive value and a disk which is free to turn but cannot move upward. The absorbent plate rests on a permanent base plate which is simultaneously rotated and elevated by means of suitable gearing. As the base and specimen turn, the friction of the specimen on the disk causes it to turn and this motion winds up a cord attached to a pendulum. The maximum force developed is measured on a scale attached to the pendulum and from this figure and the time required a plasticity figure is calculated.

Samples of hydrate were sent to several plasterers with the request that they rank them according to plasticity as determined from practical test. In every case their opinions checked the results which had been obtained by the plasticimeter. The machine has thus demonstrated its value as a means of distinguishing masons' hydrate from finishing hydrate.

CHEMICAL DEPARTMENT ACCOMPLISHMENTS AND PLANS

Dr. M. E. Holmes, manager of the chemical department of the association, reviewed the work which had been done during the year and the plans for the future.

The chemical uses of lime have been neglected and the problem of extending present uses and developing new ones offers many opportunities for interesting and profitable research. Rapid strides in this direction are being made through studies at the association's laboratories and through co-operation with university, industrial and Government laboratories. During the year the chemical department issued Lime Brief 250, "Outline of the Process of Lime Manufacture," which includes an excellent flow sheet. It is planned to follow this with a brief on the distribution of the uses of lime in agriculture, construction, and over 100 chemical industries.



Meeting of the New Jersey Clay Workers

Report of the Summer Joint Meeting at Trenton, N. J., of the New Jersey Clay Workers' Association and Eastern Section of the American Ceramic Society, June 17, 1921

THE regular summer meeting of the New Jersey Clay Workers' Association and Eastern Section of the American Ceramic Society was held at Trenton, N. J., on Friday, June 17, with morning and afternoon sessions. As in the case of previous years, the Trenton Country Club was selected for the gathering, and there is no doubt that this choice is a happy one in making for a delightful environment for the event.

With President Abel Hansen in the chair, the meeting was called to order close to 11 o'clock, and getting right down to business, Charles Howell Cook, chairman of the executive committee of the association, was called upon for a report relative to the new ceramic school and research station at Rutgers College.

Mr. Cook said that the contract had just been awarded to the Franklin M. Harris Co., Philadelphia, Pa., for the erection of the building, at a price of \$73,877, and ground will be broken at an early date. Other contracts for plumbing, heating, lighting, etc., also have been let, including an award to the New Jersey Terra Cotta Co., Perth Amboy, for terra cotta at a price of \$6,955. The total appropriation of \$100,000 granted by the State Legislature will be absorbed in the construction, and contributions aggregating \$25,000 are expected from the different manufacturers of ceramic products in the state to provide necessary materials as well as proposed equipment. Mr. Cook made an urgent plea to interest the young men of the state in the new ceramic school building and the opportunity to be presented for instruction in ceramic engineering under the direction of Prof. George H. Brown.

The first paper on the program was by William Burgess of the United States Potters' Association on the subject of the tariff, and through necessary absence at Washington, the paper was read by R. H. Minton.

Setting forth that tariff revision, at best, is a difficult matter, Mr. Burgess explained that from first-hand

knowledge gathered upon visits to England, France, Germany, Austria, Holland, Belgium, Japan and China, he has been impressed with the urgent need for a fair tariff to protect the pottery industries of the United States. Not only do low wages prevail in these countries, but conditions under which goods are produced are decidedly different from those here.

With a wage scale of 70c. an hour in the United States, those in the various other countries mentioned are: Great Britain, 18c.; France, 15c.; Holland, 13c.; Germany, 6 to 7c.; and Japan, 4 to 5c. While women are employed in the pottery industry in the United States, largely in the decorating shops, the aggregate is about one-third of the total number of operatives. In England it is one-half, and in Germany and central Europe about two-thirds. In these countries the women do much of the heavier work, such as placing kilns and the like, handled in the United States by men.

In Japan, in addition to the employment of a large number of women, many small boys are engaged, largely in decorating work, at a very nominal wage. Even the best of Japanese workers, such as may handle the big jigger, receive at the maximum 85c. a day of twelve hours, while the women earn from 20 to 25c. a day.

Explaining in detail how goods were being brought into the United States with low duty, through invoicing at about one-half the proper value, Mr. Burgess urged a basis for assessing duties so that the American wholesale selling value will be taken in place of the foreign market value, and said that the present Ways and Means Committee at Washington was giving serious consideration to such a plan.

In conclusion, he set forth that it is not the desire of any of the pottery manufacturers to prohibit the importation of foreign ware of any kind, but so to hold it in check that the American producer can obtain a fair share of the market. Previous to the outbreak of the

war the United States did not supply more than 45 per cent of the consumption of this country; during the war period the pottery industry developed under extreme pressure so that up to six months ago the United States manufacturer was supplying upward of 60 per cent of the demand.

HOLLOW BUILDING TILE

The second and concluding paper of the morning session comprised a short illustrated talk on the subject of "Hollow Building Tile," by Walter A. Hull, Bureau of Standards, Washington, D. C.

He spoke of the work now being conducted at the bureau to ascertain the different characteristics of hollow building tile, the operations being carried out in close co-operation with the Hollow Building Tile Association and its different members. He pointed out that the matter of fire resistance of hollow tile was one of primary importance, and showed a number of lantern slides illustrating the tests for this work at the bureau.

Again, consideration has been given to the relation of fire resistance to other physical properties of the material, such as absorption, strength at different temperatures, expansion, etc. With substantial and encouraging progress being made, he said that the end would be the placing of the industry upon the right footing with respect to other building commodities. This is the big goal that is sought.

FACTORY PREPARATION AND BURNING OF WHITEWARE BODIES

Following an enjoyable luncheon, the larger part of the afternoon session was given over to a highly interesting and illuminating talk by Prof. A. S. Watts, Ohio State University, Columbus, on the subject of "The Factory Preparation and Burning of Whiteware Bodies."

The topic was treated at great length, dealing with the work in its different stages, as (1) raw materials; (2) mixing the body; (3) preparation of stain; (4) equipment; (5) setting the kiln; and (6) firing the kiln. With respect to the grinding of raw materials, he said that fine grinding reduces the amount of feldspar and ball clay, which should improve the color of the ware. With respect to the frequent question, "Does fine grinding cause cracking?" he said that this is a disputed subject, but the raw body is made more dense, which may cause cracking. If the ball clay can be reduced, the tendency to crack should be reduced. The European porcelains do not contain any ball clay.

To clean dirty ball clay properly, Prof. Watts said that it should be dried at not over 100 deg. F., and then plunged into nine times its weight of water. After that, it should be screened through a 150-mesh sieve, and used on a stop weight basis.

With respect to mixing the body, he said that the best practice was to introduce the ball clay slip into a large ball mill, with one-third charge of pebbles; then add the feldspar and flint. Add additional water, if necessary to make a thin slip. Then grind two to three hours; add stain and china clay, and grind to point of mix only.

Mr. Watts gave a number of interesting references at this point with regard to cobalt stain in whiteware bodies. He spoke about the faulty methods of adding cobalt, resulting in a blue gray cast when the body is hard fired. The correct preparation of stain from cobalt sulphate was explained, and the adding of the

stain to the body. Reference also was made to the proper proportions of stain to the body, and the use of stains in glazes.

With regard to equipment, he compared rotary and shaking sieves, pointing out the features of merit of the different types. Slip pumps and compression tanks were then considered, and he urged that pumps should not be operated at too high speed.

In the matter of filter presses, it was pointed out that maximum pressure for a good working body was an item of much importance. He recommended that this be 80 lb. for a body free from ball clay, with an addition of 2 lb. for each 2 per cent of ball clay present. For instance, a 100-lb. pressure for a body containing 10 per cent ball clay; 110-lb. pressure for a body with 15 per cent of ball clay, and so on. When the press stops running water, the pressure should be increased 10 lb. for a few minutes before opening the press.

Speaking of the aging of clay and its effect, Mr. Watts said that this develops plasticity by fermentation. Aging causes fine gas cavities, and accordingly is not to be recommended for electrical porcelain production. The clay cellar should be maintained at a temperature above 80 deg. F. and 90 per cent relative humidity.

Dealing with the subject of pug mills, it was brought out that for every body there is only one satisfactory rate of travel through any given pug mill with a given size and shape of outlet. A slower rate produces an open body, and a faster rate produces a granular weak body, due to the friction in the mill. The control is by the regulation of the number of knives in the mill and the slope of the knife blades. All blades should slope the same, for if the top knife, for instance, is sloped the most, the lower blades are only a hindrance and cause heating.

In setting the kiln, Mr. Watts said that in his experience the first and second rings should be set 1 in. apart except midway between the cuts, and the inside rings all set 1 in. apart. A 1-in. opening should be left between all rings, and not more than 6 in. should be left between the top bungs and crown at any point.

In updraft kilns, the well-hole should equal the sum of the cross-sections of the flues leading to it. In such case the center ring of saggers can run to 6 in. below the crown if braced properly. In the matter of downdraft kilns, the center of the kilns may be set 12 to 15 in. below the crown, and the burn improved with an opening provided from top to bottom in center.

Speaking of the firing of the kiln, with particular reference to hard fire porcelain, free from ball clay, he said that with the body biscuit, the fire may progress as fast as the coal will burn, maintaining a condition bordering on reduction from the time the kiln is hot enough to develop such characteristic, or from about the tenth hour. For the best results, the fuel beds never should burn low enough to permit air leakage, as a highly oxidizing condition is as dangerous as a condition of extreme reduction, and results in blue and cream ware instead of white. The temperature is dropped fast after finish to an orange red.

VISITS TO POTTERIES

The meeting was adjourned about 4 o'clock to allow time to visit local potteries, and automobiles were provided for the members and guests, with choice of selection between the new plant of Lenox, Inc., manufacturer of fine chinaware, and the new sanitary ware plant of the Mutual Potteries Co.

Meeting of Society of Testing Materials at Asbury Park

Sulphur or Phosphorus Limits Raised on Structural Steel and Steel Castings—Tentative Standards for Metallographic Testing of Iron and Steel Proposed—Impact Testing Given Special Consideration in Session on Steel and Wrought Iron

ABOUT six hundred members of the American Society for Testing Materials unsuccessfully attempted to dodge the prevailing hot wave by assembling at Asbury Park last week. Unfortunately the breeze was from the land most of the time, and the summer is too young to have tempered the frigid Atlantic. Nevertheless the usual number of committee meetings and general sessions drew a large attendance.

SULPHUR AND PHOSPHORUS IN STEEL

The committee on steel presented a voluminous report recommending changes or additions to forty-four standards, mostly in an attempt to remove ambiguity from the existing wording or to permit acceptance of steel made by duplex or more complicated processes. Furthermore, the note regarding sulphur and phosphorus limits was removed on ten of the fourteen specifications on which it yet remained.

It will be remembered that due to the difficulty in getting low-sulphur fuels and melting stock and the increasing scarcity of low-phosphorus ores, a war emergency measure was passed by the society, temporarily increasing the limiting percentages 0.01 per cent on a considerable number of standards. It was stipulated, however, that this was done merely to enable the large volume of steel required for war purposes to be produced within recognized specifications, and the original analyses would be restored with the passing of the emergency. Consequently a year ago the note was removed from all but fourteen of the standards, these fourteen, however, including the "tonnage materials"—rails, structural steel, rivet material and tubes.

Meanwhile an ambitious program of experiments had been begun by a joint committee of interested organizations (of which the Society for Testing Materials was one) to determine the effect of residual sulphur and phosphorus in otherwise normal open-hearth rolled steel products. It was felt that this investigation would supply numerical and precise data, which are now almost wholly missing from the literature, on the specific effect of these elements; numerical data which would enable the society to decide intelligently whether it would be safe to permit a permanent increase in sulphur and phosphorus tolerances. Owing to the great amount of work which this joint committee has laid out, its findings have not yet been completed, notwithstanding vigorous prosecution of the tests. It is understood, however, that those on rivet steel (sulphurs ranging up to 0.17 per cent) have been completed by the Watertown Arsenal and the Naval Experiment Station, and will be published by the Bureau of Standards as soon as they can be collated and analyzed.

BOTH LIMITS EXTENDED

In view of all the facts, however, the committee on steel decided that it would involve no danger to extend permanently the sulphur limits from 0.05 to 0.06 per cent on structural steel for locomotives, cars and ships,

owing to the heavy tonnages involved and to the continued difficulty in obtaining low-sulphur fuels and melting stock. Phosphorus and sulphur were both extended 0.01 per cent for steel castings, for the same reason. It is worthy of remark that the sulphur limit is now reduced on all materials which are to be worked hot (rivets, tubes and chain) and increased on structural materials which are to be fabricated cold.

STEEL RAILS

A proposal for a new tentative specification for "special quality" rails, closely following those recently adopted by the American Railway Engineering Association, was under consideration. This would be an addition to the present standard—a second specification which should be favored by heavy traffic railroads. However, the steel committee refused to recommend its adoption, in view of very diverse opinions on the manufacturing minutiae responsible for sound rails and the doubt as to whether the more rigid test requirements would produce rails which would unquestionably stand severe traffic more successfully.

TESTS OF STEEL AT HIGH TEMPERATURES

Much interest was shown in the paper by R. S. MacPherran on "Comparative Tests of Steels at High Temperatures" published on page 1153 of this issue. Albert P. Spooner of the Bethlehem Steel Co. described some work in progress in that company's laboratory, quite independent of that by Mr. MacPherran but with a very similar instrumental equipment. He gave some curves from both laboratories, plotted in comparison, which showed substantial parallelism, the difference being easily accounted for by minor differences in chemical composition or previous treatment. Nearly all the curves for tensile strength show a valley between 200 and 400 deg. C. (an occurrence which has not yet been given a rational explanation) and a peak between 600 and 800 deg. C., usually higher than the strength at room temperature, and then on higher temperature a very sudden drop. Reduction-of-area curves are quite generally opposite, showing minima where those for tensile strength have maxima. Mr. Spooner also noted that high-alloy steels broken at elevated temperatures appeared as if they had been burned, but microscopic examination showed that this was not the case; however, fracture in those cases was intercrystalline.

H. J. French called attention to work of several former investigators on this subject, and pointed out that the maxima in the tensile strength curves had been found at a considerably lower temperature than those reported by Mr. MacPherran. In view of the difficulty of producing a zone of uniform temperature, even without the effect of large masses of metal conducting heat out the ends of the furnace at a rapid rate, he recommended that a special study be made to determine whether there was not uniformly plus error in the recorded temperatures.

ATMOSPHERIC CORROSION

Committee A-5 on corrosion of iron and steel reported that the test on uncoated sheets exposed in the Pittsburgh district for the last five years is nearing completion.

"The results of the observations at the Pittsburgh tests have now reached a point where we may definitely conclude that copper-bearing metal shows marked superiority in rust-resisting properties as compared to non-copper-bearing metal of substantially the same general composition, from which superiority we may truly anticipate a marked increase in the service life for copper-bearing metals under atmospheric exposure of uncoated sheets.

"It is interesting to note in this connection that the A and O groups of sheets, the light gage non-copper-bearing bessemer and open-hearth metals, which failed first at Pittsburgh, have also failed first at Fort Sheridan, which would indicate that the two different atmospheric conditions have shown substantially the same general tendencies, only with varying rates of corrosion."

A summary of results of the Pittsburgh tests follows. It should be noted that iron or steel containing less than 0.15 per cent copper have been classed as "non-copper bearing." Also that no 16-gage sheet containing 0.06 per cent copper or more has failed. In other words, of 175 16-gage sheets analyzing 0.06 copper or more, not one has failed in Pittsburgh atmosphere after 52 months' exposure. Of 83 16-gage sheets analyzing 0.3 copper or less, 54, or 65 per cent, have failed:

Type Designation	Gage	Number of Groups	Total Number of Sheets	Number Failed	Total Failures at Each Inspection, Expressed as Percentages of Total Sheets of Each Type Exposed							
					10 Mo.	16 Mo.	22 Mo.	28 Mo.	35 Mo.	41 Mo.	46 Mo.	52 Mo.
Copper-bearing.....	16	14	132	None	None	None	None	10.3	15.9	26.2	32.6	42.9
Non-copper-bearing.....	16	11	126	54	None	None	None	4.1	13.7	27.4	44.5	63.7
Copper-bearing.....	22	15	146	93	None	None	1.4	91.6	94.0	96.4	96.4	97.6
Non-copper-bearing.....	22	11	84	82	None	35.7	79.7					

Before starting the Pittsburgh test, pieces were sheared from the edges for preservation. Small rectangles were later cut from these trimmings, and immersed in water pumped from the Calumet mine containing much sulphuric acid, iron and aluminum sulphates. Failure was reported after ¼ in. indentation from the edge, or a perforation. Results on 16-gage sheets are tabulated below:

	Average Life in Days	
	Copper Greater Than 0.15	Copper Less Than 0.15
Bessemer steel.....	124	135
Open-hearth steel.....	113	114
Pure iron.....	99	124
Wrought iron.....	128	158

"In the imersion tests under the conditions which prevail at the Calumet mine, the presence of copper would indicate little influence on the life of the specimen and if any difference, the presence of copper would seem to give a slightly shorter life, also the order of failure of the various groups is decidedly changed, but it would be safer not to draw definite conclusions until we have the finished results of the various atmospheric and immersion tests."

IMPACT TESTS ON CAST STEEL

"Some Impact Tests on Cast Steel" were presented by F. C. Langenberg. In one investigation a heat of normal steel from a side-blown converter was selected, and half of it poured into a preheated ladle containing

a certain amount of 20 per cent ferrophosphorus. Castings were then made from both the normal and the phosphorized steel. Castings were annealed at 950 deg. C. for two hours, air-cooled, and drawn four hours at 500 deg. C. Tests follow:

Mark	Analysis					Charpy Impact
	C	Mn	Si	S	P	
5775	0.42	0.86	0.20	0.065	0.043	6.69
5775X	0.42	0.86	0.20	0.065	0.104	3.10
5807A	0.42	0.65	0.28	0.069	0.043	5.46
5807B	0.40	0.63	0.30	0.069	0.058	4.65
5807C	0.42	0.60	0.27	0.066	0.068	3.56
5807D	0.41	0.61	0.27	0.065	0.075	2.40

Little difference was noted in the results of the ordinary static tests, except that 5807 D was somewhat lacking in ductility.

A second investigation was on a series of high manganese castings, air-cooled from 900 deg. C. The extraordinarily high impact value of 30 or more was noted from those which analyzed 0.22 to 0.30 C and 1.08 to 1.29 Mn. Higher carbons with lower manganese, or *vice versa*, lowered the Charpy figure greatly.

An acid open-hearth casting containing C 0.30 per cent, Mn 0.62, Si 0.18, S 0.038 and P 0.038 was given three heat-treatments as follows:

A: Quenched in water from 900 deg. C.; drawn two hours at 650 deg. C. and furnace-cooled. B: Furnace-cooled from 900 deg. C. C: Air-cooled from 950 deg. C., drawn two hours at 500 deg. C. and furnace-cooled. Physical properties follow:

Heat-Treatment	Yield Point	Tensile Strength	Elonga-gation	Con-traction	Charpy Impact	Brinell Hardness
A	57,500	87,333	15.3	22.8	14.25	176
B	46,333	79,333	18.3	27.2	11.32	156
C	49,500	82,666	16.2	23.9	11.87	159

C. E. Margerum pointed out that many steel objects intended to resist impact are hardened. Single-blow impact tests on such material are misleading, since hardness (a desirable quality) and internal flaws (an undesirable quality) both reduce the amount of energy necessary to break the specimen. In an effort to translate the foot-pounds at rupture to a force required to break the specimen, the author has devised a simple apparatus, as follows:

A hammer, falling at a controlled speed, strikes a plunger, capable of limited vertical motion, the lower end of which is formed into a yoke, and which transmits the blow to the ends of the specimen. The test-piece is 0.35 x 0.35 x 1.75 in., resting on a central support, which in turn rocks on a hardened 10-mm. steel ball. Supporting all this is a record bar, calibrated with the same ball (after the fashion of the Brinell test) by static pressure. The force existing on the central bearing at the instant of rupture may then be taken from the calibration curve, after measuring the indentation made by the ball. A series of tests on 1.08 per cent C tool steel shows the greatest impact strength after a draw ranging from 570 to 700 deg. C. If the same apparatus is used in a compression machine, holding each increment of load two minutes, the "static strength" is 40 to 60 per cent less for these draws.

Sir Robert Hadfield, Fritz Medalist

IT IS doubtless unnecessary to remind American engineers that the John Fritz award was instituted twenty years ago by the American societies of Civil, Mining, Mechanical and Electrical Engineers, and the first medal bestowed upon its namesake on his eightieth birthday. Designed to perpetuate that genial iron master's achievements in technology, particularly mechanical engineering applied to steel manufacture, it has become the most coveted honor at the disposal of American engineers and has been bestowed upon the following eminent scientists and engineers:

Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas Alva Edison, Charles T. Porter, Alfred Nobel, Sir William Henry White, Robert W. Hunt, John Edson Sweet, James Douglas, Elihu Thomson, Henry Marion Howe, J. Waldo Smith, George W. Goethals, Orville Wright.

During the past year it has been the ambition of the board of award to express the obligation which American engineers feel not only for the terrible sacrifices made by the engineers of Great Britain in the war, but for their great engineering achievements for the preservation of civilization. It ultimately found expression in making Sir Robert Hadfield the next John Fritz Medalist, not only for his personal achievements, especially the invention of manganese steel, but through him, to his brother-engineers. A deputation of representative Americans, including Ambrose Swasey, Ira N. Hollis, Charles T. Main, F. B. Jewett, Christopher R. Corning, Arthur S. Dwight, John R. Freeman and Charles F. Rand, will bear this message of good cheer to the other side, and present the medal on June 29, during the meeting of the Institution of Civil Engineers of Great Britain, in London. Far from a jealous feeling that such an honor should go beyond our boundaries, nothing but good will and cordiality accompany it, and the wish that the problems of reconstruction may be as effectively surmounted as those of the great war!

Sir Robert Hadfield, although born in Sheffield, Yorkshire, in the year 1859, comes from the Derbyshire family of that name who live at Edale. This quaint Derbyshire village is surrounded by the Kinderscout Hills, almost mountains, from 1,800 to 2,000 ft. in height. It is the center described both by Mrs. Humphry Ward in "David Grieve," and Charlotte Brontë in her novel "Jane Eyre." Edale is not far from historic Castleton, celebrated by Sir Walter Scott in his "Peveril of the Peak,"

with its Mam Tor, Win Hill, the Shivering Mountain, the famous Blue John mine and other fascinating places of historic interest. Chatsworth, Haddon Hall and Rowsley are all within hailing distance, and through these Derbyshire vales flows the well-known River Derwent of Isaak Walton fame.

Young Hadfield was educated at Sheffield Collegiate School, where he obtained in 1874 two scholarships and prizes in natural science. In 1876 he entered the laboratory of his father's works, and at the age of twenty-three discovered the remarkable properties of manganese steel. Another very important invention—low hysteresis steel, which is also saving the electrical trades many millions of dollars annually—was made a few years later. More recent research has been particularly successful in the line of development of heavy

armor-piercing projectiles, and light body armor. In 1888 he became chairman and managing director of Hadfields, Ltd., which post he has continuously held. Despite the demands upon a busy executive, he has never lost his keen interest in fundamental metallurgical research. In fact, his important contributions to scientific literature number 128 in all, and cover, often in encyclopaedic manner, such subjects as manganese and alloy steels, sound ingots, corrosion, research, physical testing, microscopic and X-ray examinations, ancient and modern metallurgical history, shorthand (Sir Robert makes free use of this method in handling his voluminous correspondence), patents, and the labor question. That his interest in the latter is not entirely academic may be inferred from the fact that he introduced the forty-eight-hour week at the Hadfield works in 1891.

His honorary memberships and fellowships, awards, presidencies, vice-presidencies and degrees are far too numerous to catalog. Among the most notable might be mentioned Master Cutler of Sheffield, 1899-1900; president of the Iron and Steel Institute, 1905-1907; president of the Faraday Society, 1914-1920; Bessemer Medalist and special gold medal from Société d'Encouragement pour l'Industrie Nationale. He received special letters of thanks from the Prime Minister and the French Ambassador for services rendered to the nation during the war, in connection with the Hadfield Hospital at Wimereux, near Boulogne, and for which he was entirely responsible from November, 1914, to January, 1919; during this time no less than 16,300 cases were dealt with; also from the Minister of Munitions (Winston S. Churchill) for services rendered as a member of the advisory panel of the Munitions Inventions Department.



SIR ROBERT HADFIELD

Pipe-Line Transportation of Hot Oil

A Study of Thermal Losses in Hot Petroleum Transit Lines — Calculations Based on d'Arcy's Hydraulic Formula for Spacing Pumping and Heating Stations — Curves of Hydraulic Gradient for Insulated and Uninsulated 8-In. Lines

BY LEONARD L. BARRETT*

IT IS the object of this paper to calculate the effect of applying insulating coverings to hot oil pipe lines such as are found in the California, Texas and Mexican fields, and to deduce the economic results to be obtained by such practice. In order that such calculations may be of value they must be based on correct data and must be in such form that the methods can be followed and applied by engineers who may be called upon to lay out the design of pipe lines. In addition, therefore, to attempting to carry out the main purpose of this paper an effort has been made to compile the results of the best practice in pipe-line design and to elucidate the application of the methods described.

The rate of heat loss from a hot oil pipe line has a governing effect upon the location of stations. As the temperature of the oil drops due to loss of heat by radiation, the viscosity of the oil increases rapidly and a point is reached where it becomes necessary to install a pumping station and heaters to force the oil along. The low specific heat of crude oil, approximately 0.5, accounts in a measure for the rapidity with which the oil drops in temperature during its passage through the pipe line, because for a given loss of heat the temperature of the oil will drop twice as fast as would that of water.

The heat loss from a heated surface varies with the difference in temperature of the surface and the surrounding air. In oil pipe lines where the oil is heated to 170 deg. F. and discharged around 100 deg. F. the temperature difference between the pipe and the air (or earth) will vary generally from 30 to 100 deg. F. In passing through varied country a ditched line unprotected by insulation meets with varied radiation losses.

THERMAL LOSSES IN TRANSIT LINES

The loss from such a line is vastly increased during rainy periods when the ground is full of moisture which leads the heat away from the pipe line by conduction. In such cases it is very difficult to estimate the terminal and intermediate temperatures of the oil in advance of the construction of the line. The use of a suitable insulating covering on the pipe line will in large measure nullify the effect of these variations, thus adding greatly to the reliability of temperature determinations in advance of construction. The chief virtue of such a covering is, however, to be found in the enormous heat saving which is effected. The oil retains its heat much longer and the costly pumping and heating stations which form the principal element of cost in pipe-line construction and maintenance can be spaced considerably further apart. When it is considered that one of these stations costs in the neighborhood of \$300,000 this aspect becomes most important. The

reason for this saving in heat is to be found in the fact that the conductivity of a 1 in. thickness of 85 per cent magnesia covering per square foot of pipe surface per hour per degree temperature difference averages 0.45 B.t.u. for temperature differences between 25 and 125 deg. F., while the bare pipe loss in air is between four and five times as much and the ditched pipe loss lies between the two and may exceed that in air if the ground is wet.

The questions to be considered are: (a) How much further will the heat carry in an insulated line than in a bare line, and (b) how much further apart can stations be spaced if the line be insulated? The proper spacing of stations must be determined by the hydraulic formula.

CALCULATION OF THE FLOW OF VISCOUS FLUIDS

The formula we shall use is the d'Arcy formula as modified by Prof. W. F. Durand for use with viscous fluids.¹

Let u = viscosity in absolute units;

ρ = density, lb. per cu.ft.;

D = diameter of pipe in feet;

L = length of pipe in feet;

v = velocity, feet per second;

p = loss in pressure head due to friction, in lb. per sq.in.

The formula may then be put in the form

$$p = \frac{f \rho v^2 L}{288 g D} \quad (1)$$

where f is a function of $\frac{D \rho v}{u}$ defined by $f = \phi \left(\frac{D \rho v}{u} \right)$

Prof. Durand has shown that where the value of $\frac{D \rho v}{u}$ is less than 2,000 there will be stream line or sinuous flow,

and in such case $f = \frac{64 u}{D \rho v}$. Where the value of $\frac{D \rho v}{u}$ exceeds 2,000 there will be turbulent flow and the value of f in such case is given by the following table:

$\frac{D \rho v}{u}$	f	$\frac{D \rho v}{u}$	f
2,500	0.0442	12,000	0.0304
3,000	0.0426	14,000	0.0292
3,500	0.0412	16,000	0.0280
4,000	0.0400	18,000	0.0271
4,500	0.0390	20,000	0.0264
5,000	0.0382	25,000	0.0249
6,000	0.0364	30,000	0.0238
7,000	0.0350	35,000	0.0228
8,000	0.0340	40,000	0.0219
9,000	0.0330	45,000	0.0213
10,000	0.0320	50,000	0.0208

In order to be on the side of safety in design the value 0.0442 should be taken for f when the value of $\frac{D \rho v}{u}$ is 2,000.

It will be observed from equation 1 that the loss of

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¹Journal of Electricity, vol. 44, p. 434. See also article by A. C. Preston in CHEM. & MET. ENG., vol. 23, pp. 607-613 and 685-689.

pressure in any section of a given pipe line of constant diameter will vary with both the viscosity and the density of the oil in that particular section. It will not do to assume a constant viscosity and density throughout the length of the pipe line, as both these quantities vary with the temperature of the oil and the temperature is dropping continuously as the oil proceeds from one pumping station to the next. The viscosity, particularly, increases so rapidly as the temperature is reduced that we have very different conditions in the various sections of the same line. For these reasons the loss of head will be computed from point to point along the line. The variations referred to may give rise to such pronounced effects that while we may have turbulent flow at the beginning of a line where the oil is warmest, a point will be reached further along the pipe where the flow will become stream line in character as the temperature decreases and the viscosity rises. An example of such a case will be given later on.

SPACING OF PUMPING STATIONS

The following steps are necessary for the solution of the question regarding the spacing of stations. They are:

(1) The construction of a curve showing the temperature of the oil as a function of distance traveled.

(2) The construction of curves showing the viscosity and density of the oil as a function of distance traveled.

(3) The construction of curves showing the values of $\frac{Dv_o}{u}$ and of f as a function of the distance.

(4) The construction of a curve showing the pressure in the pipe line as a function of the distance. This curve gives the hydraulic gradient. The point of intersection of the hydraulic gradient with the line representing zero pressure gives the location of the next pumping station if the elevations are equal.

TEMPERATURE OF THE OIL DURING FLOW

Let us now develop a formula for the determination of the temperature of the oil at any point in the pipe line, as it is on this determination that all subsequent work must be based.

Let V = velocity of oil, feet per hour;

L = length of pipe, feet;

t = time required for oil to pass through L feet of pipe, hours.

w = weight of oil in 1 ft. of pipe, pounds;

T = temperature of oil at beginning of length L ;

T' = temperature of oil at end of length L ;

T'' = mean temperature difference between oil and air in length L ;

k = specific heat of oil = 0.5;

T_o = temperature of air;

Q = quantity of heat radiated from pipe of length L in time t ;

a = radiating surface of 1 ft. length of pipe, in square feet;

t' = thickness in inches of an insulating covering on a flat surface which will give the same thermal resistance as the thickness of the same material which is used on the given pipe, or the equivalent thickness of the insulating material if applied to a flat surface;

c' = conductivity of 1 in. thickness of insulation in B.t.u. per sq.ft. per hour per degree temperature difference between pipe and air;

R' = radius of outside of pipe in inches;

R'' = radius of outside surface of insulation in inches;

c = radiation from bare pipe, B.t.u. per sq.ft. per hour per degree temperature difference between pipe and air.

The radiation from L feet of bare pipe in time t will be

$$Q = acT''Lt \quad (2)$$

As the wL pounds of oil contained in the L feet of pipe will lose this same amount of heat in the time t , the temperature of the oil falling from T to T' , we may also write

$$Q = wLk(T - T') \quad (3)$$

Equating these values of Q , substituting for t its value $\frac{L}{V}$, and solving for L , we have

$$L = \frac{(T - T') Vwk}{acT''} \quad (4)$$

$$\text{Also, } T'' = \frac{T - T'}{\ln \frac{T - T_o}{T' - T_o}} \quad (5)$$

$$\therefore L = \frac{Vwk}{ac} \ln \frac{T - T_o}{T' - T_o} \quad (6)$$

Values of T'' and $\ln \frac{T - T_o}{T' - T_o}$ are given in the Table I.

Initial and Final Temperature of Oil	Temperature of Air					
	70 Deg.		80 Deg.		90 Deg.	
	T''	$\ln \frac{T - T_o}{T' - T_o}$	T''	$\ln \frac{T - T_o}{T' - T_o}$	T''	$\ln \frac{T - T_o}{T' - T_o}$
170	96	0.1044	85	0.1177	76	0.131
160	85	0.1177	76	0.131	64	0.157
150	76	0.131	64	0.157	55	0.182
140	64	0.157	55	0.182	45	0.223
130	55	0.182	45	0.223	35	0.285
120	45	0.223	35	0.285	24.5	0.4055
110	35	0.285	24.5	0.4055	14.5	0.6931
100						

Values of c for above-ground uninsulated pipes to be used in formula 6 are as follows (see *Trans. A.S.M.E.*, vol. 40, p. 674):

T''	30	40	50	60	70	80	90	100	110
c	1.90	1.92	1.95	1.99	2.03	2.07	2.11	2.15	2.22

From equation 6 we may obtain the distance the oil can be pumped before its temperature falls to T' .

In the case of an insulated pipe, equation 2 takes the form

$$Q = \frac{ac'T'Lt}{t'} \quad (7)$$

and equation 3 remains the same. The corresponding solution for L gives

$$L = \frac{(T - T') Vt'wk}{ac'T'} \quad (8)$$

Since $t' = R' \ln \frac{R''}{R'}$, and substituting for T'' its value as given by equation 5, we have

$$L = \frac{VwkR'}{ac'} \ln \frac{T - T_o}{T' - T_o} \ln \frac{R''}{R'} \quad (9)$$

Values of c' for 85 per cent magnesia to be used in

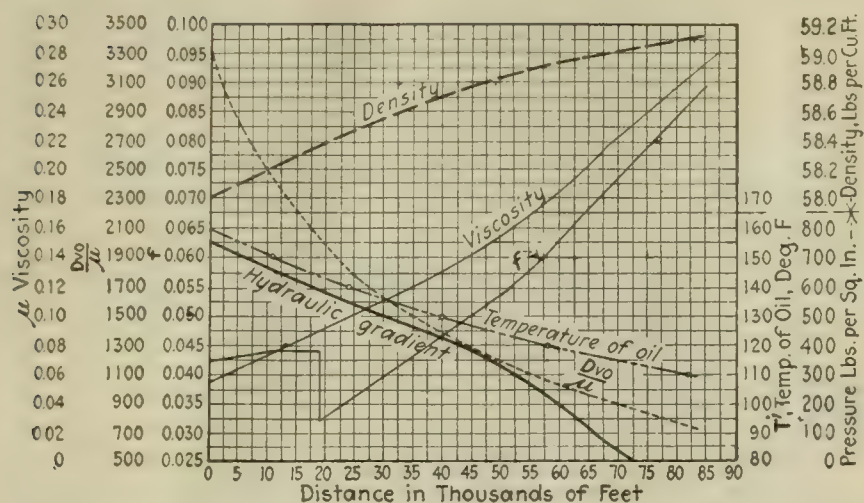


FIG. 1. 8-IN. PIPE LINE, UNINSULATED, DITCHED
25,000 bbl. of 15 deg. BÉ. per 24 hr. Initial temperature,
160 deg. F. Initial pressure, 750 lb. per sq.in.

this equation have been carefully worked out from experiments conducted at the Mellon Institute (see *Trans. A.S.M.E.*, vol. 40, p. 674) and are as follows:

T''	25	50	75	100	125
c'	0.43	0.44	0.45	0.46	0.47

TEMPERATURE-DISTANCE CURVES

As a specific example to illustrate the application of formulas 6 and 9 and to illustrate the plotting of the temperature-distance curves, let us take 15 deg. BÉ. oil with an initial temperature of 160 deg. F. and being pumped through an 8-in. line at the rate of 25,000 bbl. every twenty-four hours, and let us first determine the distance it will travel through an above-ground uninsulated pipe before its temperature falls to 150 deg. F. We have then

$$\begin{aligned} V &= 16,740; \\ w &= 0.347 \times 58.12 = 20.17; \\ T_o &= 80, T = 160, T' = 150, T'' = 76; \\ a &= 2.258; \\ c &= 2.05. \end{aligned}$$

Substituting these values in equation 6, we get $L = 4,970$ ft.

Now if the pipe be covered with a standard 85 per cent magnesia covering $1\frac{1}{4}$ in. thick, we will have

$$c' = 0.45, \text{ and } R' \ln \frac{R''}{R'} = 1.1, \text{ which substituted in}$$

equation 9 gives $L = 24,000$ ft.

The temperature-distance curves in the figures are plotted in this manner for every 10 deg. temperature difference. The values of c and c' used in each computation must be changed to accord with the value of T'' . The values of L given by equation 9 are conservative, as c' gives only the conductivity of the covering and no allowance has been made for the resistance to heat transfer from the surface of the covering to the air. Unless the air circulates so rapidly as to reduce the temperature of the surface of the covering to the same temperature as the air, this surface resistance will be an added resistance to heat loss and the length of pipe traversed by the oil before it reaches a temperature of 150 deg. F. will be somewhat greater than that given by the formula.

Expressed in a different way, we may say that equation 9 gives the length of pipe in which the temperature of the oil will fall from T to T' degrees when the wind is blowing strong enough to reduce the temperature of the outer surface of the insulation to the temperature of the air, which is the only safe condition to assume in a calculation of this sort. Equation 9 is equally appli-

cable to insulations other than magnesia provided the conductivity (c') of such insulation is known.

CALCULATIONS FOR DITCHED PIPE LINES

For the case of an uninsulated ditched pipe line equation 6 is to be used. A fair value of c to be used for ditched lines in the formula in this paper is 0.9, which will give a temperature drop of the oil in a given distance corresponding to that found in practice. The corresponding spacing of stations will be slightly in excess of that found in practice (without looping), thus affording a conservative basis for the economic comparisons to be made later on.

This value of c is too low for moist ground, as still water conducts heat about eight times as rapidly as air does. The rate of conduction is much increased if the water has any motion whatever. The fact must always be borne in mind that the value of c for a ditched line will vary with the nature of the ground. This variation is much less pronounced when the line is insulated, providing the insulation is waterproof. Applying the value $c = 0.9$ to the example we have taken and substituting in equation 6, we obtain $L = 10,900$ ft.

The case of insulated ditched lines is also handled by the use of equation 6 after the determination of a proper value of c . Assuming that the pipe is covered with a 1.25 in. thick insulating covering of conductivity 0.45 prior to filling the trench and that the heat loss from a ditched bare pipe is 0.9 B.t.u. per sq.ft. per hour per degree temperature difference of pipe and air, the computed value of c which may be used in formula 6 for the case of the pipe covered with the insulating covering and ditched the same distance under the ground is 0.28.

This value is obtained from the rational formula

$$c'' = \frac{1}{\frac{1}{c} + \frac{t'}{c'}}$$

where c' = conductivity of insulating material per inch thickness per hour per sq.ft. per degree temperature difference between pipe and air = 0.45;

c = heat loss per sq.ft. per hour per degree temperature difference between pipe and air of an uninsulated ditched pipe = 0.9;

t' = equivalent thickness of the insulating material if applied to a flat surface = 1.1 in.

THERMAL EFFICIENCIES OBTAINED IN PRACTICE

Taking the efficiency of the system as the ratio of the heat saving due to ditching or covering, or both, to the heat loss in air, the efficiency of the various systems mentioned for a temperature difference of 100 deg.

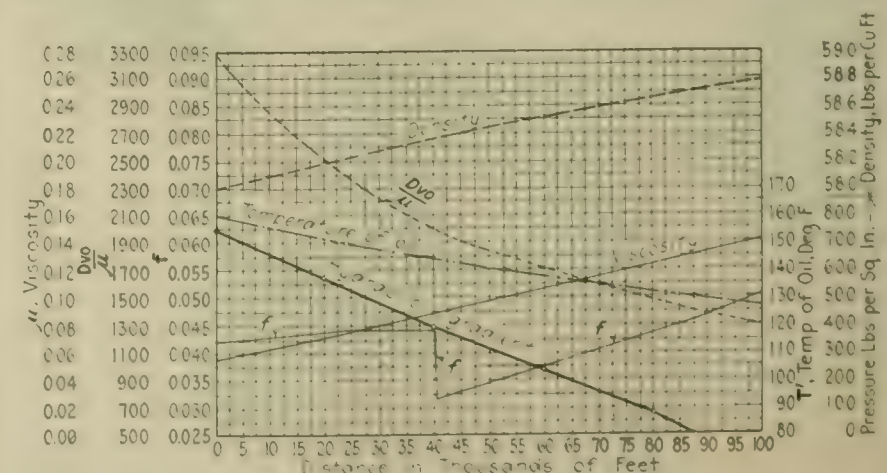


FIG. 2. 8-IN. PIPE LINE, ABOVE GROUND, INSULATED
25,000 bbl. of 15 deg. BÉ. per 24 hr. Initial temperature,
160 deg. F. Initial pressure, 750 lb. per sq.in.

between pipe and air will be found by referring to the tables of values c and c' and the value of c'' just determined for ditched lines.

- The results are as follows:
- (a) for above-ground uncovered pipe the efficiency is 0.
 - (b) For above-ground 8-in. pipe covered with 1.25-in. thick magnesia the efficiency is

$$\frac{100 (2.15) - 100 (0.46) \div 1.1}{100 (2.15)} = 80 \text{ per cent}$$

- (c) For ditched 8-in. bare pipe, the efficiency is
- $$\frac{100 (2.15) - 100 (0.9)}{100 (2.15)} = 58 \text{ per cent}$$

- (d) For ditched 8-in. pipe covered with 1.25 in. of insulation of conductivity 0.45 the efficiency is
- $$\frac{100 (2.15) - 100 (0.28)}{100 (2.15)} = 87 \text{ per cent}$$

RELIABILITY OF THE C COEFFICIENTS

Summarizing what has been said concerning the radiation coefficient, let us consider in turn the reliability of the information given for each type of system. The values of the coefficient c' as given for above-ground insulated lines are very reliable and may be used with confidence. They do not fluctuate except slightly on the side of safety when the wind losses are small. The values of c for above-ground uninsulated lines are reliable and well established. They were determined, however, for still air conditions and would increase for air in motion. The value of the coefficient for ditched uninsulated lines is subject to very large fluctuations according to the nature of the ground and is by far the least reliable. The value of c'' for ditched insulated lines also fluctuates with the nature of the ground, but to a much less extent than the coefficient for ditched uninsulated lines.

THE VISCOSITY-DISTANCE CURVE

The viscosity-distance curve is constructed from the temperature-distance curve and from the viscosity-temperature curve of the oil to be handled as determined by a laboratory test with the viscosimeter.

Where viscosities are measured by means of Saybolt times, the absolute viscosity can be found from the formula

$$\frac{u}{o} = 0.00000237t - \frac{0.00194}{t}$$

where u = viscosity in absolute units;
 o = density, lb. per cu.ft.;
 t = Saybolt time.

If no laboratory determination of the viscosity is available and only the Baumé gravity of the oil is known, the viscosities may be approximated from the following values given by Dyer for California crudes. The curves in the figures are constructed from these values:

Gravity Bé. at 60 deg. F.....	18 2	16 6	15	12 1
Density at 60 deg. F.....	58.95	59.59	60.26	61.48
Temperature, F.	Viscosity			
75.....	0.2450	0.4970	1.5670	.....
100.....	0.1220	0.2230	0.3440	.....
110.....	.....	.....	.....	1.6610
125.....	0.0670	0.0990	0.1500	0.6140
150.....	0.0365	0.0490	0.0750	0.2110
175.....	0.0242	0.0245	0.0310	0.1020

THE DENSITY-DISTANCE CURVE

The density-distance curve is constructed from the temperature-distance curve by the use of formula

$$o = o' - \frac{121.2 - o'}{2713} (t - 60)$$

Where o' = density in lb. per cu.ft. at 60 deg. F.;
 o = density in lb. per cu.ft. at t deg. F.

The curve giving the value of $\frac{Dvo}{u}$ as a function of distance is then computed. Glancing at the curve for the ditched uninsulated line, it will be noted that the flow changes from turbulent to stream line at about 19,000 ft. from the beginning of the line, the value of $\frac{Dvo}{u}$ at this point being 2,000.

THE COEFFICIENT F CURVE

The curve giving the value of f is then constructed by the formula $f = \frac{64u}{Dvo}$ for values of f less than 2,000 and from the table for values of f greater than 2,000.

The pressure curve is now constructed by the use of formula 1 and the curves giving the values of f and o . The pressure drop has been computed and plotted every 20,000 ft., the value of f and o used in each case being the mean values of these quantities for the length of pipe under consideration. Glancing again at the curve for the ditched uninsulated line, it will be observed that the change from turbulent to stream-line flow causes a

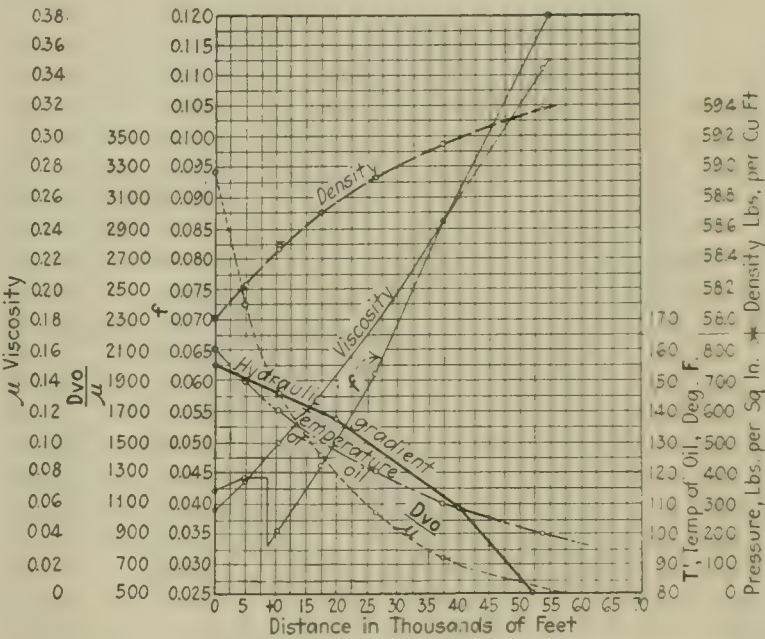


FIG. 3. 8-IN. PIPE LINE, ABOVE GROUND, BARE 25,000 bbl. of 15 deg. Bé. per 24 hr. Initial temperature, 160 deg. F. Initial pressure, 750 lb. per sq.in.

point of inflection in the pressure curve, the curve changing from concave upward to concave downward at this point. In building a line the stations would be spaced a little closer together than given by the curves (assuming no looping or change in pipe sizes) in order to take care of unusual conditions in the viscosity of the oil, in the temperature of the air, and in the moisture content of the ground. As some such correction would be required on all the types of line discussed, although in the insulated lines the pressure drop would increase only due to unusual temperature or viscosity conditions, it follows that the ratio between the computed spacings is about correct and that the spacings found by the curves can be used for the purpose of comparisons of the various systems.

The distance between stations can be increased by adding a "loop" or increasing the pipe size near the end of the line. One of these expedients can always be employed, but they will not be discussed here, as they

do not affect the validity of the results arrived at or of the comparisons to be made.

DISCUSSION OF RESULTS

It is apparent from the curves in the figures that under the assumed conditions the stations on the above-ground uninsulated line can be spaced 9.85 miles apart, those on the buried uninsulated line can be spaced 13.73 miles apart, and those on the above-ground insulated line can be spaced 16.57 miles apart.

Let us now consider the economic aspects of the question. The cost of a steam-operated pumping station for 8-in. line was about \$150,000 when the report of the Federal Trade Commission on pipe-line transportation was prepared in 1916. The cost now would be about \$300,000, and such was indeed the approximate cost of recently constructed stations in Mexico. The annual operating expense and fixed charges per station, including labor, fuel, supplies, interest at 6 per cent, depreciation at 10 per cent, taxes and insurance at 5 per cent, is about \$98,000. With stations spaced every 13.73 miles and pumping at the rate of 25,000 bbl. every twenty-four hours, this amounts to 78c. per thousand barrel miles, the cost of transporting one barrel a thousand miles being the unit of cost employed in the pipe-line industry.

With stations spaced every 16.57 miles and the same rate of pumping, the cost will be 64 $\frac{1}{4}$ c. per thousand barrel miles. The cost of 1 $\frac{1}{4}$ -in. thick 85 per cent magnesia covering applied and covered with standard roofing is approximately \$3,900 per mile. The cost of ditching a pipe line is about \$900 a mile, the cost in 1910 as given by the Federal Trade Commission being \$470 per mile.

We may now form our balance sheet. Comparing an above-ground insulated line with a ditched uninsulated line, the stations in the first case being spaced 16.57 miles apart and those in the second case being spaced 13.73 miles apart, then by the use of the insulated above-ground line we have a capital saving in the original cost of stations of \$372,000 per 100 miles due to the elimination of 1.24 stations, and a saving in the cost of trenching of \$90,000, or a total of \$462,000 per 100 miles, as against a cost of \$390,000 for the necessary insulation. In addition there is a saving in operating expenses, etc., from the elimination of 1.24 stations per 100 miles, of \$122,500 per 100 miles per year, and the 1,000 barrel mile cost for pumping stations is reduced from 78c. to 64 $\frac{1}{4}$ c. The 1,000 barrel mile cost for pipe line is increased by the following charges on the insulation, interest at 6 per cent, depreciation at 10 per cent, taxes and insurance at 5 per cent, repairs at 1 per cent, or a total of \$85,800 per hundred miles of line, or 9 $\frac{3}{4}$ c. per 1,000 barrel miles.

The net savings are: a capital saving of \$72,000 per 100 miles, an annual saving of \$36,700 per 100 miles, and a saving in the 1,000 barrel mile cost of 3.85c.

The balance sheet presented was based on a comparison of a ditched uninsulated line with an above-ground insulated line, for the reason that this appears to be the most conservative and appealing comparison, because the ditched uninsulated line is the type now in general use and because the above-ground insulated line presents the simplest conditions for the application of insulating covering and at the same time gives the steadiest or least fluctuating value of the radiation coefficient.

In addition to the considerations already discussed there is also to be considered the protection of the pipe from electrolysis which is gained by placing it above ground, and the steadiness in operating conditions which is gained by eliminating all the trouble due to moist ground during rainy weather.

Setting a Recording Pyrometer for Cold-Junction Temperature

BY KIRTLAND MARSH*

A recording pyrometer of the deflection or millivoltmeter type, on which it is necessary to set the galvanometer for the cold-junction temperature of the couples connected to it, oftentimes offers considerable difficulty to an accurate cold-junction setting because the lowest graduation on the scale or chart is seldom less than 75 deg. F., while the actual cold-junction temperature is often as low as 50 deg. F. When the cold-junction temperature is higher than the lowest chart or scale division the galvanometer can be set to this temperature as closely as the instrument can be read, but when the cold-junction temperature is lower than the lowest division this setting cannot be made so accurately because there is a scale division on only one side of the setting to serve as a guide.

In many cases very little attention is paid to cold-junction settings; but for those users of pyrometers who endeavor to maintain their equipment as accurate as possible and eliminate all sources of error possible the following method for setting deflection instruments when the cold-junction temperature is lower than the lowest scale division may be of some value:

Disconnect the instrument from the couple and set the galvanometer pointer on the lowest scale or chart division. By means of a potentiometer, Wheatstone bridge or other source of a small variable e.m.f. connected to the instrument deflect the galvanometer an amount equal to the difference between the actual cold-junction temperature and the lowest scale division. With the source of e.m.f. unchanged and still connected to the instrument, reset the pointer to the lowest scale division by means of the zero adjuster. Then when the source of e.m.f. is disconnected from the instrument the zero or cold-junction setting will correspond with the actual cold-junction temperature as closely as the instrument can be read.

For example, given an instrument graduated from 75 to 1,800 deg. F. and a couple the cold junction of which, buried in the ground or in a water-cooled well, is at a temperature of 55 deg. F. With the couple disconnected, set the galvanometer pointer at 75 deg. F. and then by means of a potentiometer connected to the instrument deflect the pointer an amount equal to 75 — 55 deg., or 20 deg., when the reading of the instrument will be 75 + 20, or 95 deg. F. By means of the zero adjuster return the pointer to 75 deg. F. Then when the potentiometer is disconnected the instrument will read 75 — (75 — 55), or 55 deg. F., which is the cold-junction temperature.

Inasmuch as the pointer can be set on a scale division with great accuracy, the error of the final cold-junction setting will be the error of setting the pointer at 95 deg. F., which is less than the error of setting the pointer at 55 deg. F. directly when the lowest scale division is 75 deg. F.

*Aluminum Company of America, New Kensington, Pa.

Comparative Tests of Steels at High Temperatures*

The Tests Recorded in This Paper Were Made to Determine the Comparative Properties of Various Steels at High Temperatures With a View to Obtaining Information as to the Best Material for Use Under Operating Conditions of 600 to 1,000 Deg. F.

BY R. S. MACPHERRAN†

THE following tests were made in the laboratory of the Allis-Chalmers Manufacturing Co. to determine the comparative properties of various steels at high temperatures. The work was undertaken with a view to obtaining information as to the best material for use under operating conditions of 600 to 1,000 deg. F. A large number of these tests were made on sheet metal, turbine blading and other material too thin to allow a pyrometer head to be inserted. It was therefore decided to use for all tests a heating box in which the pyrometer head was practically in contact with the center of the test specimen.

The heating box used was 7 in. square by 9 in. high. The hole in which the test specimen was inserted was 2 in. in diameter and was lined with a core of alundum cement wound with No. 22 gage chromel wire. This wire was wound in two coils, one over the top and one over the lower half of the alundum core. They were connected in multiple. The coils were then covered with alundum cement and the box filled with magnesia. (See Fig. 1.) The couple entered at the top of the box and ran down to such a position that the point was opposite the center of the test specimen. A spring on the outside of the box forced a porcelain rod through a hole and against the base metal couple, holding the point of same against the test specimen. The temperatures were taken by a Leeds & Northrup pyrometer, using a base metal

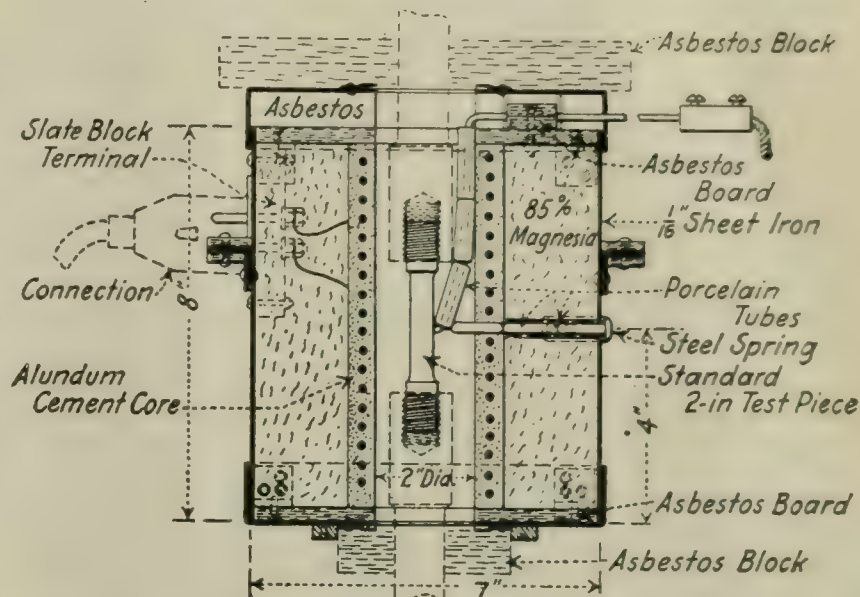


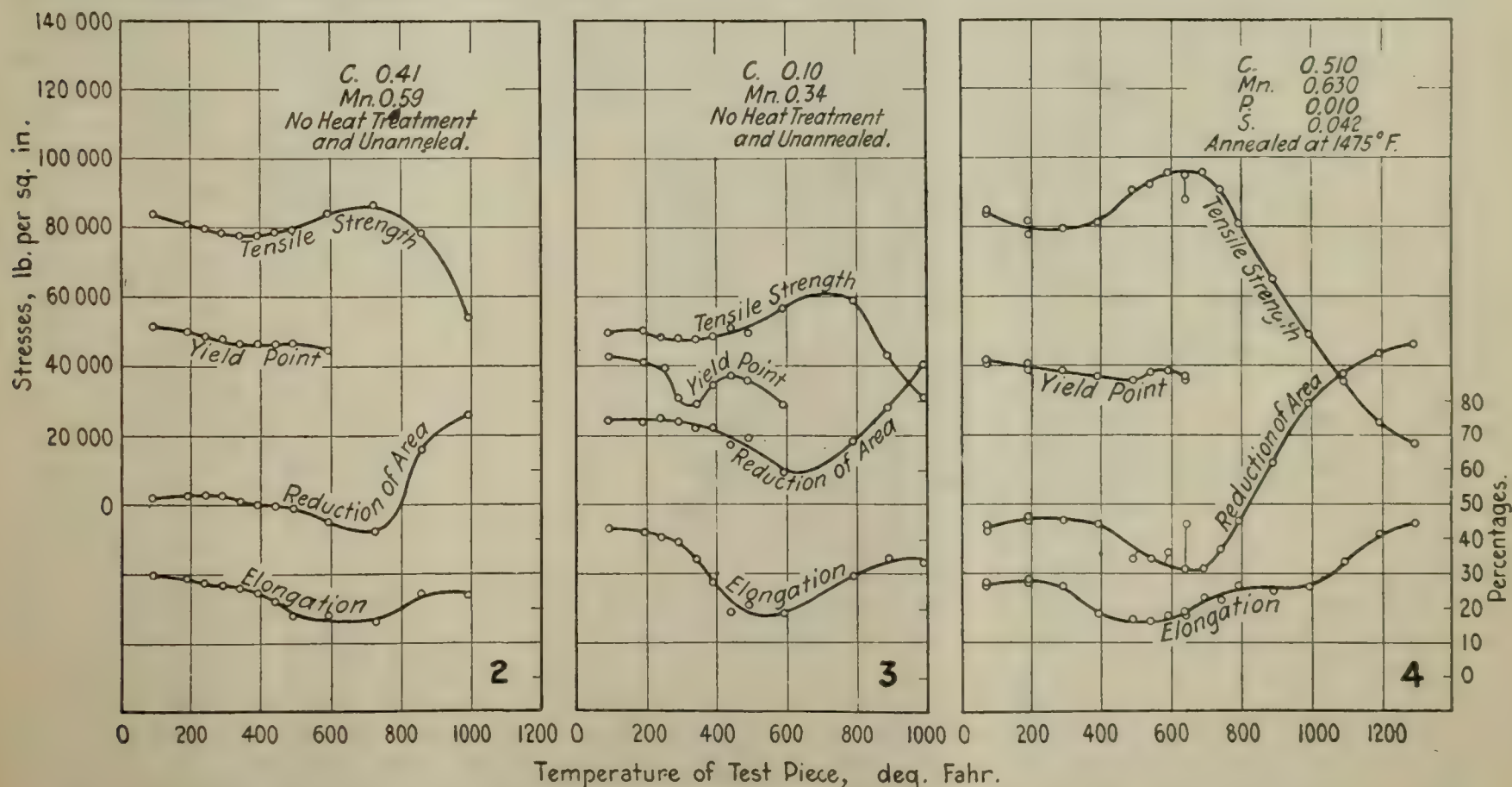
FIG. 1. VERTICAL SECTION OF ELECTRIC HEATER

couple. The specimens used had threaded ends and were for the most part 0.505 in. in diameter. All tests were held at constant temperature for fifteen to thirty minutes before pulling. The yield points were taken by the drop of beam only and above 600 deg. F. are very uncertain.

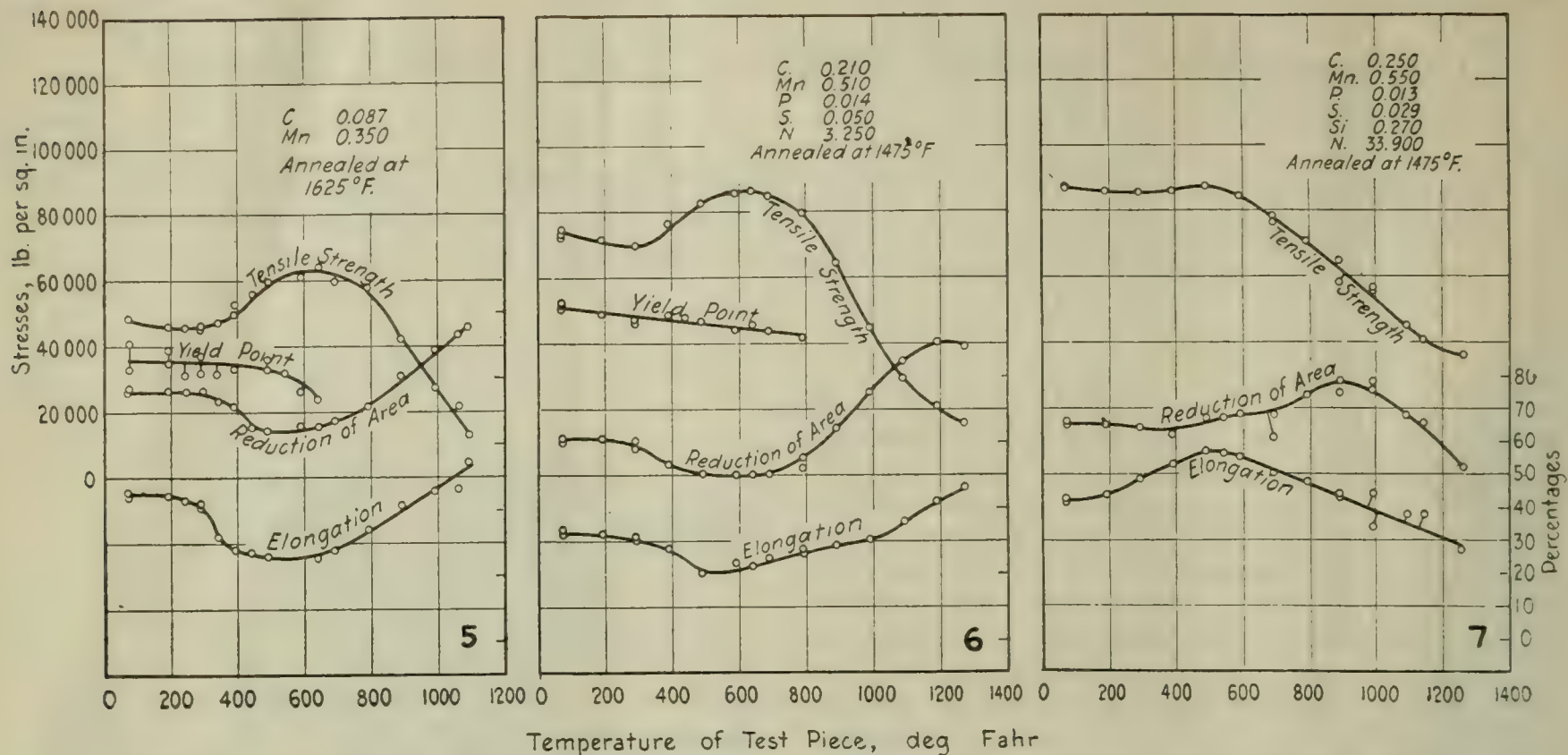
The chrome-vanadium and chrome-nickel steels were quenched and drawn as indicated in the figures. The drawing temperatures are much above the usual, but as the tests were to be run as high as 1,300 deg. F. it was useless to draw the bars at lower than test temperatures.

*Paper read at the meeting of the American Society for Testing Materials, Asbury Park, N. J., June 24, 1921.

†With the assistance of J. F. Harper and E. H. Brown.



FIGS. 2 TO 4. PHYSICAL PROPERTIES AT HIGH TEMPERATURE OF 1-IN. ROUND, ROLLED OPEN-HEARTH STEEL



FIGS. 5 TO 7. PHYSICAL PROPERTIES AT HIGH TEMPERATURES OF CARBON AND NICKEL STEEL

Fig. 5. 3/4-in. round, rolled open-hearth steel. Fig. 6. Forged 3.25 per cent nickel steel. Fig. 7. Forged 34 per cent nickel steel.

All forged test-bars in any one series were made from one billet or piece of steel, this being hammered out into several 1-in. rounds about 30 in. in length. These latter pieces were then all heated at the same time in the same furnace and as far as possible given identical treatment. With the best of care, however, the irregularities were greater than with the rolled material tested after annealing, Fig. 8, for example, showing considerable variations in breaking loads. Fig. 9 is from rolled stock sent in by outside parties and was not treated. Figs. 2 and 3 show results of tests on carbon steel, unannealed, and Figs. 4 and 5 on carbon steel, annealed. The latter are freer from irregularities due to lack of uniformity in material and for this reason are more reliable.

While we cannot assume many definite conclusions from our limited number of tests, the following items seem to be at least probable:

1. There is no one temperature at which all steels will show a decided change in physical properties; this

point will vary in steels of different compositions or treatments.

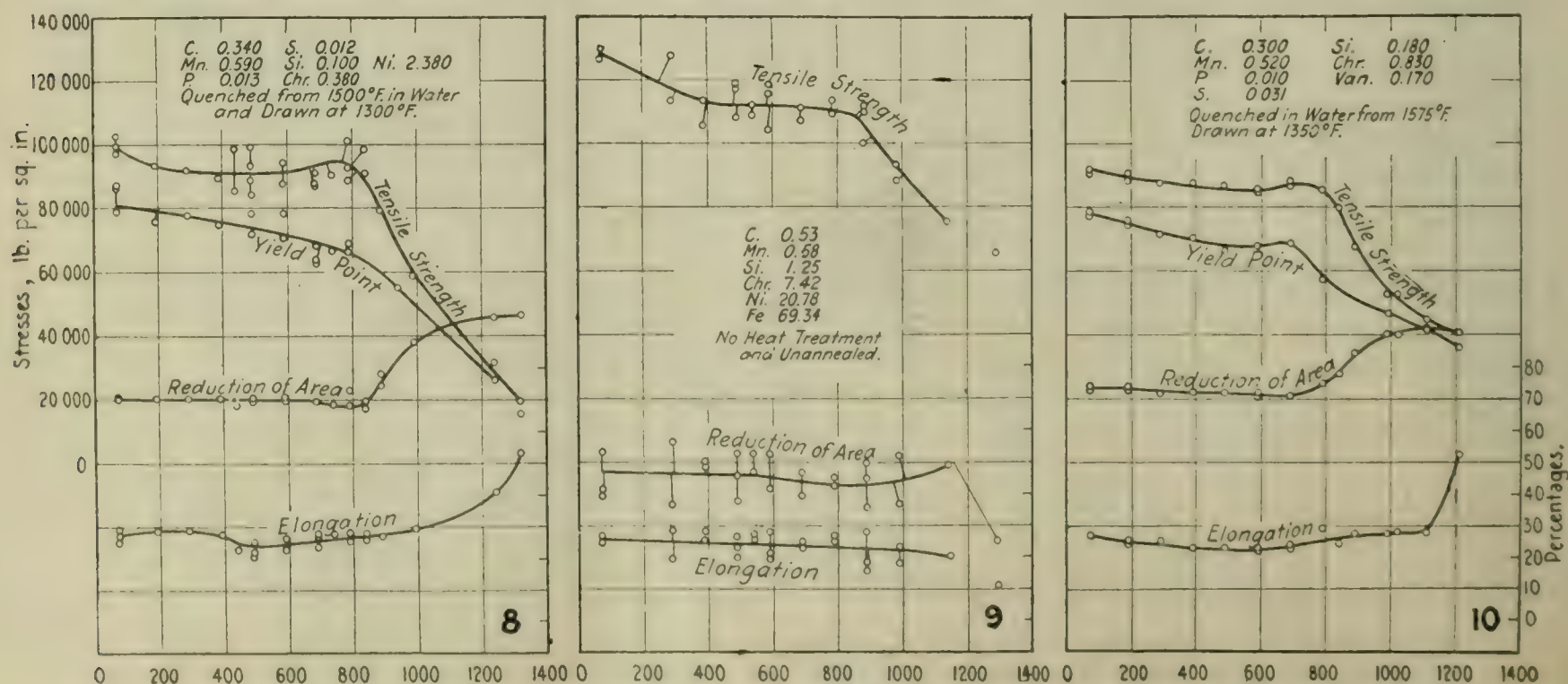
2. The maximum tensile strength for rolled carbon steel, annealed, and forged 3.25 per cent nickel steel, annealed, occurs at between 600 and 650 deg. F.

3. The maximum tensile strength usually occurs at a higher temperature than the minimum ductility.

The majority of the tensile strength curves, especially those of heat-treated steels, drop sharply as the temperature exceeds 800 deg. F.

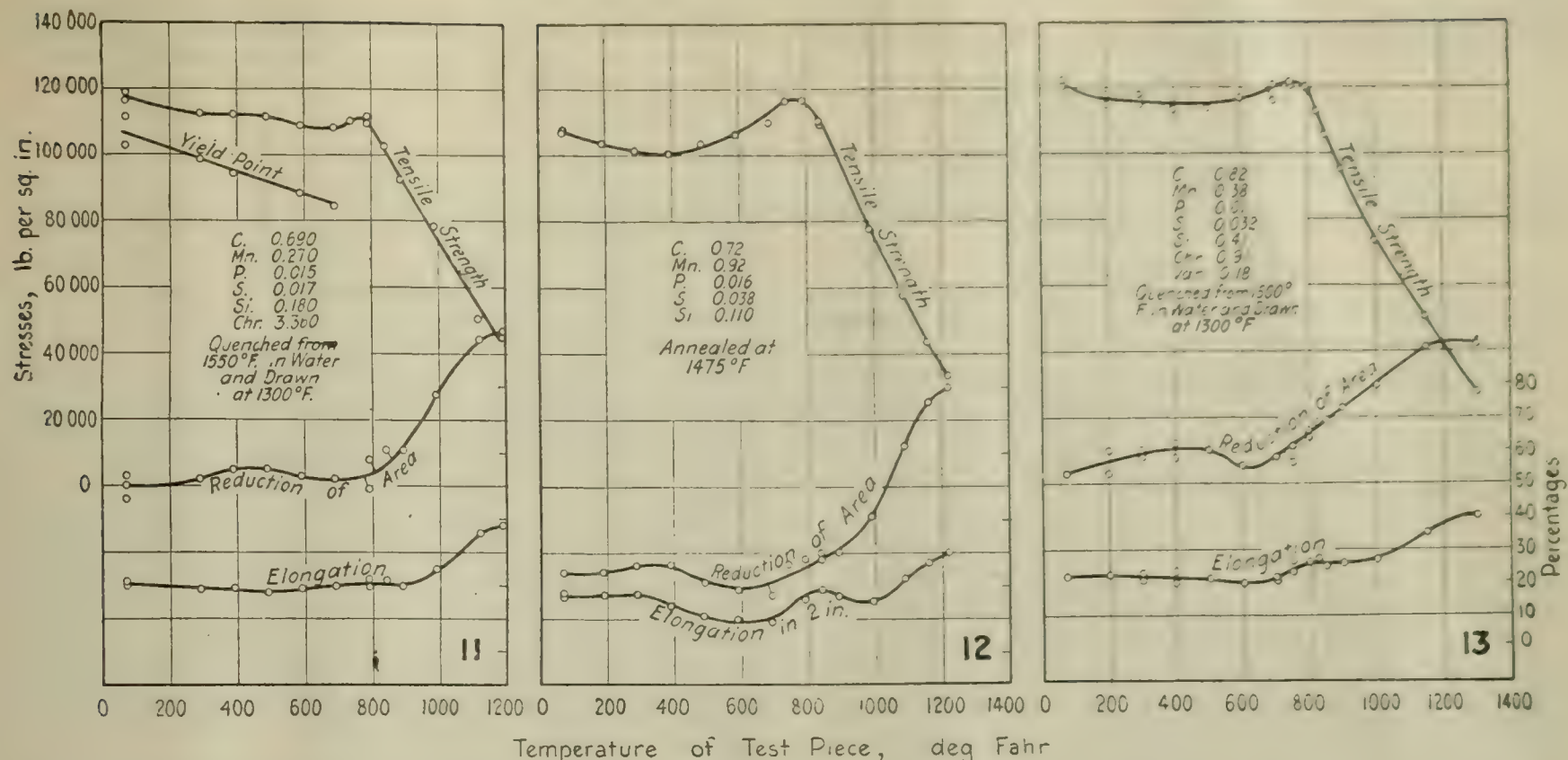
The effect of nickel in small amounts is slight, but in large percentages it tends to lower the temperature at which tensile strength begins to decline. Steel containing nickel is also the only steel examined where the ductility materially diminishes at the higher temperatures. It may here be noted that the same property was observed in the one set we ran of forged Monel metal bars.

The alloy steels containing chromium are less affected by rise in temperature than carbon steels. The curves



FIGS. 8 TO 10. PHYSICAL PROPERTIES OF ALLOY STEEL AT HIGH TEMPERATURES

Fig. 8. Forged chrome-nickel steel. Fig. 9. Rolled high chrome-high nickel steel. Fig. 10. Forged chrome-vanadium steel.



FIGS. 11 TO 13. PHYSICAL PROPERTIES OF ALLOY STEEL AT HIGH TEMPERATURES

Fig. 11. Forged high-chrome steel. Fig. 12. Forged high manganese steel. Fig. 13. Forged high-carbon-chrome-vanadium steel.

of the tensile loads, elongation and reduction all run out more nearly straight than in carbon steels and the maximum loads occur at higher temperatures. It is true that the carbon steels were not heat-treated and it is possible that quenching and tempering would alter the shape of these curves.

The results so far obtained would indicate that the introduction of metals forming carbides tends to strengthen steels at high temperatures.

It is interesting to note that in tests for the comparative retention of physical properties in alloy steels at 1,200 deg. F. and over, Leslie Aitchison¹ finds the order of value to be:

1. Tungsten.
2. High chromium.
3. Nickel, 3 per cent.

It would seem with higher steam pressures and increased use of internal combustion engines that the properties of the various alloy and carbon steels at high temperatures should receive further consideration.

Pulp and Paper Developments in Quebec During 1920

In a report to the Bureau of Foreign and Domestic Commerce on the paper industry of the Province of Quebec for 1920 Consul E. Haldeman Dennison, Quebec, says:

The forest industry holds second place in the province from the standpoint of value of its products, and the Quebec Government last year derived from its forest resources, principally from its pulpwood limits, over \$2,600,000, or about 15 per cent of its total revenues.

Quebec continues to lead all Canadian provinces in the pulp and paper industry. Capital to the amount of over \$100,000,000 is now invested therein. The annual combined wages of the employees amount to over \$10,000,000. The industry consumes over 1,000,000 cords of pulpwood and produces pulp and paper products to the

value of upward of \$75,000,000 annually, nearly all of which is sold in foreign markets.

The production of pulp and paper in 1920 showed a marked increase over that of the previous year. The price of newsprint at the beginning of 1920 was 3½c. per lb. and by the end of the year had risen to 6½c.

Several important developments are now under way in the province. They include the erection of new pulp and paper mills at Three Rivers by the International Paper Co., which, when completed, will have a daily capacity of 200 tons of pulp and 200 tons of paper. The Laurentide Co. is installing two new newsprint machines at Grand Mère, with a daily capacity of 350 tons of newsprint and 60 tons of board.

Four new kraft paper machines, capable of producing about twelve tons a day each, are being installed at Three Rivers by the Wayagamack Pulp and Paper Co., which will bring the total kraft production up to 100 or 115 tons a day. This company recently added 2,000 square miles to its timber limits. At Kenogami the firm of Price Bros. & Co. is adding a new 50-ton newsprint machine, increasing its newsprint output to 300 tons daily. The Howard-Smith Paper Mills at Crabtree are adding a new paper machine which will increase their output of high-grade writing paper from their two mills to 100 tons daily.

During the year the Saguenay Pulp & Paper Co. increased its output from 80 to 130 tons a day, while the Brompton Pulp & Paper Co. at East Angus is now constructing a new groundwood mill of 100 tons daily capacity. This company has recently acquired an additional tract of land comprising 90,000 acres, estimated to contain over 1,000,000 cords of pulpwood. The Belgo-Canadian Pulp & Paper Co. is also building a new groundwood mill of 40 tons daily capacity at Shawinigan Falls and making other extensive additions.

At the beginning of 1920 Canadian newsprint mills had a total capacity of 2,775 tons per day, and it is estimated that at the beginning of 1922 this capacity will have increased to 3,245 tons per day and that by 1923 Canada's newsprint production will total over 1,000,000 tons per year.

¹Leslie Aitchison, "Valve Failures and Valve Steels in Internal Combustion Engines," *London Engineer*, Dec. 12-19, 1910.

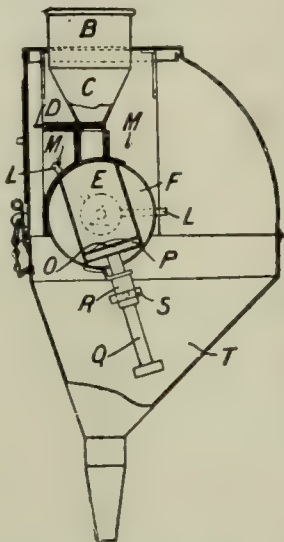
Recent Chemical & Metallurgical Patents

British Patents

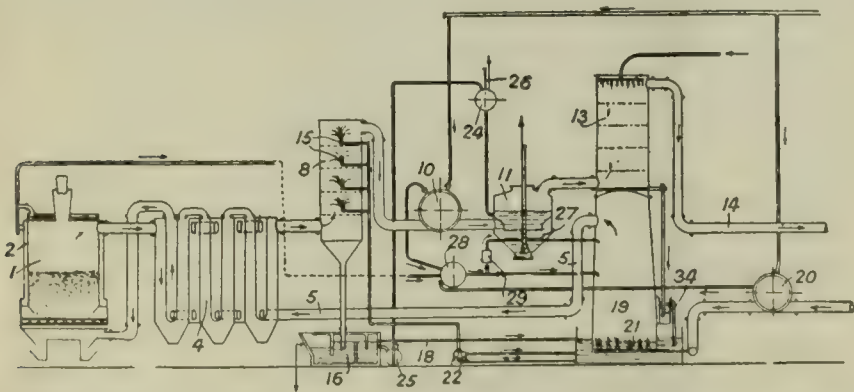
For complete specifications of any British patent apply to the Superintendent British Patent Office, Southampton Buildings, Chancery Lane, London, England.

Delivering Measured Quantities of Granular Materials.—

A device for delivering measured quantities of granular materials, in which an adjustable measuring chamber *E* forming part of pivotally-mounted oscillatory cylinder *F* has an opening which is brought into register with the lower part of a chute *C* communicating with an upper hopper through a chute or tube *B*, has an adjustable piston *O* in the measure *E* encircled by a resilient ring *P* to insure a sliding fit. It is adjusted by a graduated depending stem *Q* secured in position by a clamping screw *S* carried by a bracket *B*. Supplies to the measuring chamber may be cut off by sliding plate *D*. Arms *L* engaging stops *M* limit the movement of the cylinder *F*, which discharges into chute *T*. (Br. Pat. 160,005; J. W. CROWTHER, Darlington, County Durham, May 11, 1921.)



Gas-Producer Plant.—In a gas-producer plant, the air for use in the producer is heated and charged with steam by being brought into contact with water that has been used to remove fixed ammoniacal compounds from and cool the hot gases. The gases leaving the producer 1 pass through a heat-exchanger 4, a chamber 8 having spraying nozzles 15, a tar extractor 10, a saturator 11 and a scrubber 13, finally passing away through a pipe 14. Air under the action of a fan 20 is bubbled through a hot ammoniacal solution by a device 21, passes up the lower part 19 of the scrubber, is mixed with steam, not only from the jacket 2 of the gas producer, but also from the exhaust from the engines driving the fans 10 and 20, this steam passes through a chamber 28, and the mixture of air and steam pass by a pipe 5 through the heat-exchanger 4 to the producer. Water from the nozzles 15 charged with tarry compounds and fixed ammoniacal



salts falls to a receptacle 16, in which tar is separated and the liquor flows by a pipe 18 to the lower part 19 of the scrubber, to be used to supply steam to and heat the incoming air, the liquor then being passed by a pump 22 to the spraying chamber 8. A portion of the liquor is supplied by a liquid-raising device 25 to a receptacle 24, where it is mixed with the sulphuric acid for feeding the saturator 11, hydrochloric acid and the like escaping through a pipe 26. The saturator is steam heated by a coil 27 supplied with steam from the chamber 28, which steam may be superheated in an apparatus 29 burning producer gas. Some of the water from the scrubber 13 passes through an overflow device 34 to the bottom of the lower part 19 of the scrubber. (Br. Pat. 160,151; not yet accepted; SOC. FRANCO-BELGE DE FOIRS A COKE, Brussels. May 11, 1921.)

Sodium Bicarbonate-Ammonium Chloride.—In a modified ammonia-soda process, salt and gaseous ammonia are dissolved in a mother liquor containing ammonium carbonate and ammonium chloride, and carbon dioxide, preferably pure and under pressure, is passed into the liquor until sodium bicarbonate equivalent in quantity to the salt and ammonia added is precipitated. The carbonating apparatus is provided with stirring means—e.g. of the Boulevard type—and also with a cooling system. Although the salt must be dissolved separately, it is advantageous to add some during the carbonation. The sodium bicarbonate is removed and washed and the mother liquor, after the addition of ammonia to convert the ammonium bicarbonate present to carbonate, is run to crystallizers fitted with stirrers and cooling coils. Ammonium chloride is separated at atmospheric temperature or at 5-10 deg. C., and the washing water, etc., having been added to the liquor to maintain its initial volume, the whole process is repeated. Alternately, a solution of ammonium bicarbonate prepared from wash-water by means of ammonia and carbon dioxide may be added to the saline solution of ammonium carbonate, instead of saturating successively with ammonia and carbon dioxide. (Br. Pat. 160,172; not yet accepted; L'AIR LIQUIDE SOC. ANON. POUR L'ETUDE ET L'EXPLOITATION DES PROCÉDÉS GEORGES CLAUDE, Paris. May 11, 1921.)

Scouring and Leather Dressing Composition.—A composition to be mixed with water to scour leather, with soda solution to scour wool and with oils to dress leather is prepared by mixing a neutralized sulphonated oil such as sulphuricinate of soda or ammonia with an organic solvent, preferably non-flammable. Solvents specified are carbon tetrachloride, tetrachlorethane, trichlorethylene, tetrahydronaphthalene, benzene and naphtha. In an example, 40 parts sulphuricinate are mixed with 60 parts tetrachlorethane. For wool scouring, 1 part of the product is used with 10 of soda, and for dressing chrome leather 4 parts with 2 parts of neatsfoot oil and 2 parts of oil. (Br. Pat. 160,738; not yet accepted; A. T. HOUGH, Choisy-le-Roi, Seine, France. May 19, 1921.)

Purifying Blast-Furnace Gases.—The flammable dust contained in blast-furnace and like gases is oxidized by the admission of a small quantity of air to the gas before purification. The control of the air supply may be co-ordinated with the gas generation in order to prevent the formation of an explosive mixture by closing the air-inlet valve when the main gas valve or the blast valve or damper is closed or by mounting the air supply fan on the shaft of the gas exhauster. Indicating or registering means may be provided for the air supply. (Br. Pat. 160,758; not yet accepted; HALBERGERHÜTTE GES., Halbergerhütte, near Brebach, Germany. May 19, 1921.)

Firing of Ceramic Ware in Tunnel Ovens.—In the firing of ceramic ware in tunnel ovens the heating of the high-temperature zone is interrupted at intervals to allow the goods therein to cool down to a temperature at which they are sufficiently hard to allow the trucks to be moved forward without risk of damage. The gas connections to two adjacent tunnels may be so arranged that their high-temperature zones are fixed alternately. During the interruption in firing the temperature of the preliminary heating zone of the oven is maintained or increased by auxiliary burners. Cooling devices may be fitted in the cooling zone and the heat abstracted may be used for drying. (Br. Pat. 160,814; not yet accepted; ALLGEMEINE ELEKTRICITÄTS GES., Berlin. May 19, 1921.)

Phosphate Fertilizer.—Natural calcareous phosphates or analogous phosphates, such as bone phosphate, which contain tricalcium phosphate and carbonate of lime, are treated in a rotary furnace with a current of sulphur dioxide, air and steam, at a temperature not exceeding 1,000 deg. C., whereby a mixture of mono- and di-calcium phosphates with calcium sulphate is produced, which is suitable for use as a manure. The presence of a small amount of a chloride, such as calcium chloride, facilitates the reaction. (Br. Pat. 160,847; J. J. MOREL, Grenoble, France. May 19, 1921.)

Current Events

in the Chemical and Metallurgical Industries

Burgess Nominated for Tariff Commission

William Burgess, of Trenton, N. J., prominently associated with ceramic industries since 1879, has been nominated by President Harding to be a member of the United States Tariff Commission. Mr. Burgess is executive commissioner of the United States Potters' Association and prominent in the affairs of the American Ceramic Society. He formerly was a professor of chemistry at Princeton University. His business activities have been devoted largely to the importing and jobbing of china and pottery wares. He is widely known for his public-spirited efforts to be helpful to the entire pottery and other ceramic industries.

For many years he has made a special study of the tariff and has made numerous confidential trips abroad to make studies of the tariff situation for the Government. For a time he was United States consul in the great pottery-producing district of Stoke-on-Trent, England. During the war he was one of the department heads of the War Industries Board.

U. S. Industrial Waste Commission Proposed

A federal commission to study waste elimination in industry is proposed in a bill which has been introduced by Senator Calder. The bill is intended to continue and to amplify the survey made by the Federated American Engineering Societies at the instigation of Herbert Hoover, who at that time was president of the organization.

Senator Calder's bill provides that the commission is to be known as the United States Industrial Waste Commission. It is to be composed of seven commissioners "of eminent attainment," appointed by the President. The bill specifies that the Secretary of Commerce is to be the chairman.

The commission is directed by the bill to make a final report on or before Sept. 21, 1922. The report is to cover waste in "timber, power, transportation, oil, coal, essential minerals and other basic raw materials. The commission is specifically instructed to recommend improved methods and means of eliminating intermittent and seasonal production, and is to serve without salary.

There is reason to believe that the Committee on Commerce, to which the bill has been referred, will take prompt and favorable action on it. The attention of the committee has been called to the fact that needless waste in industry is levying a heavy toll on business and on the public. It is emphasized that no regulation is contemplated in this legislation and that there is not to be a suggestion of interference with private initiative.

It is believed that such a commission will be able to draw public attention to some of the basic causes of waste and to practical methods by which they may be checked.

Irregularity of employment is recognized as one of the matters to which the commission would have to give much attention. The Committee on Commerce, in considering the bill, has before it information to the effect that the shoe-maker is idle 35 per cent of his time, the clothing worker 31 per cent. In other industries conditions are even more unfavorable. Data before the committee show that labor, directly and indirectly, is responsible for 88 per cent of the total cost of building. This high labor cost is due, in part, to the fact that in normal years building labor is idle one-third of its time.

The Superpower Survey is cited as an effort to eliminate waste. In the Boston-Washington industrial area about 17,000,000 hp. is being produced. Of this only 10,000,000 hp. is actually productive. The remaining 7,000,000 hp. either is wasted or is used to transport the fuel for the

10,000,000 hp. actually effective. The Superpower Survey is expected to show that the gradual development of an interlocking system of electrical transmission between superpower plants, to which coal could be transported economically, and a gradual development of hydro-electric plants would result in saving most of this 7,000,000 hp. In addition, byproducts could be saved and the transportation system correspondingly relieved. This has been cited to the committee as one example of what may be accomplished along the line of waste elimination.

The committee has also been furnished with data showing that there is great waste resulting from lack of co-ordination of railways, waterways and coastwise shipping, which among other things would relieve the rail lines of much of their burden of low grade, unprofitable freight. Specific instances of waste in coal production, petroleum production, lumber manufacture and many other activities have been pointed out to the committee.

International Standards

The secretary of the American Engineering Standards Committee, Dr. P. G. Agnew, has attended a conference in London of the secretaries of the national standardizing bodies. The conference had for its object an interchange of experience and the furtherance of co-operation among the various national bodies in their work of industrial and engineering standardization.

It is interesting that, notwithstanding great differences in the details of procedure, the same general method of work is followed in the different countries—namely, technical decisions concerning any specific piece of work are in the hands of a working committee which is so constituted as to be broadly representative, from both the technical and the managerial points of view, of the particular branch of the national industry concerned.

Suggestions of the conference have to do with the interchange of publications, a reciprocal arrangement for making foreign standards available and the exchange of information as to the status of work in progress. It was the view of the conference that international co-operation in industrial standardization work should proceed along such informal lines, being based primarily upon the interchange of information on active subjects of mutual interest, rather than by any attempt at the present time to form a general international standardizing body.

Conference on Petroleum Specifications

The Technical Committee on Standardization of Petroleum Specifications plans an open meeting in the offices of the United States Bureau of Mines in Washington, Tuesday, July 12, at 10 a.m. Eastern Standard time, for the consideration of suggested modifications and additions to Bulletin 5, which contains the specifications under which governmental purchases of gasoline, kerosene, fuel and lubricating oils are made.

From the standpoint of the oil trade the most important change proposed is the addition of a corrosion test to the specifications for motor gasoline. Some of the gasoline recently purchased has been found to be corrosive, and a test has been proposed to insure against a repetition of the trouble.

A few new specifications to cover products not now listed in Bulletin 5 have been suggested. Other modifications have been proposed, looking to improvement in the manner of making some of the tests.

N. A. C. Smith, petroleum chemist of the Bureau of Mines, is chairman of the technical committee.

Manufacturing Chemists' Association Annual Meeting

At the annual meeting of the Manufacturing Chemists' Association, the following officers were elected:

President, Charles L. Reese; vice-presidents, H. H. S. Handy and C. Wilton Miller; treasurer, S. W. Wilder; secretary, John I. Tierney; executive committee, Henry Howard, chairman; Adolph G. Rosengarten, Lancaster Morgan, C. Wilbur Miller, D. W. Jayne, H. H. Dow, E. L. Pierce.

The executive committee report for the year ended June 15, 1921, was presented by Dr. Henry Howard. Activities during the year included: Recommendations for tariff revision; arguments against the Federal Trade Commission section of the Nolan patent bill; appointment of a committee to co-operate with Secretary Hoover in collecting statistics on the production of sulphuric acid, nitric acid, soda ash, caustic soda and methanol; investigations at the Bureau of Explosives on a standard package for acid carboys; a conference with the Consolidated Classification Committee in regard to a suggested reclassification of acid shipments.

British Columbia Notes

The B. C. Cement Co. has closed its plant at Tod Inlet, ten miles from Victoria. For some time the plant has been kept in operation by orders from the Orient. With the exception of three or four heads of departments, the plant has been run entirely by Chinese labor. The value of the output of the plant in 1919 was \$260,000. The company owns and operates another plant on Vancouver Island.

The Prince Rupert Paper & Pulp Co. has acquired the British Columbia holdings of the North Empire Timber Co. This is one of the biggest timber deals that has been made in the province for some time. The timber area that has been purchased is only a few miles from Prince Rupert, and it is said to contain a billion feet of timber, 90 per cent of which is spruce and hemlock. The North Empire company is controlled in Cedar Rapids and other cities in Iowa.

John Bull, president of the Reliance Paper & Trading Co., which undertook the management of the Whalen Paper & Pulp Co.'s three plants in British Columbia last year, has reported to the directors of the latter company that a saving of \$2,500,000 has been made during the past year in the operation of the company's plants. The percentage of No. 1 pulp produced has been increased from an output of 20 to an output of 85 per cent.

The Clayburn Co. has reopened its plant at Kilgard, B. C., where it will manufacture only sewer pipe. Fifty men have been taken on the payroll. The company's Clayburn plant is working at capacity, manufacturing ornamental, pressed, and fire bricks.

A NEW MINERAL

What is believed to be a new mineral, a borate of magnesium, isomorphous with chrysotile, has been found at Douglas Lake, near Merritt, B. C. The mineral occurs in small veins, from the thickness of a sheet of paper up to 5 in., crisscrossing through serpentine. It has been analyzed by H. V. Ellsworth at the laboratories of the Dominion Department of Mines, at Ottawa, and found to contain magnesia, 47.87 per cent; boric acid, 41.44 per cent; water, 10.69 per cent. A physical examination has been made by Eugene Poitevin, who has been unable to classify it as any known mineral, so provisionally it has been named *camsellite*, after Charles Camsell, Deputy Minister of Mines for Canada, in consideration of the excellent geological field work that he has done in British Columbia.

Robert A. A. Johnston, chief of the Division of Mineralogy of the Federal Department of Mines, speaking of the new mineral, said: "The new mineral is finely fibrous and distinguished only with difficulty from chrysotile, with which often it is intimately mixed. In addition to *camsellite*, chrysotile and dolomite are always associated with the mineral. The three minerals do not occur in any constant proportion, however—in fact, there are wide differences in this respect in the specimens that have been examined. It has not been found possible to separate *camsellite* in an ideally pure

state, but on the other hand it has been possible to separate both the dolomite and the chrysotile from the specimens, clearly showing that it is only a mechanical mixture of the three minerals."

Patent Office Bill Reported Out by Committee

The bill providing for an increase of force and salaries in the Patent Office has been reported out by the House Committee on Patents with the recommendation that it be passed at the earliest possible date. The bill as reported is substantially the same as the one which passed the House at the last session except that the section authorizing the Federal Trade Commission to administer patents for Government employees has been eliminated.

The bill increases the salaries of the principal examiners in the Patent Office from \$2,700 to \$3,900 per year. Assistant examiners are allowed increases ranging from \$150 to \$900 per year. It is generally recognized that the salary of the principal examiners is the most important feature of the entire bill. Representative Lampert of Wisconsin, chairman of the committee, expresses the opinion that the salary of the principal examiners should be much higher than the \$3,900 provided in the bill, but says the committee had agreed on that figure in the hope that it would not be questioned and the bill passed as an emergency measure. He calls attention to the fact that the American Patent Law Association after a referendum vote expressed the opinion that the principal examiners should receive \$5,000. The National Research Council placed the salary at \$4,200, but with the idea of naming a figure that would pass at a time when Congress is emphasizing the need of retrenchment. In the Lehlbach reclassification bill the salaries of these examiners are placed at \$5,040.

The bill also increases the commissioner's salary from \$5,000 to \$6,000; that of the first assistant commissioner from \$4,500 to \$5,500; second assistant commissioner from \$3,500 to \$5,000; chief clerk from \$3,000 to \$4,000; one solicitor from \$2,750 to \$5,000; five law examiners from \$2,750 to \$4,000; two examiners of interferences from \$2,700 to \$5,000. Five members of the board of examiners-in-chief who are appointed by the President and who under the statute must have both scientific and legal training, will be allowed an increase by this bill from \$3,500 to \$5,000.

The demoralized condition of the Patent Office may be understood when it is known that there are now 46,472 applications awaiting attention. The number of pending applications is increasing all the time. In a little over a year 110 examiners—one-fourth of the total examining force—have resigned. These men were experienced examiners, with from two to twenty years training. Their places have been taken by young men just out of college—the only ones apparently to whom the salaries appeal. The difficulty is, Mr. Lampert points out, that they have no patent experience, and cannot act in intricate technical cases as rapidly as can those who have spent years in the Patent Office working with those subjects.

Critical Tables of Constants

The Board for Scientific Control of the project planned by the National Research Council for publication of critical tables of physical and chemical constants is now fully organized with the following membership:

R. B. Moore, of the Bureau of Mines; C. E. K. Mees, Eastman Kodak Co., and John Johnston, Yale University. Physicists, C. E. Mendenhall, University of Wisconsin; G. K. Burgess, Bureau of Standards, and Saul Dushman, General Electric Co., Schenectady. Dr. Dushman has been appointed to succeed Dr. P. W. Bridgeman, who was previously elected to membership on the committee.

It is hoped that a preliminary effort can be made on the physical constants work in the very near future, as the sums of money already subscribed insure that some effort can be undertaken at an early date. However, the sums available do not altogether provide for the project and additional subscriptions will be sought as soon as business conditions seem to justify this.

Industrial Alcohol Legislation

After hearing representatives of the American Chemical Society and of the manufacturers of industrial alcohol, the Committee on Rules of the House of Representatives reversed its attitude on the Volstead amendment and declined to give the Judiciary Committee the rule upon which it has insisted. This unexpected obstacle to the Judiciary Committee's program made it necessary to report out a bill by Representative Campbell which covers the amendments in which the manufacturers of industrial alcohol are not interested and leaves unchanged the provisions of existing law with regard to industrial alcohol. As this is written, there is some uncertainty as to the possible effect of a committee amendment which was added to the Campbell bill. This is the provision for re-enacting the penal sections of former internal revenue legislation. Manufacturers and consumers of industrial alcohol are particularly anxious that the troublesome statute which permitted the assessment of the beverage tax on all alcohol which does not enter absolutely into manufacture be not re-enacted. Under that law, the Bureau of Internal Revenue formerly assessed the beverage tax on alcohol lost through leakage, through destruction in railroad wrecks, and on that stolen or which failed to enter into manufacture for many other reasons. A careful examination of the statute now is being made to determine just what this will re-enact.

Encouragement of Scientific Research

Encouragement of scientific research in the fields of chemistry, metallurgy and engineering as well as in other scientific lines is accomplished in America by many funds, medals, prizes, etc. The National Research Council has made an extended investigation of the means used during 1920 for this encouragement of science and research. The following items which deal specifically with chemistry are taken from the Council's bulletin No. 9, just issued. There are shown the medals and prizes, the grants for research work, the institutional funds, and the fellowships and scholarships. These form a very imposing list of items.

CHEMICAL MEDALS AND PRIZES

Awards of the Glass Container Association of America. Seven awards for theses submitted prior to June 10, 1921, to stimulate more general research along the lines of better preparation and packing of foods and beverages, and to increase our knowledge of changes induced by preparation or storage of such products. Established 1920. Annually available, \$50-\$150.

Gibbs Medal of the American Chemical Society, Chicago Section. For eminent work in and original contributions to pure or applied chemistry. Established 1911. Present fund, \$7,500.

Grasselli Medal of the Society of Chemical Industry. For thesis presented before the society and offering the most useful suggestions in applied chemistry.

Nichols Medal of the American Chemical Society, New York Section. For meritorious research in organic chemistry. Established 1902. Present fund \$1,700. Annually available, \$98.

Perkin Medal of the Society of Chemical Industry. For the most valuable work in applied chemistry. Established 1906.

Scott Medal Fund. Medal and premiums awarded from time to time for useful inventions that will advance chemical, medical or any other science, or promote the development of industry in any form. Established 1816. Original fund, about \$4,000. Present fund, about \$100,000. Annually available, \$4,000 or more.

GRANTS

Chittenden Fund of Yale University. For research in physiological chemistry. Established 1915. Original fund, \$4,000. Annually available, \$192.

Clark Fund of the Harriman Research Laboratory. Endowment Fund, for the promotion of research in medical and biological sciences. Established 1912. Annually available, \$25,000.

Gibbs Fund of the National Academy of Sciences. For research in chemistry. Established 1892. Original fund, \$2,600. Present fund, \$5,545. Annually available, \$308.

Research Fund of the American Medical Association, Council on Chemistry and Pharmacy. Fund of Committee

on Therapeutic Research, used in connection with chemical investigations conducted by accredited research workers. Annually available, \$2,000.

Research Fund of the National Cannery Association. Grants for chemical, bacteriological and technological research relating to the manufacture of canned goods, systematic study of food poisons as applied to canned foods but not limited to this phase and the study of botulism.

Warren Fund of the American Academy of Arts and Sciences. For research in chemistry. Established 1892. Original fund, \$6,000. Present fund, \$13,289. Annually available, \$1,254.

INSTITUTIONAL FUNDS

Anonymous Fund for Wolcott Gibbs Laboratory of Harvard University. For research in physical and inorganic chemistry in the Wolcott Gibbs Laboratory. Original fund, \$5,000. Present fund, \$5,055.48. Annually available, \$55.48.

Appropriation to Nutrition Laboratory of Carnegie Institution of Washington. Endowment, for the encouragement in the broadest and most liberal manner of investigation, research and discovery, and the application of knowledge to the benefit of mankind. Established 1902. Original fund, \$10,000,000. Present fund, \$22,120,000. Available for 1920, \$52,432.39.

Contract with Ordnance Division of War Department of Yale University. For experimental work on explosives. For 1920-21, \$10,000.

Dalton Fund of the Mass. Institute of Technology. For payment of fees for research in textile chemistry. Present fund, \$55,000. Annually available, \$250.

Division of Applied Chemistry Testing Work Fund of the University of Illinois. For research work in chemistry. Annually available, \$5,516.

Endowment Fund of the Harriman Research Laboratory. For the promotion of research in medical and biological sciences. Established 1912. Annually available, \$25,000.

Food Research Institute of Leland Stanford Junior University. For the intensive study of the problems of production, distribution and consumption of food. Established 1921. Present fund, \$700,000. (Provided by Carnegie Corporation for support of the Institute for ten years.)

McCurdy Research Fund of Case School of Applied Science. For the use of seniors in chemistry for research. Annually available, \$1,000.

Organic Chemistry Research Fund of Yale University. For research in this subject. Established 1918. Original fund, \$600.

Research Fund of American Institute of Drug Proving. For work on drugs. Original fund, \$3,250. Annually available, \$129.

Research Fund in Chemistry of the California Institute of Technology. For research in chemistry. Established 1915. Present fund, \$200,000. Annually available, \$10,000.

Richards Fund of Mass. Institute of Technology. For research in chemistry. Present fund, \$15,000. Annually available, \$600.

U. S. Interdepartmental Social Hygiene Fund of Northwestern University. For research in chemistry department for compounds of therapeutic value in the treatment of venereal diseases. Established 1920. Present fund, \$5,000, for 1920-21 only.

Warren Fund of Harvard University. For the promotion of chemical research or the advancement of chemical science. Established 1893. Original fund, \$4,500. Present fund, \$7,595. Annually available, \$387.

FELLOWSHIPS AND SCHOLARSHIPS

Barnard Fellowship of the University of Chicago. For research in chemistry. Established 1915. Present fund, \$3,000. Annually available, \$156.

Bloede Scholarship of the Chemists Club of New York. For research in industrial chemistry and engineering. Established 1916. Original fund, \$10,000. Present fund, \$10,000. Annually available, \$500.

Carr Fellowship of the University of Illinois. For research in chemistry. Established 1919. Original fund, \$10,000. Present fund, \$10,000.

Chemistry Fellowship of University of Utah. For research in chemistry. Annually available, \$2,800.

Class of 1883 University Fellowships of Princeton University. For research in the department of politics, physics, chemistry, biology or geology. Established 1910. Original fund, \$30,000. Annually available, \$600 to each of two fellowships.

Columbia Univ. Fellowship of the University of Washington. For research in mining, engineering, and chemistry. Established 1917. Annually available, \$250.

Emerson Scholarships of Harvard University. For research in zoology, geology, mineralogy and chemistry. Established 1903. Original fund, \$20,656. Present fund, \$37,761.17. Annually available, \$400 each.

Fellowships of the California Institute of Technology. Six teaching fellowships in chemistry, for teaching, study and research in chemistry. Established 1917 and 1919. Annually available, \$750 each; and three fellowships for physical and chemical research. Established 1916. Annually available, \$1,000 each.

Fellowships of the National Research Council. For research in physics and chemistry. Supported by the Rockefeller Foundation. Established 1920. Present fund, \$500,000. Annually available \$100,000.

Grafflin Scholarships of Johns Hopkins University. For research in industrial chemistry. Established 1915. Annually available, \$1,000.

Goldschmidt Fellowship of Columbia University. For research in chemistry. Established 1908. Present fund, \$16,350. Annually available, \$736.47 (1920-21).

Hart Fellowship of Lafayette College. For research work on problems connected with viscous and plastic flow. Restricted to students in chemistry holding bachelor's degree. Established 1910. Original fund, \$10,000. Annually available, \$500.

Harvard Fellowship in Chemistry of Princeton University. For research in chemistry. Established 1905. Original fund, \$10,000. Annually available, \$500.

Herter Research Fellowship of New York University. For research in chemical pathology, physiological chemistry or pharmacology. Established 1903. Original fund, \$6,000. Annually available, \$300.

Home Economics Research Fellowship in Nutrition of the University of Chicago. For research in nutrition or related fields. Established 1919. Annually available, \$600.

Hoskins Fellowship of the University of Chicago. For research in chemistry. Established 1919. Annually available, \$400.

Huff Memorial Research Fellowship of Bryn Mawr College. For research in either physics or chemistry. Established 1913. Annually available, \$1,200.

Hoffman Scholarship of the Chemists Club of New York. For research in industrial chemistry and engineering. Established 1916. Original fund, \$10,000. Present fund, \$10,000. Annually available, \$500.

Loewenthal Fellowship of the University of Chicago. For research in chemistry. Established 1900. Present fund, \$10,000. Annually available, \$400.

Loomis Fellowship of Yale University. For research in physics. Established 1902. Original fund, \$10,000. Annually available, \$465.

Moore Scholarship of the Mass. Institute of Technology. For study of organic chemistry in Europe. Awarded from time to time. Annually available when awarded, \$250.

Research Fellowship in Chemistry in Bryn Mawr College. Resident Research Fellowship, for research in chemistry. Established 1893. Annually available, \$530.

Shevlin Fellowship of the University of Minnesota. For research in agriculture, chemistry, medicine and one in any subject. Annually available, \$500 each.

Swift Fellowships of the University of Chicago. For research in chemistry. Established 1908. Present fund, \$17,809. Annually available, \$920.

Teaching Fellowship of Leland Stanford Junior University. For research in chemistry (2). Established 1917. Annually available, \$600 each.

Teaching Fellowship of the Calif. Institute of Technology. Six fellowships for teaching, study and research in chemistry. Established 1917 and 1919. Annually available, \$750 each.

Traveling Fellowship of the American Scandinavian Foundation. Traveling Fellowships (20) of \$1,000 each, five for travel and study in Denmark, ten in Sweden and five in Norway, for the purpose of drawing the American and Scandinavian peoples closer in bonds of intellectual kinship. Established 1911. Original fund, \$500,000. Present fund, \$565,082.48. Annually available, \$40,000. (Only one-half available for United States.)

Upjohn Co-operative Fellowship of Yale University. For research in organic chemistry. Established 1919. Annually available, \$700.

Wisconsin Gas Association Fellowship of Univ. of Wis-

consin. For research in chemical engineering. Annually available, \$500.

Woodward Fellowship of the University of Pennsylvania. For research in physiological chemistry.

Tests of Brazed Copper Sheets Intended for Roofing Purposes

Recently the Library of Congress submitted to the Bureau of Standards for test some copper sheets for roofing purposes which had been joined by brazing. Two types of joints were used, a simple "lap" joint and a "lock" joint in which the edges of the two sheets to be joined were first bent double and then "locked" into each other.

The series of examinations indicated that of the two types of joints designated as lap and lock, the lap joint is superior in strength and much more desirable in its structure. In forming the lock joint apparently it is necessary to apply the heating torch for a considerably longer period in order to cause the metal to flow into the joint. In doing this the upper fold of the sheet which forms the lock is highly heated and often burned. It was noticed in most cases that none of the brazing metal penetrated directly below the upper fold, so that the upper sheet could easily be bent along the line of the junction. It appears from the results of this examination that if the buckling of the sheets, which apparently cannot be entirely prevented with this method of joining sheets, is not too objectionable, the lap joint should be satisfactory for the purpose. The lock joint is decidedly inferior in strength and other properties to the lap joint.

It may be pointed out that the joints should be carefully cleaned after brazing. In the specimens submitted, the film of zinc chloride remaining after cleaning the specimens was sufficient to accelerate atmospheric corrosion very decidedly within a very short time.

\$250,000 Appropriated for Helium Studies

The army appropriation bill, as finally approved by the conferees on the part of the Senate and the House, carries \$250,000 for "experimentation, conservation and production of helium." This is a very material cut from the \$800,000 requested by the War Department.

The bill gives authority "to explore for, procure or reserve helium gas" and also provides for "the purchase, manufacture, construction, maintenance and operation of plants for the production of helium and experimentation therewith."

Book Reviews

METALLOGRAPHY, Part II, The Metals and Common Alloys. By S. L. Hoyt. New York: McGraw-Hill Book Co., Inc., 1921. Price, \$5. 462 pages, illustrated.

This is a continuation of the author's text and reference book on Metallography and "describes the more important metals and alloys," including chapters on Pure Metals, White Metal Alloys, Light Metal Alloys, Brasses and Bronzes, Steel and Cast Iron and Special Steels.

We have had in the past reference books dealing with the properties of alloys without much reference to their structure and constitution as well as those dealing with the structural, thermodynamic equilibrium of alloys with but little description of their properties. This is, as far as the reviewer knows, the first one that deals adequately with both phases of this subject, so intimately related, and discusses theoretical as well as practical aspects of metals and alloys. As a typical example of the mode of treatment, the chapter on light aluminum alloys discusses the structure of light alloys with the usual diagrams and typical photomicrographs, interprets by their aid the effect of different alloying elements and impurities on the properties of the alloys, and describes the useful properties of commercial alloys, giving tables of their numerical magnitude.

The material is, in general, quite up to date. The large

number of references proves a very thorough bibliographic mastery of the subject on the author's part and is of the greatest value to the reader.

It is to be hoped that in a second edition those paragraphs in description of commercial alloys available in this country will be much expanded, particularly with respect to the brasses and bronzes. Perhaps manganese bronze should be treated under the caption of brasses instead of that of bronzes if correct nomenclature is to be followed. It is possibly a personal prejudice that leads the reviewer to regret the absence of any discussion of several important alloys of nickel, such as nickel-silver, copper-nickel, nickel-chromium, and Monel metal.

The chapters on iron, steel and alloy steel are quite full; in particular there are very good paragraphs on the inclusions in steel. Adequate tables are given of the mechanical properties of the alloy, or automobile steels; it is believed, however, that these chapters would be improved by the addition of some representative photomicrographs of commercially heat-treated nickel and chromium-nickel steels of good quality. Text-books evince a disposition to reproduce structures of pathologic specimens of heat-treated steel only, which may perhaps be somewhat misleading to the student without practical experience.

In brief, this volume appears to invite frequent consultation both by experienced and inexperienced in this field and to excite the hope that the third part of this series, on Technical Practice, will soon appear.

PAUL D. MERICA.

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THE RECOVERY OF NITRATE FROM CHILEAN CALICHE. By Arthur W. Allen. 50 pages. London: Charles Griffin & Co.

Many engineers and chemists have spent years in the caliche fields of Chile and have come away without more than a descriptive outline of the processes used in the nitrate industry. Mr. Allen proves to be an exception, has had ideas on how its technology can be improved and has incorporated them into a little text that should prove to be an accelerator in speeding up the adoption of better methods. He describes the Shanks process both in the extraction and crystallization stages as now practiced. He then takes up the question whether an alternative scheme is desirable. In conclusion he lays out his own plan using upward percolation and thus reducing the frictional resistance of the slimy borra earths. Improvements in evaporation and the use of the salt grainer are amply discussed. As no adequate laboratory facilities and services were available, the chemistry of the solution of mixed salts was not taken up in the author's investigation.

WALLACE SAVAGE.

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THE MICROSCOPE: ITS DESIGN, CONSTRUCTION AND APPLICATIONS. A symposium and general discussion published in the *Transactions* of the Faraday Society, London. 260 pp. 1920. Price 15s.

The recent and rapid development of microscopes and the great interest shown in microscopic methods of research and testing are reflected in this series of articles covering the following subjects:

Introductory Address by Sir Robert Hadfield; General Papers on the Mechanical Design of Microscopes and the History and Design of Photomicrographic Apparatus; The Optics of the Microscope, Including Notes on the Resolving Power of the Microscope; The Manufacture of the Microscope; Aspects of Microscope Design and Construction; Optical Glass; Applications of the Microscope, Including Applications in Metallography, Metallurgy and Engineering and Applications to Metrology; Testing of the Microscope; Notes on Light Filters; Description of the Davon Micro-Telescope and Super-Microscope.

Sir Robert Hadfield, always an interesting writer, presents a fascinating history of the microscope from ancient times to the present which includes photographs of Dr. Sorby, Dr. Dallinger, Dr. Zacharias Jansen, Hans Lipperhey and Leeuwenhoek, a reproduction of the front page of Robert Hooke's *Micrographia* published in 1665 and a complete bibliography of the chief literature relating to micrograph from 1665 to 1919 inclusive.

A description of these *Transactions* in detail would re-

quire a volume in itself; therefore I must content myself with a few remarks on that portion of the book most interesting to chemists and metallurgists.

Sir Robert Hadfield contributes some unusual notes on the "Great Work of Sorby" and publishes some of Sorby's early photomicrographs of hammered bloom and blister steel, magnified nine diameters. By way of contrast he also shows some photomicrographs of pearlite magnified from 5,000 to 8,000 diameters. In this connection the writer would like to remark that apparently nothing is gained by an increase above 1,500 diameters, the effect at the extremely high magnification being the same as that produced on a lantern screen by enlargement of a negative taken at 1,500 diameters. In fact in one case an enlargement to approximately 5,000 diameters from a photograph taken at 1,500 diameters of pearlite and graphite in cast iron looks fully as clear if not slightly clearer than a photomicrograph taken from the identical spot and magnified 5,000 diameters. Some of these high-powered photomicrographs, however, are reproduced in plates 5¼ x 7½ in. and produce a rather striking effect.

The well-known names of LeChatelier, Sauveur, Benedicks, Rosenhain, Desch, Giolitti and E. F. Law are found in connection with brief articles on Improvements in Metallurgical Microscopes.

Benedicks comes to the following conclusions after a detailed and critical examination of the new Reichert microscope (of the LeChatelier type):

- (1) An arc lamp (350 c.p.) or an incandescent lamp (50 c.p.) gave exactly the same result.
- (2) A modification of the microscope is proposed to diminish sensitivity to vibration.
- (3) The proper arrangement of the diaphragms is discussed.
- (4) A LeChatelier prism and a 45 deg. prism give at high magnification exactly the same result.
- (5) A metal mirror gives slightly better contrasts than a prism.
- (6) In the plain glass illuminator a thickness of 0.45 mm. does not injure sensibly the image quality.
- (7) A slightly platinized glass illuminator gave somewhat finer details than any other illuminator used; this question, however, needs further research.

Dr. Zay Jeffries contributes some notes on the measurement of grain size.

Some references are found to the new Pointolite lamp, which consists of a small tungsten arc, and would seem to give promise of good results in photomicrography. It would add to the value of this book if a more complete description of this lamp had been included.¹

The book is commended as a very valuable reference book for its detailed information to all metallurgists using the microscope as a method of testing and research and to all other users of the microscope. It serves as an excellent review of the history of this instrument and its recent developments, and should be in the hands of every one interested in science, whether pure or applied.

H. M. BOYLSTON.

Personal

CHARLES COPELAND, assistant treasurer of E. I. du Pont de Nemours & Co., has been elected a member of the board of directors and secretary of the company to fill the vacancies caused by the death of Alexis I. du Pont. Mr. Copeland has been assistant treasurer of the company for eighteen years.

Mme. CURIE and IRVING LANGMUIR received honorary degrees of Doctor of Science at Northwestern University, Evanston, Ill., June 15.

OTTO EISENSCHIML, president of the Scientific Oil Compounding Co. of Chicago, sailed the latter part of June for

¹"A New Microscope Illumination," see CHEM. & MET. ENG., vol. 20, p. 281 (Feb. 11, 1920).

a trip through Europe. Among other points he will visit will be Vienna, Austria.

ISMAR GINSBERG announces the opening of an office in the Chemists' Club Building, with all facilities for undertaking investigations into the literature, patent searches and regular service on selected topics. He will also compile bibliographies and furnish translations from all foreign languages.

THOMAS F. RILEY, manager of the Imperial Porcelain Works, Trenton, N. J., has been appointed by Gov. Edwards a member of the board of directors of the Trenton School of Industrial Arts, to succeed the late Karl G. Roebling.

Prof. ROBERT F. RUTTAN, of McGill University, Montreal, Canada, has been nominated president of the Society of Chemical Industry for next year, succeeding Sir William Pope.

MAX Y. SEATON, who was chemical engineer with the Dow Chemical Co., Midland, Mich., particularly in charge of the oxygen chloride research division, is now technical director of the National Kellastone Co. of Chicago. He is also in charge of technical work for the Sierra Magnesite Corporation of Porterville, Cal.

WILLIAM O. THOMPSON has resigned as chairman of the board of directors, American Cotton Oil Co., New York, effective July 1.

FRED A. WHITAKER, superintendent of the Keasbey, N. J., plant of the General Ceramics Co., New York, will sail for Europe at an early date for a two months' pleasure trip abroad with Mrs. Whitaker. England, Germany and other countries will be visited.

GERALD L. WENDT has been promoted from assistant to associate professor at the University of Chicago.

Current Market Reports

The Chemical and Allied Industrial Markets

NEW YORK, June 27, 1921.

Irregular periods of inquiry, followed by intervals of dullness, featured the chemical market during the past week. The inquiries involved both domestic and export requirements, but buyers' and sellers' views differed on export account sufficiently in most instances to restrict any actual transactions. Italy, South America and Canada seemed to be foremost on the list of foreign buyers. Domestic consumers did not depart appreciably from their conservative attitude and showed a preference for only small lots. The market in general is behaving well under serious declines in outside commodities and securities and in the face of a cross-current of trade reports emanating from various sources. A peculiarity is that all recent advances were well sustained and there were several instances where an actual shortage of spot supplies existed.

Among the large items caustic soda and soda ash are still showing the most strength in the open market. Both chemicals have continued in scant supply on the spot and small-lot buyers often had the price advanced by sellers. This continued small-lot buying has seemed to have its effect on supplies. Producers received most of the call for carlots and it is understood that a fair volume of business was placed at the works. Italy has sent numerous inquiries for soda ash at prices a trifle below the domestic market. It was stated among leading soda ash manufacturers that foreign producers nearer Italy are naming figures which prevent any active competition on the part of American producers. Regarding the surplus supplies of caustic soda in South America, it is stated that stocks are steadily decreasing and that business in caustic will probably show some real improvement in the very near future. Nitrite of soda showed a stronger tone late in the week under an improved inquiry and a tightening of holdings. This chemical requires a license to import and should naturally recover very easily on any display of buying power. Bichromate of soda ruled fairly steady on the spot market. The

call for small lots was quite active and this with relatively low supplies in second hands had a strengthening market influence. Bleaching powder sold fairly freely at the works. Large dealers are competing for prospective business and considerable trading went through at prices ranging from \$2.10@ \$2.20 per 100 lb. at the works. Salt cake showed signs of becoming more active, and it looked as though some buyers both home and abroad were feeling out the market prior to replenishing their stocks. Camphor advanced sharply under an improved demand and strong foreign cables.

MARKET DEPENDS ON FOREIGN POLICIES

While confidence is increasing, the immediate outlook is uncertain regarding business. There are enough conflicting influences at present to create a cautious feeling among buyers and little material improvement can be expected until our foreign policies are more clearly defined and the tariff tangle is straightened out. The following is a report recently made public by the American Section of the International Chamber:

"The United States is one of the chief sufferers from the partial dislocation of the trade of the world and unless she is prepared to extend credits on a large scale she must look forward to a great decrease of her export trade which will react unfavorably upon industrial conditions and retard her recovery from the present depression. The problem of the readjustment of foreign trade relations is one of the most important developments that has resulted from the world war and upon her success in solving it the commercial prosperity of the United States during the next few years will in no small degree depend."

Labor conditions are improving and the possibility of lower freight rates seems nearer. Exchange has shown a disposition to recover and money rates have worked to a lower loaning basis. These are at least favorable factors, but a revival of export trade is what the chemical market wants.

CHEMICALS

New arrivals of German *caustic potash* are having a disposition to check any advancing tendency which this chemical might display. The general quotation for this material is 5¼@5½c. per lb. for the 88-92 per cent. Sales, however, have gone through below the inside figure and the market in some quarters is irregular owing to the keen state of competition existing. Yellow *prussiate of potash* is moving quietly on the basis of 24½c. per lb. ex-store. Sellers quote 24½@26c. per lb. The red variety is quiet, with small lots obtainable at 35c. per lb. It is very probable that on a firm offer this figure could be shaded. Sellers of *citric acid* generally quote 46@47c. per lb. for spot material, but odd lots are obtainable below these prices and in one quarter 45c. is heard. The quiet extent of the inquiry at present has left the market somewhat irregular, although supplies do not seem to be heavy and it looks as though the market is in a position to respond to any real improvement in demand. Odd lots of imported *oxalic acid* are offered on the spot at 18c. per lb. Most sellers are maintaining prices at 19c. and upward, depending upon the brand and quantity.

Small-lot trading continues to feature the market. Resale *bichromate of soda*, standard make, was somewhat irregular during the latter part of the week, with dealers quoting 8@8½c. per lb. on spot, and rumors of odd-lot sales a shade under the inside figure. Demand was not active and scarcely enough business passed to really test values. Offerings were not heavy and some interests express the opinion that relatively little stock could be purchased around prevailing quotations. No important change in spot prices for resale lots of standard brands of solid *caustic soda* could be noted. Prominent dealers stated that \$4.10 per 100 lb. could be done, on limited quantities, while most sellers quoted the market at \$4.15@ \$4.25 ex-store according to size of order. The contract price is steady at 3¼c. per lb., basis 60 per cent, f.o.b. works. Domestic *cyanide of soda* is quoted at 29c. per lb. asked, while the French and German grades are quoted at 19½ and 20c. per lb. respectively. The market is irregular with competition keen for new business. It is possible that domestic producers will shade

the above price when there is sufficient business to warrant it. Spot *nitrite of soda* was quoted at 7½@8c. per lb. by dealers with trading rather quiet. Some odd lots could probably be purchased at concessions, but the bulk of supplies appears to be well held at present. Small-lot inquiries are reaching the market occasionally, but there is no permanent buying movement in progress at the moment. The inquiry for light *soda ash* is holding up now and prominent dealers state that sales of single bags are going through at \$2.15@\$2.20 per 100 lb. ex-store and that a good movement of small lots in barrels is in progress at \$2.60@\$2.70 per 100 lb. Dealers quote at the works \$1.60 per 100 lb., basis 48 per cent, in single bags and \$1.95, basis 48 per cent, in barrels. Leading producers reported a fairly good call for *bleaching powder* at the works and stated that sales went through in moderate volume at \$2.10@\$2.20 per 100 lb. in large drums and up to 2½c. per lb. in small drum containers. Moderate trading on spot was reported at 2¼@2½c. per lb. Trading in the technical variety of *epsom salts* was reported at \$1.20 per 100 lb., while considerable business in the U.S.P. grade went through at 2¾c. per lb. The above prices were named by prominent sellers at the close.

COAL-TAR PRODUCTS

The tone of the coal-tar products market during the past week has been steady, but there has been no tendency shown to operate on other than a routine small-lot basis. A wider range of trading is developing and some of the more stagnant materials are beginning to move into consuming channels. While the summer period will be attended with the usual quiet trading, the outlook is healthy and no setbacks are expected. Prices are holding well and few distressed lots are glaring among the offerings. *Benzene* is in heavy demand and with production curtailed the available supply is said to be shy and prices are firm. *Cresylic acid* is in easy supply and prices depend on seller. *Naphthalene* is in very light demand and while resale lots range around 7@7½c. per lb. producers seem to be holding at the former level of 8½@9½c. for the prime white flakes. Quite a number of foreign inquiries have reached the market for *phenol*, but no sales have resulted as yet. Orders for intermediates in small quantities have been fairly well distributed and a few inquiries for round lots are reported. There seems to be a scarcity of *para-nitrophenol*, and orders for spot goods are not available. The market for *beta-naphthol* is reported firm at 38@42c. per lb. Supplies of *aniline oil* are reported easy at 20@26c. per lb. *Dimethylaniline* is steady at 40@50c. per lb., depending on quantity and seller. The inquiry for *benzoate of soda* is showing seasonable improvement and in some directions a decidedly better run in business was reported. It is stated that a fair volume of sales has been made for shipment to canneries on the Pacific Coast, and it is expected that demand from the East will increase with the advance of the season. Prices range from 55@60c. per lb., according to quantity and seller. The market is quoted firm at the inside figure. The output of *para-dichlorobenzene* is confined to few makers and at the moment available supplies are scarce. The consuming demand, however, is not very active and prices are quotably unchanged at 15@25c. per lb., depending on quantity. The demand for supplies of *para-phenylenediamine* has fallen away lately, but the tone is steady and prices range from \$1.75@\$2 per lb. The consuming demand for *nitro-benzene* still holds to a dull routine nature for small quantities, while supplies are easy and quoted at 12@15c. per lb. The demand for supplies of *meta-phenylenediamine* continued in fair volume during the period and sales were on the basis of \$1.15@\$1.20 per lb.

The St. Louis Market

ST. LOUIS, Mo., June 24, 1921.

The fine chemical market continued to expand the last week, with inquiries more frequent and for larger quantities. In spite of the slumping off in demand the past two weeks for heavy chemicals in general, prices for the most part remain unchanged. This would indicate that the second-hand's stocks are about depleted and that the present quotations are again based upon the actual manufacturers' cost.

The drug market underwent little change during the last week and the present prices quoted could be safely taken as a level at which buyers could operate and feel assured that no further reductions would take place.

ALKALIS

Caustic soda continues to move in small lots even to the formerly large buyers, with no contracting being done. Price, the same. *Soda ash* is still quoted at \$2.90@\$3 per 100 lb., basis 58 per cent, with demand slightly under routine. *Sal soda* is in routine demand, price \$1.90@\$2.50 per 100 lb. according to the quantity ordered. *Bicarbonate of soda* is inactive.

INDUSTRIAL CHEMICALS

There has been a heavy demand for *ammonia water*, 26 deg., with the market firm. *Carbon bisulphide* has shown some improvement since our last report. A heavy demand for *iron sulphate crystals* has been evident lately. The outdoors season is showing very good effects on the *hypo-sulphite of soda* demand, which continues to increase. *Sulphur* holds very firm at 2½c. for the commercial in bags, with a good demand.

DRUGS AND PHARMACEUTICALS

Citrates continue to command a fair volume of business. An excellent demand for both *soda* and *potassium bromide* has been experienced since our last report, with the market firm in spite of the heavy importations. *Cream of tartar* continues in a fair way. *Glycerine* again declined and is now quoted at 16c. per lb. for both spot and contract. Shading to 15½c. per lb. on *glycerine* is not uncommon. The majority of contracts for the next six months have been signed. A very brisk demand for *hydrogen peroxide* is now coming from all sources and some fair sized business has passed in the last ten days. An improved demand for *iodides* has been experienced since our last report, especially the *potash salt*, which undoubtedly is due to the resale stocks having been practically absorbed. *Mercurials* have shown a lack of interest in spite of the reduction made a couple of weeks ago. *Salicylates* continue to enjoy a fair demand and business in a routine way is being done.

ACIDS

There has been no change in the conditions of *carbolic acid crystals* since the last report. The demand for *citric acid* fails to show any improvement and new features of interest are still lacking. Apparently beverage manufacturers continue to pursue their conservative policy in buying. The revival of activity in aniline dye manufacture has led to an improvement in the demand for *gallic acid* and a very nice business is now being transacted in this commodity. Factors report that the demand for *hydrochloric*, *nitric* and *sulphuric acid*, commercial grades, is remarkably good despite the increase in price recently made by the manufacturers. *Phosphoric acid sirupy* fails to show any improvement. A heavy demand for *acid pyrogallie* both *resublimed* and *crystals* is coming from the photographic trade.

VEGETABLE OILS

Linseed oil reached a peak of 82c., basis raw in cooperage, from warehouse, and today holds at 79c. per gal. for spot and forward to Aug. 1, though practically no contracting is being done. *Castor oil* continues to hold at 10½c. per lb. in drums, with fair demand. The *turpentine* demand is under routine with price uniform at 65c. in 5-bbl. lots.

The Iron and Steel Market

PITTSBURGH, June 24, 1921.

From an already light demand for steel products there has been a further decrease, one that can hardly be explained on the ground of further decrease in consumption, and is probably attributable to manufacturing consumers making a still more strenuous effort to dispose of such stocks as they have had on hand. Manufacturing consumers who normally carry thousands of tons of rolled steel are now unwilling to carry hundreds of tons and if they cannot use the steel themselves they sell it for what it will bring. The most drastic liquidation in the history of the steel industry in stocks of steel is in progress, and is now nearly completed. The liquidation would be easier were

not manufacturing consumption so light. The direct bar to manufacturing activity is large stocks of manufactured goods, agricultural implements, machinery, hardware, cutlery, tools and the like. These manufactured goods will be liquidated in time, but the process is slow.

NO "CONSUMPTION" OF STEEL

Meanwhile the country's general activity has not slowed down by anything like the percentages that are shown by steel production. The freight ton mileage on the railroads in March was 63 per cent of the rate in the record month in all history—August, 1920—while it was approximately equal to the average rate in the best year before the war. The trade now has to make a distinction between the "consumption" of steel and the "use" of steel. Before the war it was held, and the point was supported by all experience, that the production of steel could not go below about 50 per cent of capacity, because the country always had to have a considerable quantity of steel even in bad times. The country is employing or using steel fairly well even at the present time, but it is not putting much more into use—it is not "consuming" steel in that sense.

STEEL PRODUCTION

The production of steel is now at about 22 or 23 per cent of capacity, against an average rate of 80 per cent in the first nine months of last year, and the rate may get down to 15 per cent or even 10 per cent in July. As liquidation in stocks of steel and, still more important, in stocks of wares made from steel, progresses there will be increased demand upon the steel mills, probably in August, quite certainly in September. If July shows a 15 per cent production of steel and September a 30 per cent production there will be a 100 per cent gain, and the steel industry will still be operating at a rate inconceivably low from the viewpoint of all times before the war. The demand is going to increase slowly, beginning in August or September. At no time in the discernible future will there be a rush for steel, since the mills have shown wonderful ability to fill orders within a very few days of their receipt and occasion will not arise in the near future for anyone to build up stocks of steel or of goods made from steel.

STEEL PRICES

Steel prices are sagging, yielding on the slightest provocation of inquiry that is at all tempting. Three weeks ago the Steel Corporation reduced prices on wire products \$5 a ton, following selling by independents for some time at cut prices. A week ago today the Republic Iron & Steel Co. reduced its prices on sheets \$5 a ton, on account of cutting by several other interests, three other sellers immediately following Republic, while last Tuesday the Steel Corporation met the reduction. The reductions are from the so-called "April prices." Bars are being shaded at least \$2 a ton and plates and shapes \$4, but no formal reductions in these lines have thus far been announced. Prices made just now are not regarded as a criterion for the future, when, with enough buying to make a real market, prices are going to be made that will yield with great difficulty if at all. A sound schedule of prices cannot be developed now, as there is not sufficient business going to make such a market.

PIG IRON AND COKE

Pig iron prices are off about 50c. in the week, the market being now quotable at \$22.50 for bessemer, \$20.50 for basic and \$21.50 for foundry, f.o.b. valley furnaces, with \$1.96 freight to Pittsburgh.

Connellsville furnace coke has eased off and has sold at \$3 per net ton at ovens, with extremely light demand.

A few sales of Lake Superior ore have established prices for the 1921 season, at \$1 reduction from the 1920 schedule, thus restoring the 1919 prices, Mesabi non-bessemer being \$5.55 per gross ton at Lake Erie dock. The reduction corresponds with the amount many furnace companies wrote off their ore inventories at the close of last year. The pig iron market some time ago reflected the decline in ore. The pig iron market is made by sales from furnace stocks, there being scarcely any production of furnace iron, and prices are in relation to prospective replacement cost, not the cost of the iron that is being sold.

General Chemicals CURRENT WHOLESALE PRICES IN NEW YORK MARKET

	Carlots		Less Carlots	
Acetic anhydride.....lb.			\$0.40 - \$0.45	
Acetone.....lb.	\$0.12½ - \$0.12½		.13 - .13½	
Acid, acetic, 28 per cent.....100 lbs.	2.50 - 2.75		3.00 - 3.25	
Acetic, 56 per cent.....100 lbs.	4.00 - 4.25		4.50 - 5.50	
Acetic, glacial, 99½ per cent, carboys, 100 lbs.	9.75 - 10.00		10.25 - 10.50	
Boric, crystals.....lb.	.13½ - .14		.14½ - .15	
Boric, powder.....lb.	.15 - .15½		.16 - .16½	
Citric.....lb.			.46 - .47	
Hydrochloric.....100 lb.	1.50 - 1.65		1.75 - 2.00	
Hydrofluoric, 52 per cent.....lb.	.12½ - .12½		.12½ - .13	
Lactic, 44 per cent tech.....lb.	.10 - .11		.11½ - .12	
Lactic, 22 per cent tech.....lb.	.04½ - .05½		.06 - .07	
Molybdic, C. P.....lb.	4.00 - 4.50		4.50 - 5.00	
Muriatic, 20 deg. (see hydrochloric).....lb.				
Nitric, 40 deg.....lb.	.06½ - .06½		.07 - .07½	
Nitric, 42 deg.....lb.	.07½ - .07½		.07½ - .08½	
Oxalic, c. ysta's.....lb.	.18 - .18½		.19 - .20	
Phosphoric, 50 per cent solution.....lb.	.13½ - .14		.14 - .18	
Picric.....lb.	.20 - .25		.27 - .35	
Pyrogallol, resublimed.....lb.			1.90 - 2.15	
Sulphuric, 60 deg., tank cars.....ton			11.50 - 13.00	
Sulphuric, 60 deg., drums.....ton			13.00 - 15.00	
Sulphuric, 66 deg., tank cars.....ton	18.00 - 20.00			
Sulphuric, 66 deg., drums.....ton	22.00 - 22.50		23.00 - 23.50	
Sulphuric, 66 deg., carboys.....ton				
Sulphuric, fuming, 20 per cent (oleum) tank cars.....ton	22.00 - 23.00			
Sulphuric, fuming, 20 per cent (oleum) drums.....ton	25.00 - 26.00		26.50 - 27.00	
Sulphuric, fuming, 20 per cent (oleum) carboys.....ton	31.00 - 32.00		33.00 - 34.00	
Tannic, U. S. P.....lb.			.90 - 1.00	
Tannic (tech.).....lb.	.50 - .52		.54 - .57	
Tartaric, crystals.....lb.			.30 - .32	
Tungstic, per lb. of WO.....lb.			1.30 - 1.40	
Alcohol, Ethyl.....gal.			4.80 - 5.00	
Alcohol, Methyl (see methanol).....gal.				
Alcohol, denatured, 188 proof.....gal.			.31 - .36	
Alcohol, denatured, 190 proof.....gal.			.38 - .42	
Alum, ammonia lump.....lb.	.03½ - .03½		.04 - .04½	
Alum, potash lump.....lb.	.03½ - .04		.04 - .04½	
Alum, chrome lump.....lb.	.13 - .13½		.14 - .14½	
Aluminum sulphate, commercial.....lb.	.01½ - .02		.02 - .02½	
Aluminum sulphate, iron free.....lb.	.03 - .03½		.03½ - .04	
Aqua ammonia, 26 deg., drums (750 lb.).....lb.	.07½ - .07½		.08 - .08½	
Ammonia, anhydrous, cyl. (100-150 lb.).....lb.	.30 - .32		.33 - .35	
Ammonium carbonate, powder.....lb.	.08 - .08½		.09 - .10	
Ammonium chloride, granular (white sal-amoniac).....lb.	.06½ - .06½		.07 - .07½	
Ammonium chloride, granular (gray sal-amoniac).....lb.	.07½ - .08		.08 - .08½	
Ammonium nitrate.....lb.	.07½ - .07½		.08 - .08½	
Ammonium sulphate.....100 lb.	2.60 - 2.75		2.80 - 3.00	
Amylacetate.....gal.			4.00 - 4.25	
Amylacetate tech.....gal.			2.50 - 3.00	
Arsenic oxide, (white arsenic) powdered lb.	.06½ - .07		.07½ - .08	
Arsenic, sulphide, powdered (red arsenic) lb.	.11 - .11½		.12 - .13	
Barium chloride.....ton	59.00 - 59.50		60.00 - 62.00	
Barium dioxide (peroxide).....lb.	.19 - .20		.21 - .22	
Barium nitrate.....lb.	.08½ - .09		.09½ - .10	
Barium sulphate (precip.) (blanc fixe).....lb.	.04½ - .05		.05½ - .06	
Bleaching powder (see calc. hypochlorite).....lb.				
Blue vitriol (see copper sulphate).....lb.				
Borax (see sodium borate).....lb.				
Brimstone (see sulphur, roll).....lb.				
Bromine.....lb.	.41 - .42		.43 - .45	
Calcium acetate.....100 lbs.	2.00 - 2.05			
Calcium carbide.....lb.	.04½ - .04½		.05 - .05½	
Calcium chloride, fused, lump.....ton	24.00 - 25.00		26.00 - 27.00	
Calcium chloride, granulated.....lb.	.01½ - .02		.02½ - .03	
Calcium hypochlorite (bleach'g powder) 100lb.	2.15 - 2.25		2.35 - 2.50	
Calcium peroxide.....lb.			1.40 - 1.50	
Calcium phosphate, tribasic.....lb.			.15 - .16	
Camphor.....lb.			.75 - .78	
Carbon bisulphide.....lb.	.06½ - .07		.07½ - .08	
Carbon tetrachloride, drums.....lb.	.10½ - .10½		.11 - .12	
Carbonyl chloride (phosgene).....lb.			.75 - 1.00	
Caustic potash (see potassium hydroxide).....lb.				
Caustic soda (see sodium hydroxide).....lb.				
Chlorine, gas, liquid-cylinders (100 lb.).....lb.	.08 - .09		.09½ - .10	
Chloroform.....lb.			.42 - .44	
Cobalt oxide.....lb.			3.00 - 3.10	
Copperas (see iron sulphate).....lb.				
Copper carbonate, green precipitate.....lb.	.20 - .21		.22 - .23	
Copper cyanide.....lb.			.50 - .62	
Copper sulphate, crystals.....lb.	.05½ - .06		.06½ - .06½	
Cream of tartar (see potassium bitartrate).....lb.				
Epsom salt (see magnesium sulphate).....lb.				
Ethyl Acetate Com. 85%.....gal.			.85 - 1.00	
Ethyl Acetate pure (acetic ether 98% to 100%).....lb.			.50 - .52	
Formaldehyde, 40 per cent.....lb.	.13½ - .14		.14½ - .15	
Fusel oil, ref.....gal.			3.00 - 3.25	
Fusel oil, crude.....gal.			1.75 - 2.00	
Glauber's salt (see sodium sulphate).....lb.				
Glycerine, C. P. drums extra.....lb.			.16 - .16½	
Iodine, resublimed.....lb.			3.65 - 3.75	
Iron oxide, red.....lb.			.10 - .20	
Iron sulphate (copperas).....ton	19.00 - 20.00		21.00 - 22.00	
Lead acetate.....lb.			.11½ - .13½	
Lead arsenate, paste.....lb.	.09 - .09½		.10 - .11	
Lead nitrate.....lb.			.15 - .20	
Litharge.....lb.	.08½ - .08½		.08½ - .09	
Lithium carbonate.....lb.			1.30 - 1.40	
Magnesium carbonate, technical.....lb.	.09 - .09½		.10 - .11	
Magnesium sulphate, U. S. P.....100 lb.	2.40 - 2.75			
Magnesium sulphate, technical.....100 lb.			1.20 - 1.75	
Methanol, 95%.....gal.			.78 - .80	
Methanol, 97%.....gal.			.80 - .85	
Nickel salt, double.....lb.			.14 - .14½	
Nickel salt, single.....lb.			.15 - .15½	
Phosgene (see carbonyl chloride).....lb.				
Phosphorus, red.....lb.	.45 - .46		.47 - .50	
Phosphorus, yellow.....lb.			.35 - .37	
Potassium bichromate.....lb.	.11½ - .12		.12 - .12½	

	Carlots	Less Carlots
Potassium bitartrate (cream of tartar)..... lb.	\$.35 — .40	\$0.30 — \$0.31
Potassium bromide, granular..... lb.	.35 — .40	.16 — .25
Potassium carbonate, U. S. P..... lb.	.05 — .05½	.45 — .50
Potassium carbonate, 80-85%..... lb.	.08½ — .10	.06 — .07
Potassium chlorate, crystals..... lb.	.05 — .05½	.10½ — .14
Potassium cyanide..... lb.	.05 — .05½	.26 — .28
Potassium hydroxide (caustic potash)..... lb.	.05 — .05½	.05½ — .07
Potassium muriate, 80% K.C.L..... ton	49.00 — 50.00	
Potassium iodide..... lb.	.09½ — .09½	2.75 — 3.00
Potassium nitrate..... lb.	.31 — .32	.10 — .12½
Potassium permanganate..... lb.	.35 — .37	.33 — .34
Potassium prussiate, red..... lb.	.24½ — .25	.38 — .40
Potassium prussiate, yellow..... lb.		.25½ — .26
Potassium sulphate (powdered)..... per 100 lb.		1.50 — 1.75
Rochelle salts (see sodium potas tartrate)		
Salammoniac (see ammonium chloride)		
Sal soda (see sodium carbonate)		
Salt cake..... ton		30.00 — 32.00
Silver cyanide..... oz.		1.35 — 1.38
Silver nitrate..... oz.		.40 — .41
Soda ash, light..... 100 lb.	2.15 — 2.20	2.30 — 2.70
Soda ash, dense..... 100 lb.	2.40 — 2.45	2.50 — 2.75
Sodium acetate..... lb.	.04½ — .04½	.04½ — .05½
Sodium bicarbonate..... 100 lb.	2.25 — 2.40	2.50 — 2.75
Sodium bichromate..... lb.	.08 — .08½	.08½ — .09½
Sodium bisulphate (nitre cake)..... ton	5.00 — 5.25	5.50 — 6.50
Sodium bisulphate powdered, U.S.P..... lb.	.05 — .05½	.05½ — .06
Sodium borate (borax)..... lb.	.06½ — .06½	.07 — .07½
Sodium carbonate (sal soda)..... 100 lb.	1.90 — 2.00	2.10 — 2.40
Sodium chlorate..... lb.	.07½ — .07½	.08 — .08½
Sodium cyanide..... lb.	.19½ — .21	.22 — .30
Sodium fluoride..... lb.	.11½ — .12	.12 — .13½
Sodium hydroxide (caustic soda)..... 100 lb.	4.15 — 4.25	4.30 — 4.80
Sodium hyposulphite..... lb.	.03½ — .03½	.03½ — .03½
Sodium nitrate..... 100 lb.	2.90 — 3.00	3.00 — 3.00
Sodium nitrite..... lb.	.07½ — .07½	.08 — .09
Sodium peroxide, powdered..... lb.	.25 — .26	.27 — .30
Sodium phosphate, dibasic..... lb.	.04½ — .04½	.05 — .05½
Sodium potassium tartrate (Rochelle salts)..... lb.	.12½ — .12½	.12½ — .13½
Sodium prussiate, yellow..... lb.	1.25 — 1.35	1.40 — 1.50
Sodium silicate, solution (40 deg.)..... lb.	.02½ — .03	.03½ — .03½
Sodium silicate, solution (60 deg.)..... lb.	1.50 — 1.75	2.00 — 2.25
Sodium sulphate, crystals (Glauber's salt) 100 lbs.	.05½ — .05½	.06 — .06½
Sodium sulphide, fused, 60-62 per cent (conc.) lb.	.03½ — .04	.04½ — .04½
Sodium sulphite, crystals..... lb.	.15 — .15½	.16 — .17
Strontium nitrate, powdered..... lb.	.07 — .07½	.07½ — .08
Sulphur chl ride, red..... ton	20.00 — 22.00	
Sulphur, crude..... lb.	.08 — .08½	.09 — .10
Sulphur dioxide, liquid, cylinders extra..... 100 lb.		2.25 — 3.10
Sulphur (sublimed), flour..... 100 lb.		2.00 — 2.75
Sulphur, roll (brimstone)..... 100 lb.		
Tin bichloride, 50 per cent..... lb.	.18 — .19	.40 — .42
Tin oxide..... lb.	.16 — .18	.19 — .20
Zinc carbonate, precipitate..... lb.	.11 — .11½	.11½ — .12
Zinc chloride, gran..... lb.	.45 — .49	.50 — .60
Zinc cyanide..... lb.	.12 — .13	.13½ — .14
Zinc dust..... lb.	.09 — .09½	.09½ — .10
Zinc oxide, XX..... lb.	2.90 — 3.00	3.25 — 3.75
Zinc sulphate..... 100 lb.		

Coal-Tar Products

NOTE—The following prices are for original packages in large quantities:

Alpha-naphthol, crude..... lb.	\$1.10 — \$1.15
Alpha-naphthol, refined..... lb.	1.25 — 1.30
Alpha-naphthylamine..... lb.	.35 — .40
Aniline oil, drums extra..... lb.	.20 — .27
Aniline salts..... lb.	.26 — .29
Anthracene, 80% in drums (100 lb.)..... lb.	.75 — 1.00
Benzaldehyde U.S.P..... lb.	1.50 — 1.50
Benzidine, base..... lb.	.85 — 1.00
Benzidine sulphate..... lb.	.75 — .85
Benzoic acid, U.S.P..... lb.	.60 — .65
Benzoate of soda, U.S.P..... lb.	.55 — .60
Benzene, pure, water-white, in drums (100 gal.)..... gal.	.27 — .32
Benzene, 90%, in drums (100 gal.)..... gal.	.25 — .28
Benzyl chloride, 95-97%, refined..... lb.	.28 — .30
Benzyl chloride, tech..... lb.	.20 — .25
Beta-naphthol benzoate..... lb.	3.50 — 4.00
Beta-naphthol, sublimed..... lb.	.70 — .75
Beta-naphthol, tech..... lb.	.38 — .40
Beta-naphthylamine, sublimed..... lb.	1.75 — 1.80
Cresol, U. S. P., in drums (100 lb.)..... lb.	.16 — .18
Ortho-cresol, in drums (100 lb.)..... lb.	.25 — .27
Cresylic acid, 97-99%, straw color, in drums..... gal.	.70 — .80
Cresylic acid, 35-97%, dark, in drums..... gal.	.65 — .70
Cresylic acid, 50%, first quality, drums..... gal.	.45 — .50
Dichlorobenzene..... lb.	.05 — .09
Diethylaniline..... lb.	1.20 — 1.25
Dimethylaniline..... lb.	.40 — .50
Dinitrobenzene..... lb.	.26 — .28
Dinitrochlorobenzene..... lb.	.20 — .30
Dinitronaphthalene..... lb.	.30 — .40
Dinitrophenol..... lb.	.35 — .40
Dinitrotoluene..... lb.	.27 — .30
Dip oil, 25%, car lots, in drums..... gal.	.40 — .45
Diphenylamine..... lb.	.60 — .65
H-acid..... lb.	1.20 — 1.30
Meta-phenylenediamine..... lb.	1.15 — 1.20
Monochlorobenzene..... lb.	.12 — .14
Monoethylaniline..... lb.	1.75 — 1.85
Naphthalene crushed, in bbls..... lb.	.07 — .08½
Naphthalene, flake..... lb.	.07 — .08
Naphthalene, balls..... lb.	.08½ — .09
Naphthionic acid, crude..... lb.	.70 — .75
Nitrobenzene..... lb.	.12 — .15
Nitro-naphthalene..... lb.	.30 — .35
Nitro-toluene..... lb.	.16 — .18
Ortho-amidophenol..... lb.	3.10 — 3.20
Ortho-dichlor-benzene..... lb.	.15 — .20
Ortho-nitro-phenol..... lb.	.80 — .85
Ortho-nitro-toluene..... lb.	.15 — .20
Ortho-toluidine..... lb.	.20 — .25
Para-amidophenol, base..... lb.	1.50 — 1.60
Para-amidophenol, HCl..... lb.	1.75 — 1.80

Para-dichlorobenzene..... lb.	.15 — .20
Paranitroaniline..... lb.	.85 — 1.00
Para-nitrotoluene..... lb.	.85 — .95
Para-phenylenediamine..... lb.	1.75 — 2.00
Para-toluidine..... lb.	1.25 — 1.40
Phthalic anhydride..... lb.	.50 — .60
Phenol, U. S. P., drums..... lb.	.11 — .13
Pyridine..... gal.	2.00 — 3.50
Resorcinol, technical..... lb.	1.75 — 1.85
Resorcinol, pure..... lb.	2.25 — 2.30
Salicylic acid, tech., in bbls..... lb.	.19 — .22
Salicylic acid, U. S. P..... lb.	.20 — .25
Salol..... lb.	.80 — .85
Solvent naphtha, water-white, in drums, 100 gal..... gal.	.25 — .28
Solvent naphtha, crude, heavy, in drums, 100 gal..... gal.	.14 — .16
Sulphanilic acid, crude..... lb.	.30 — .35
Tolidine..... lb.	1.25 — 1.35
Toluidine, mixed..... lb.	.40 — .45
Toluene, in tank cars..... gal.	.25 — .28
Toluene, in drums..... gal.	.28 — .31
Xylidines, drums, 100 gal..... lb.	.40 — .45
Xylene, pure, in drums..... gal.	.40 — .45
Xylene, pure, in tank cars..... gal.	.45 — .45
Xylene, commercial, in drums, 100 gal..... gal.	.33 — .35
Xylene, commercial, in tank cars..... gal.	.30 — .30

Waxes

Prices based on original packages in large quantities.

Beeswax, refined, dark..... lb.	\$0.22 — \$0.23
Beeswax, refined, light..... lb.	.24 — .26
Beeswax, white pure..... lb.	.42 — .45
Carnauba, Flora..... lb.	.58 — .60
Carnauba, No. 2, North Country..... lb.	.25 — .26
Carnauba, No. 3, North Country..... lb.	.16 — .17
Japan..... lb.	.17 — .17½
Montan, crude..... lb.	.06½ — .06½
Paraffine waxes, crude match wax (white) 105-110 m.p..... lb.	.03½ — .03½
Paraffine waxes, crude, scale 124-126 m.p..... lb.	.02 — .03
Paraffine waxes, refined, 118-120 m.p..... lb.	.03 — .03½
Paraffine waxes, refined, 125 m.p..... lb.	.04 — .04½
Paraffine waxes, refined, 128-130 m.p..... lb.	.04 — .05
Paraffine waxes, refined, 133-135 m.p..... lb.	.05 — .05½
Paraffine waxes, refined, 135-137 m.p..... lb.	.05 — .06
Stearic acid, single pressed..... lb.	.09 — .09½
Stearic acid, double pressed..... lb.	.09½ — .10
Stearic acid, triple pressed..... lb.	.10 — .10½

Naval Stores

All prices are f.o.b. New York unless otherwise stated, and are based on carload lots. The oils in 50-gal. bbls., gross weight, 500 lb.

Rosin B-D, bbl..... 280 lb.	\$5.00 —
Rosin E-I..... 280 lb.	5.30 — 5.50
Rosin K-N..... 280 lb.	5.70 — 6.50
Rosin W. G.-W. W..... 280 lb.	6.60 —
Wood rosin, bbl..... 280 lb.	6.25 —
Spirits of turpentine..... gal.	.58½ —
Wood turpentine, steam dist..... gal.	.56 —
Wood turpentine, dest. dist..... gal.	.54 —
Pine tar pitch, bbl..... 200 lb.	6.75 —
Tar, kila burned, bbl. (500 lb.)..... bbl.	11.50 —
Retort tar, bbl..... 500 lb.	11.50 —
Rosin oil, first run..... gal.	.36 —
Rosin oil, second run..... gal.	.38 —
Rosin oil, third run..... gal.	.43 —
Pine oil, steam dist., sp.gr. 0.930-0.940..... gal.	\$1.00 —
Pine oil, pure, dest. dist..... gal.	1.50 —
Pine tar oil, ref., sp.gr. 1.025-1.035..... gal.	.46 —
Pine tar oil, crude, sp.gr. 1.025-1.035 tank cars f.o.b. Jacksonville, Fla..... gal.	.35 —
Pine tar oil, double ref., sp.gr. 0.965-0.990..... gal.	.75 —
Pine tar, ref., thin, sp.gr. 1.080-1.960..... gal.	.35 —
Turpentine, crude, sp. gr. 0.900-0.970..... gal.	1.20 —
Hardwood oil, f.o.b. Mich., sp.gr. 0.960-0.990..... gal.	.35 —
Pinewood creosote, ref..... gal.	.52 —

Solvents

73-76 deg., steel bbls. (85 lb.)..... gal.	\$0.41 —
70-72 deg., steel bbls. (85 lb.)..... gal.	.39 —
68-70 deg., steel bbls. (85 lb.)..... gal.	.38 —
V. M. and P. naphtha, steel bbls. (85 lb.)..... gal.	.30 —

Crude Rubber

Para-Upriver fine..... lb.	\$0.16 — .17
Upriver coarse..... lb.	.09 — .09½
Upriver caucho ball..... lb.	.11 — .12
Plantation—First latex crepe..... lb.	.14½ — .12½
Ribbed smoked sheets..... lb.	.12 — .12½
Brown crepe, thin, clean..... lb.	.15 —
Amber crepe No. 1..... lb.	.17 —

Oils

VEGETABLE

The following prices are f.o.b. New York for carload lots.

Castor oil, No. 3, in bbls..... lb.	\$0.08½ — \$0.09
Castor oil, AA, in bbls..... lb.	.10 — .10½
China wood oil, in bbls. (f.o.b. Pac. coast)..... lb.	.13½ — .13½
Cocanut oil, Ceylon grade, in bbls..... lb.	.10½ — .10½
Cocanut oil, Cochín grade, in bbls..... lb.	.11 — .11½
Corn oil, crude, in bbls..... lb.	.07½ — .07½
Cottonseed oil, crude (f. o. b. mill)..... lb.	.05½ — .05½
Cottonseed oil, summer yellow..... lb.	.07½ — .08
Cottonseed oil, winter yellow..... lb.	.08 —
Linseed oil, raw, car lots (domestic)..... gal.	.76 —
Linseed oil, raw, tank cars (domestic)..... gal.	.70 —
Linseed oil, in 5-bbl lots (domestic)..... gal.	.80 —

Olive oil, Denatured.....	gal.	\$1.35	—	\$1.45
Palm, Lagos.....	lb.	.06	—	.07
Palm, Niger.....	lb.	.05	—	.05
Peanut oil, crude, tank cars (f.o.b. mill).....	lb.	.06	—	.06
Peanut oil, refined, in bbls.....	lb.	.10	—	.10
Rapeseed oil, refined in bbls.....	gal.	.88	—	.90
Rapeseed oil, blown, in bbls.....	gal.	.94	—	.95
Soya bean oil (Manchurian), in bbls. N. Y.....	lb.	.07	—	....
Soya bean oil, tank cars, f.o.b., Pacific coast.....	lb.	.05	—	....

FISH

Light pressed menhaden.....	gal.	\$0.40	—	\$0.41
Yellow bleached menhaden.....	gal.	.42	—	....
White bleached menhaden.....	gal.	.44	—	....
Blown menhaden.....	gal.	.80	—	....

Miscellaneous Materials

All f.o.b. New York Unless Otherwise Stated

Barytes, ground, white, f.o.b. Kings Creek, S. C.....	net ton	\$24.00	—	30.00
Barytes, ground, off color, f.o.b. Kings Creek.....	net ton	22.00	—	26.00
Barytes, crude, 88% @ 94% ba., Kings Creek.....	net ton	10.00	—	12.00
Barytes, floated, f.o.b. St. Louis.....	net ton	26.50	—	28.00
Barytes, crude, first grade, Missouri.....	net ton	7.00	—	....
Blanc fixe, dry.....	lb.	.04	—	.04
Blanc fixe, pulp.....	net ton	45.00	—	55.00
Casein.....	lb.	.08	—	.10
Chalk, domestic, extra light.....	lb.	.05	—	.05
Chalk, domestic, light.....	lb.	.04	—	.05
Chalk, domestic, heavy.....	lb.	.04	—	.05
Chalk, English, extra light.....	lb.	.05	—	.07
Chalk, English, light.....	lb.	.05	—	.06
Chalk, English, dense.....	lb.	.04	—	.05
China clay (kaolin) crude, f.o.b. mines, Georgia.....	net ton	8.00	—	10.00
China clay (kaolin) washed, f.o.b. Georgia.....	net ton	12.00	—	15.00
China clay (kaolin) powdered, f.o.b. Georgia.....	net ton	18.00	—	22.00
China clay (kaolin) crude f.o.b. Virginia points.....	net ton	8.00	—	12.00
China clay (kaolin) ground, f.o.b. Virginia points.....	net ton	15.00	—	30.00
China clay (kaolin), imported, lump.....	net ton	2.00	—	20.00
China clay (kaolin), imported, powdered.....	net ton	22.00	—	30.00
Feldspar, crude, f.o.b. Maryland and North Carolina points.....	gross ton	8.00	—	14.00
Feldspar, crude, f.o.b. Maine.....	net ton	7.50	—	10.00
Feldspar, ground, f.o.b. Maine.....	net ton	21.00	—	23.00
Feldspar, ground, f.o.b. North Carolina.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. N. Y. State.....	net ton	17.00	—	21.00
Feldspar, ground, f.o.b. Baltimore.....	net ton	27.00	—	30.00
Fullers earth, f.o.b. Mines.....	net ton	16.00	—	17.00
Fullers earth, granular, f.o.b. Pa.....	net ton	15.00	—	18.00
Fullers earth, powdered, f.o.b. Fla.....	net ton	18.00	—	....
Fullers earth, imported, powdered.....	net ton	24.00	—	27.00
Graphite, Ceylon lump, first quality.....	lb.	.07	—	.08
Graphite, Ceylon chip.....	lb.	.06	—	.06
Graphite, high grade amorphous crude.....	lb.	.02	—	.03
Pumice stone, imported, lump.....	lb.	.04	—	.50
Pumice stone, domestic lump.....	lb.	.05	—	.05
Pumice stone, ground.....	lb.	.06	—	.07
Quartz (acid tower) first to head, f.o.b. Baltimore.....	net ton	....	—	10.00
Quartz (acid tower) 1 1/2 @ 2 in., f.o.b. Baltimore.....	net ton	....	—	14.00
Quartz (acid tower) rice, f.o.b. Baltimore.....	net ton	....	—	17.00
Quartz, lump, f.o.b. North Carolina.....	net ton	5.00	—	7.50
Shellac, orange fine.....	lb.	.70	—	....
Shellac, orange superfine.....	lb.	.73	—	.74
Shellac, A. C. garnet.....	lb.	.54	—	.55
Shellac, T. N.....	lb.	.69	—	.70
Soapstone.....	ton	12.00	—	15.00
Sodium chloride.....	long ton	12.50	—	13.00
Talc, paper-making grades, f.o.b. Vermont.....	ton	11.00	—	20.00
Talc, roofing grades, f.o.b. Vermont.....	ton	8.50	—	13.00
Talc, rubber grades, f.o.b. Vermont.....	ton	11.00	—	18.00
Talc, powdered, Southern, f.o.b. cars.....	ton	10.00	—	14.00
Talc, imported.....	ton	30.00	—	40.00
Talc, California talcum powder grade.....	ton	18.00	—	40.00

Refractories

Bauxite brick, 56% Al, f.o.b. Pittsburgh.....	per ton	\$37.50—40.00
Carborundum refractory brick, 9-in.	1,000	1250.00
Chrome brick, f.o.b. Eastern shipping points.....	net ton	60
Chrome cement, 40-45% Cr ₂ O ₃	net ton	30—32
Chrome cement, 40-45% Cr ₂ O ₃ , sacks, in car lots, f.o.b. Eastern shipping points.....	net ton	33—35
Fireclay brick, 1st quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	36—40
Fireclay brick, 2nd quality, 9-in. shapes, f.o.b. Pennsylvania, Ohio and Kentucky works.....	1,000	30—35
Magnesite brick, 9-in. straight.....	net ton	70
Magnesite brick, 9-in. arches, wedges and keys.....	net ton	77
Magnesite brick, soaps and splits.....	net ton	98
Silica brick, 9-in. sizes, f.o.b. Chicago district.....	1,000	42—45
Silica brick, 9-in. sizes, f.o.b. Birmingham district.....	1,000	46—50
Silica brick, 9-in. sizes, f.o.b. Mt. Union, Pa.....	1,000	35—38

Ferro-Alloys

All f.o.b. Works

Ferro-titanium, 15-18%, f.o.b. Niagara Falls, N. Y.....	net ton	\$200.00 — \$225.00
Ferrochrome per lb. of Cr. contained, 6-8% carbon, carlots.....	lb.	.14 —
Ferrochrome, per lb. of Cr. contained, 4-6% carbon, carlots.....	lb.	.15 —
Ferromanganese, 76-80% Mn, domestic.....	gross ton	70.00 — 75.00
Ferromanganese, 76-80% Mn, English.....	gross ton	70.00 — 75.00
Spiegel, 18-22% Mn.....	gross ton	27.00 — 28.00
Ferromolybdenum, 50-60% Mo, per lb. of Mo.....	lb.	2.50 —
Ferrosilicon, 10-15%.....	gross ton	40.00 — 42.00
Ferrosilicon, 50%.....	gross ton	68.00 — 70.00
Ferrosilicon, 75%.....	gross ton	40.00 — 145.00
Ferrotungsten, 70-80%, per lb. of contained W.....	lb.	.45 — .50
Ferrouanium, 35-50% of U, per lb. of U content.....	lb.	6.00 —
Ferrovandium, 30-40% per lb. of contained V.....	lb.	5.00 — 6.50

Ores and Semi-finished Products

All f.o.b. New York, Unless Otherwise Stated

Bauxite, 52% Al content.....	gross ton	\$8.00 — \$10.00
Chrome ore, Calif. concentrates, 50% min. Cr ₂ O ₃	unit	.40 — .45
Chrome ore, 50% Cr ₂ O ₃ , f.o.b. Atlantic seaboard.....	unit	.40 — .45
Coke, foundry, f.o.b. ovens.....	net ton	4.00 — 4.50
Coke, furnace, f.o.b. ovens.....	net ton	3.00 — 3.25
Coke, petroleum, refinery, Atlantic seaboard.....	net ton	15.00 — 16.00
Fluorspar, lump, f.o.b. mines, New Mexico.....	net ton	12.50 —
Fluorspar, standard, domestic washed gravel Kentucky and Illinois mines.....	net ton	18.00 — 20.00
Ilmenite, 52% TiO ₂ , per lb. ore.....	lb.	.01 — .01
Manganese ore, 50% Mn, c.i.f. Atlantic seaport.....	unit	.25 —
Manganese ore, chemical (MnO ₂).....	gross ton	55.00 — 60.00
Molybdenite, 85% MoS ₂ , per lb. of MoS ₂ , N. Y.....	lb.	.55 — .60
Monazite, per unit of ThO ₂ , c.i.f. Atlantic seaport.....	unit	30.00 —
Pyrites, Spanish, fines, c.i.f. Atlantic seaport.....	unit	.14 — .14
Pyrites, Spanish, furnace size, c.i.f. Atlantic seaport.....	unit	.14 — .14
Pyrites, domestic, fines, f.o.b. mines, Ga.....	unit	.12 — .13
Rutile, 95% TiO ₂ per lb. ore.....	lb.	.15 —
Tungsten, scheelite, 60% WO ₃ and over, per unit of WO ₃ (nominal).....	unit	2.75 — 3.00
Tungsten, Wolframite, 60% WO ₃ and over, per unit of WO ₃ , N. Y. C.....	unit	3.00 — 3.25
Uranium ore (carnotite) per lb. of U ₃ O ₈	lb.	1.50 — 2.50
Uranium oxide, 96% per lb. contained U ₃ O ₈	lb.	2.25 — 2.50
Vanadium pentoxide, 99%.....	lb.	12.00 — 14.00
Vanadium ore, per lb. of V ₂ O ₅ contained.....	lb.	1.00 —
Zircon, washed, iron free.....	lb.	.03 —

Non-Ferrous Metals

New York Markets

	Cents per Lb.
Copper, electrolytic.....	12.85—13.00
Aluminum, 98 to 99 per cent.....	28.00 @ 28.5
Antimony, wholesale lots, Chinese and Japanese.....	5 1/2
Nickel, ordinary (ingot).....	41.00
Nickel, electrolytic.....	44.00
Monel metal, spot and blocks.....	35.00
Monel metal, ingots.....	38.00
Monel metal, sheet bars.....	40.00
Tin, 5-ton lots, S. rail.....	28.75—29.00
Lead, New York, spot.....	4.40
Lead, E. St. Louis, spot.....	4.15
Zinc, spot, New York.....	4.75
Zinc, spot, E. St. Louis.....	4.35—4.40

OTHER METALS

Silver (commercial).....	oz.	\$0.58 1/2
Cadmium.....	lb.	1.00—1.25
Bismuth (500 lb. lots).....	lb.	1.50 @ 1.55
Cobalt.....	lb.	4.00
Magnesium (f.o.b. Philadelphia).....	lb.	1.25
Platinum.....	oz.	75.00
Iridium.....	oz.	160.00 @ 180.00
Palladium.....	oz.	70.00
Mercury.....	.75 lb.	46.00—47.00

FINISHED METAL PRODUCTS

	Warehouse Price Cents per Lb.
Copper sheets, hot rolled.....	21.25—21.50
Copper bottoms.....	28.75—29.00
Copper rods.....	20.00
High brass wire.....	17.25
High brass rods.....	14.25
Low brass wire.....	18.75
Low brass rods.....	18.75
Brazed brass tubing.....	27.50
Brazed bronze tubing.....	32.25
Seamless copper tubing.....	22.00
Seamless high brass tubing.....	20.00

OLD METALS—The following are the dealers' purchasing prices in cents per pound:

	New York Current	Cleveland	Chicago
Copper, heavy and crucible.....	9.25 @ 9.50	9.25	9.50
Copper, heavy and wire.....	8.25 @ 8.50	8.50	8.50
Copper, light and bottoms.....	7.25 @ 7.75	7.50	7.25
Lead, heavy.....	3.25 @ 3.50	3.25	3.25
Lead, tea.....	2.25 @ 2.35	2.25	2.25
Brass, heavy.....	4.25 @ 4.50	4.50	5.00
Brass, light.....	3.25 @ 3.50	3.25	3.50
No. 1 yellow brass tubing.....	4.25 @ 4.50	4.25	4.50
Zinc.....	2.00 @ 2.50	2.00	2.25

Structural Material

The following base prices per 100 lb. are for structural shapes 3 in. by 1/2 in. and larger, and plates 1/2 in. and heavier, from jobbers' warehouses in the cities named:

	New York	Cleveland	Chicago
Structural shapes.....	\$2.60	\$3.23	\$3.23
8 ft. steel bars.....	2.50	3.00	3.13
Soft steel bar shapes.....	2.50	3.13	3.13
Soft steel bands.....	2.85	3.83	3.78
Plates, 1/2 to 1 in. thick.....	2.50	3.30	3.23

*Add 15c per 100 lb. for trucking to Jersey City and 10c for delivery in New York and Brooklyn

Industrial

Financial, Construction and Manufacturers' News

certain equipment have been awarded. William A. Taylor is president. A. B. Patterson, Tulsa, Okla., is engineer.

TULSA—Cassien & Co., operating a local oil refinery, will make improvements and extensions at their power house to cost about \$100,000, including boilers and other equipment.

Construction and Operation

Arkansas

HELENA—S. A. and B. L. Lane, Little Rock, Ark., are negotiating with the Chamber of Commerce, Helena, for a suitable site for the erection of a new local oil refinery. The initial unit is estimated to cost about \$35,000.

Connecticut

NORWALK—Charles H. Harris, Inc., has been incorporated under Connecticut laws with capital of \$500,000, to manufacture glassware products. The company has recently awarded a contract for the erection of a new 1-story plant on Main Street, 100 x 200 ft., estimated to cost about \$75,000. It will be affiliated, it is understood, with the company of the same name, with offices at 135 W. 24th St., New York. Charles H. Harris, Penn Ave., Norwalk, is president.

Delaware

WILMINGTON—The Darco Corp., a subsidiary of the Atlas Powder Co., du Pont Bldg., has arranged for a bond issue of \$1,500,000, the proceeds to be used for the erection of a new plant in Louisiana for the manufacture of refined carbon products, known as "Darco," used in connection with the production of sugar, gelatine, etc. The plant will have an initial daily capacity of close to 5,000 tons.

Florida

ST. PETERSBURG—The Shinem Mfg. Co., manufacturer of polishes, has plans under way for the erection of a new 2-story plant, 40 x 100 ft., for the manufacture of its regular specialties. George W. Wrennick is general manager.

Georgia

ATLANTA—The Cotton State Rubber Mfg. Co., recently organized, is planning for the establishment of a new plant for the manufacture of rubber goods, including belting, packing and other mechanical specialties. George J. Reiter is president, and W. S. McKemia secretary.

Illinois

OREGON—The Paragon Foundries Co., manufacturer of plates and other iron castings, has plans under way for the erection of a new 1-story addition, 100 x 200 ft., to cost about \$50,000. N. E. Buser, Mount Morris, Ill., is architect; James Reed is president.

Kentucky

LOUISVILLE—The Southern Iron & Steel Co., recently organized, will operate a local plant for the manufacture of bar iron, squares, rounds, etc. It is planned to develop a daily output of about 75 tons. E. M. Drummond is president, and James A. Drummond secretary and treasurer.

Maryland

BALTIMORE—The American Sugar Refining Co. is continuing to file plans for the erection of buildings at its new local refinery at Woodall and Clement Sts., and the latest permit issued provides for the construction of a 7-story pan house, 80 x 154 ft.

Massachusetts

EAST LONGMEADOW—The New England Steel Castings Co., Shaker Rd., is reported to be planning for the rebuilding of its plant, destroyed by fire, June 15, with loss estimated at close to \$100,000, including equipment.

FALL RIVER—The New England Refining Co., Peat St., has filed plans for the erection of a new oil separator building to cost about \$50,000, and new gas holder to

cost about \$36,000. Construction will begin at once.

Minnesota

HIBBING—The Mahoning Iron & Steel Co. has completed plans for the immediate erection of a new laboratory building at its local properties, known as the Mahoning Mine.

New Jersey

PERTH AMBOY—One of the buildings at the plant of the American Agricultural Chemical Co., Roosevelt district, was recently destroyed by fire, with loss estimated at about \$15,000.

TRENTON—The Miller-Steiner Rubber Co., recently incorporated with a capital of \$100,000, has taken over the plant of the Olden Rubber Co., 678-94 North Olden Ave., and will establish a plant for the manufacture of mechanical rubber goods. Alterations will be made and machinery installed at once. It is proposed to commence operations early in July. John M. Miller is president and general manager.

NEWARK—The Wilson Imperial Co., Hermon St., manufacturer of polishes, paint and varnish removers, etc., has acquired property adjoining its plant, heretofore held by the Storms Co., manufacturer of dumb-waiters, etc. The property is 90 x 165 ft., improved with a 2-story building, totaling about 15,000 sq. ft. of manufacturing space. It will be used, in part, by the new owner for expansion.

NEWARK—The Irvington Smelting & Refining Works, Nye Ave., has commenced the installation of a new precipitator for the prevention of acid fumes at its plant.

New York

BEACON—The Beacon Tire & Rubber Co. has awarded a contract to Amos Jones, 45 North St., for the erection of a 3-story addition to its plant, 50 x 80 ft., estimated to cost about \$25,000.

ITHACA—The Superintendent of Buildings and Grounds, Cornell University, has taken bids for the erection of the proposed new 4-story chemical laboratory at the institution, 192 x 268 ft., estimated to cost close to \$2,000,000. Gibb & Waltz, 110 North Tioga St., are architects.

North Carolina

ASHEVILLE—James E. Rector, head of Rector, Blackstock & Taylor, 8 Technical Bldg., is planning for the installation of new equipment at his local brick manufacturing plant, comprising the former works of the Asheville Shale Brick Co., recently acquired under lease. New drying machinery and burning apparatus will be provided. It is proposed to develop an output of about 25,000 bricks per day.

Ohio

CAREY—The Hume China Co. will take bids early in July for the erection of its proposed new 1-story pottery, 150 x 500 ft., to be equipped for the manufacture of general ware. W. W. Matchett, 408 Alliance Bank Bldg., Alliance, O., is architect. George H. Hume is president.

NILES—F. A. Sebring, Sebring, O., operating a local pottery for the manufacture of general ware, has acquired the interests of W. H. Tritt in the Tritt China Co., Niles.

Oklahoma

ONETA—The Oneta Refining Co. is perfecting plans for the erection of its proposed new oil refinery at Pine Bluff, Ark., to have an initial daily capacity of about 1,000 bbl. The new plant with machinery is estimated to cost close to \$300,000. H. C. Mier, vice-president, is in charge.

PRESTON—The Taylor Oil & Gasoline Co., 265 Post Office Bldg., Okmulgee, Okla., recently organized with a capital of \$500,000, has perfected plans for the erection of a new two-unit gasoline plant at Preston. It is proposed to develop a daily output of about 2,500 gal. The plant is estimated to cost in excess of \$150,000. Contracts for

Pennsylvania

PARKERS LANDING—The Wightman Bottle & Glass Co. has resumed operations at two more shops at its local plant for increased production. A number of repairs and improvements have been made in the buildings during a shut-down for over a month past. The plant will operate on two 8-hour shifts.

BEDFORD—Property of the Philadelphia Vitriified Brick Co., in Bedford Co., near Bedford, will be offered at public sale on July 11, by J. M. Fink, trustee. The plant consists of a complete works for the manufacture of vitriified brick, with adjoining property totaling over thirty-five acres.

PHILADELPHIA—The Mutual Rendering Co. has taken title to the plant of the Haffleigh Rendering Co., Ontario and Brabant Sts., devoted to the manufacture of tallow and affiliated products, and will operate the plant at this location. A consideration of about \$90,000 was given for the property.

South Carolina

GAFFNEY—The McCraw Brick Co. is planning for the installation of new machinery at its plant, to include a department for the manufacture of pressed bricks. A new steam shovel is also being considered, for installation at the clay properties. C. D. Meadows is secretary and treasurer.

Virginia

RICHMOND—The R. A. Cauthorne Paper Co., Inc., Tenth and Carey Sts., has tentative plans under way for the erection of a new local paper manufacturing plant, on site at Hull and Brander Sts., estimated to cost about \$75,000. Carneal & Johnson, Chamber of Commerce Bldg., are architects.

BOYDTON—Baptist & Goode are considering the erection of a new plant on local site for the manufacture of bricks and other burned clay products.

Tennessee

MT. PLEASANT—The Phosphates Products Co., recently incorporated with a capital of \$25,000, will operate a local fertilizer manufacturing plant. E. E. Fisher and N. B. Stewart, Mt. Pleasant, head the company.

KINGSFORD—Under a decree issued by the Chancery Court, the local plant of the Union Dye & Chemical Co. will be offered at public sale on Aug. 10. The plant is now in the possession of the Equitable Trust Co., New York, trustee. It is estimated in value in excess of \$2,500,000.

Texas

SHERMAN—The Buffalo Producing & Refining Co. is arranging for an increase in the capacity of its plant from 300 to 1,000 bbl. of oil daily. The company recently acquired the Texas Interstate Producing & Refining Co. in connection with its expansion plans.

Washington

LA GRANDE—The American Nitrogen Products Co., operating a local plant, has made application to the Port Commission, Seattle, Wash., for a suitable site for the erection of a new plant for the manufacture of nitrogen products. It is proposed to acquire a tract of about four acres of land for the works, which are estimated to cost approximately \$500,000 with machinery. The company is now operating a branch plant at Lake Buntzen, near Vancouver, B. C.

West Virginia

FAIRMONT—The Monongah Glass Co. has awarded contracts for the installation of new equipment at its plant, to provide for increased production. Gas producers, conveying apparatus and kindred machinery will be installed. R. T. Cunningham is secretary and treasurer.

HORTON—The Parsons Pulp & Lumber Co., Finance Bldg., Philadelphia, Pa., is planning for the erection of a new mill in the vicinity of Horton for the manufacture of pulp products. The company will develop extensive properties both at Horton and Seneca, W. Va.

New Companies

THE PREMIUM OIL CORP., 1404 Harris Trust Bldg., Chicago, Ill., has been incorporated with a capital of \$50,000 to manufacture refined oil products. The incorporators are H. M. Cassidy, Stanley Rich and R. O. Farrell.

THE ADAMANTEX BRICK CO. OF NEW ENGLAND, INC., Boston, Mass., has been incorporated with a capital of \$400,000, to manufacture bricks and burned clay products. John R. Honors is president; and Frank S. Perkins, 393 Essex St., Salem, Mass., treasurer.

THE LIPTON SALT CO., New York City, has been incorporated with a capital of \$10,000 to manufacture salt and salt by-products. The incorporators are C. Lipton, J. Schlesinger and H. Dressner. The company is represented by L. Schfran, 51 Chambers St.

THE LA-HUNT OIL CO., Los Angeles, Cal., has been incorporated with a capital of \$500,000 to manufacture petroleum products. The incorporators are John G. Clark, S. J. Bowman and George Dennison. The company is represented by Cranahan & Clark, 501 Chapman Bldg.

THE BLACK DIAMOND IRON SYNDICATE, Salem, Ore., has been incorporated with a capital of \$100,000 to operate an ore reduction and smelting plant. The incorporators are E. S. Deardorff and O. P. Coshaw, Salem.

THE PETROLEUM PRODUCING & REFINING CO., 10 South La Salle St., Chicago, Ill., has been incorporated with a capital of 200 shares of stock, no par value, to manufacture refined oil products. The incorporators are John B. Weeden, H. J. Chatford and S. X. Willard.

THE LEATHER CHEMICAL PRODUCTS CORP., Newark, N. J., has been incorporated with a capital of \$100,000 to manufacture chemical products for leather service. The incorporators are Benjamin Shanefield, H. Kearns and Meyer Rashkes, 9 Clinton St.

THE FARNUM GLASS CO., Cambridge, Mass., has been incorporated with a capital of \$10,000 to manufacture glass specialties. G. F. Farnum is president; and Henry M. Rockwell, 496 Commonwealth Ave., is treasurer.

THE RIBBON STEEL PRODUCTS CORP., Brooklyn, N. Y., has been incorporated with a capital of \$50,000, to manufacture steel specialties. The incorporators are C. V. Reynolds, C. W. Lockwood, and R. Rae. The company is represented by J. P. Bromell, 17 E. 42d St.

THE LONG BEACH-MIDWAY PETROLEUM CO., Long Beach, Cal., has been incorporated with a capital of \$400,000 to manufacture petroleum products. The incorporators are J. F. Steele, Carl Pohl, and John H. Burke, First National Bank Bldg., Long Beach.

GEORGE F. SNYDER, INC., Alpena, Mich., has been incorporated with a capital of \$50,000 to manufacture aluminum, brass, bronze and other metal castings. Samuel Taig and George F. Snyder, Alpena, are the incorporators.

THE THREE POINT PRODUCTS CORP., Albany, N. Y., has been incorporated with a capital of \$200,000 to manufacture chemicals, soaps and kindred products. The incorporators are E. F. Dolan, L. K. Luff and F. P. Gutelius. C. J. Tobin, Albany, represents the company.

THE LA PREME IVORY NOVELTY CO., East Passaic Ave. and Center St., Bloomfield, N. J., has filed notice of organization to manufacture celluloid and other composition products. Richard Webster heads the company.

THE GLOVER-KRASNOW CO., INC., Springfield, Mass., has been incorporated with a capital of \$10,000 to manufacture leather products. George Krasnow is president and George E. Glover, 211 Main St., treasurer.

THE METAL-CRAFT MFG. CO., Room 1018, 64 West Randolph St., Chicago, Ill., has been organized to manufacture metal products. The company is headed by Henry J. Ward and William B. Bosworth.

THE PARKER-KISKADEN CO., Detroit, Mich., has been incorporated with a capital of \$20,000 to manufacture greases, lubricants, etc. The incorporators are Charles A. Parker and Cameron H. Kiskadden, 46 Davenport St.

THE PETERSEN MFG. CO., INC., Scotch Plains, N. J., has been incorporated with a nominal capital of \$5,000, to manufacture asbestos products. The incorporators are George A. Oddie and George F. W. Petersen, Mountain Ave. and Stout St., Scotch Plains.

THE INTERNATIONAL EXTRACT CO., Lake Charles, La., has been incorporated with a capital of \$20,000, to manufacture prepared

extracts, chemicals, etc. Adolph Lagrange is president, and John J. Dubourg, secretary and treasurer, Lake Charles.

THE OCEAN OIL CO., Long Beach, Cal., has been incorporated with a capital of \$250,000 to manufacture petroleum products. The incorporators are V. S. Craig, C. M. Chandler and G. M. Spicer, 431 First National Bank Bldg., Long Beach.

THE JUS-TEL CHEMICAL CO., Brooklyn, N. Y., has been incorporated with a capital of \$50,000 to manufacture chemicals and chemical byproducts. The incorporators are A. and B. Juster, and E. Buchman. The company is represented by M. Eichner, 1545 B'way.

THE DETROIT ALLOY STEEL CO., Detroit, Mich., has been incorporated with a capital of \$50,000 to manufacture steel products. The incorporators are Frank L. Griffin, Robert H. Hall, and John Grant, 1938 Taylor Ave.

THE MACCO MFG. CO., Holyoke, Mass., has been incorporated with a capital of 5,000 shares of stock, no par value, to manufacture paper and paper products. William P. Corkindale is president; and Frank A. Gates, Holyoke, treasurer.

THE ILLINOIS GRAPHITE CO., 155 North Clark St., Chicago, Ill., has been incorporated with a capital of \$10,000 to manufacture graphite products. The incorporators are H. G. Sampson, W. J. Hough and E. M. Park.

B. TOUGIAS, INC., New York City, has been incorporated with a capital of \$25,000 to manufacture oil products. The incorporators are B. Tougas, L. Fish and S. Schiff. The company is represented by Kahn & Zorn, 66 B'way.

Capital Increases, Etc.

THE SENECA COPPER CORP., 11 B'way., New York City, has filed notice of increase in active capital from \$1,250,000 to \$1,700,000.

THE UNITED STATES REDUCTION CO., East Chicago, Ind., has filed notice of increase in capital from \$150,000 to \$350,000.

THE GENERAL CHINAWARE CORP., organized under Delaware laws with capital of \$850,000, has filed notice of organization to operate in New York for the manufacture of chinaware. R. D. Buchholtz, 15 Broad St., is representative.

THE CORONET PHOSPHATE CO., 99 John St., New York City, has filed notice of increase in capital from \$2,500,000 to \$3,000,000.

THE BROOKLYN PUTTY WORKS, 50 Bergen St., Brooklyn, N. Y., have filed notice of increase in capital to an active amount of \$10,000.

THE GENERAL PETROLEUM CO., 310 Sansome St., San Francisco, Cal., has arranged for a note issue of \$10,000,000, the proceeds to be used for expansion, general operations, financing, etc.

THE ST. LOUIS COKE & CHEMICAL CO., St. Louis, Mo., has arranged for a bond issue of \$10,000,000, the proceeds to be used for future expansion and current operations. Of the total amount, \$6,545,000 will be issued and sold immediately.

THE FISCHER & HAYES ROPE & STEEL CO., 741 West Van Buren St., Chicago, Ill., manufacturer of wire rope, etc., has filed notice of increase in capital from \$30,000 to \$150,000.

New Publications

BOOKS

AMERICAN BUSINESS METHODS. By Floyd W. Parsons, E.M. Pp. 373. New York: G. P. Putnam's Sons, 1921. Price, \$2.50.

"The purpose of this book is to supply the reader with practical knowledge of ways and means to increase production in any and all lines of business. In a material sense, production is the true measure of success of a corporation or an individual. Generally speaking, the fundamental principles of business are quite similar whether a man manufactures locomotives or sells lead pencils. The real secret of 'getting ahead' in any line of work appears to be ability to adapt the best practices of others to the business in hand.

"The data contained in this volume have been gathered from hundreds of leaders in dozens of industries. Much of the information has resulted from careful research and personal interviews, and has formed the foundation of articles published in the 'Everybody's Business' department of the *Saturday Evening Post*. In fact, the vol-

ume has been created largely as a result of the requests of many *Post* readers that the facts presented be elaborated and collected in book form.

"It is probably true that the book as a whole represents more research and more hours of labor than has ever before been devoted to any work of a kindred nature. There are many splendid books covering definite and distinct phases of business procedure, but investigation fails to disclose any volume that attempts the ambitious plan of treating all of the important problems that underlie modern commercial and industrial practice."

This mass of data has been arranged and classified so as to present continuity of thought under the headings or chapters: Industrial Relations; Health and Industry; Light and Ventilation; Labor-Saving Machinery; Advertising and Selling; Business Methods and Ideas; Foreign Trade Problems and Practices; Application of Science to Industry.

THE CHEMICAL ALLIANCE, INC., IN THE WORLD WAR. Pp. 82. Philadelphia: The Chemical Alliance, Inc., 1921.

This historical review of the Chemical Alliance, Inc., has been compiled pursuant to a request from the Historical Bureau of the General Staff, War Department, to all war service organizations to furnish reports of their activities. It has been prepared to form a permanent record of the object, organization and activities of the Chemical Alliance and its service to the Government during the war period and in the solution of after-war problems.

The first part of the review comprises a report by the president, Horace Bowker, which was presented at the second annual meeting, held at New York City, Jan. 22 and 23, 1919. Incorporated in Mr. Bowker's report are brief records of the activities of the various committees which had been functioning during the war and post-war periods.

The latter part of the book records the cessation of the activities of the Alliance, together with the appreciation of its services by Government officials. The closing record is the decision to continue the Alliance indefinitely as an inactive organization.

FACTORY CHEMISTRY. By William H. Hawkes, M.Sc., department of chemistry, Ford Institute of Technology, Detroit, Mich. Pp. 59. New York: Longmans, Green & Co., 1921. Price \$1.

This is a very elementary treatment especially designed for factory men interested in the study of chemistry as it bears on the various operations in factory processes. A short outline of qualitative analysis is included, so that the book is preparatory to courses in quantitative metallurgical analysis and metallography.

THE BUSINESS LIBRARY—WHAT IT IS AND WHAT IT DOES. By Louise B. Krause. Pp. 124, illustrated. San Francisco: *Journal of Electricity and Western Industry*.

Coming Meetings and Events

AMERICAN CERAMIC SOCIETY'S summer meeting will be held at Canton, Alliance, Sebring and East Liverpool, Ohio, July 25 to 27. Headquarters will be at the Hotel Courtland, Canton, Ohio.

AMERICAN CHEMICAL SOCIETY, THE SOCIETY OF CHEMICAL INDUSTRY and the American Section of the latter society will hold a joint meeting in New York, Sept. 6 to 10.

AMERICAN ELECTROCHEMICAL SOCIETY will hold its fall meeting in Lake Placid, N. Y., Sept. 29 and 30, and Oct. 1.

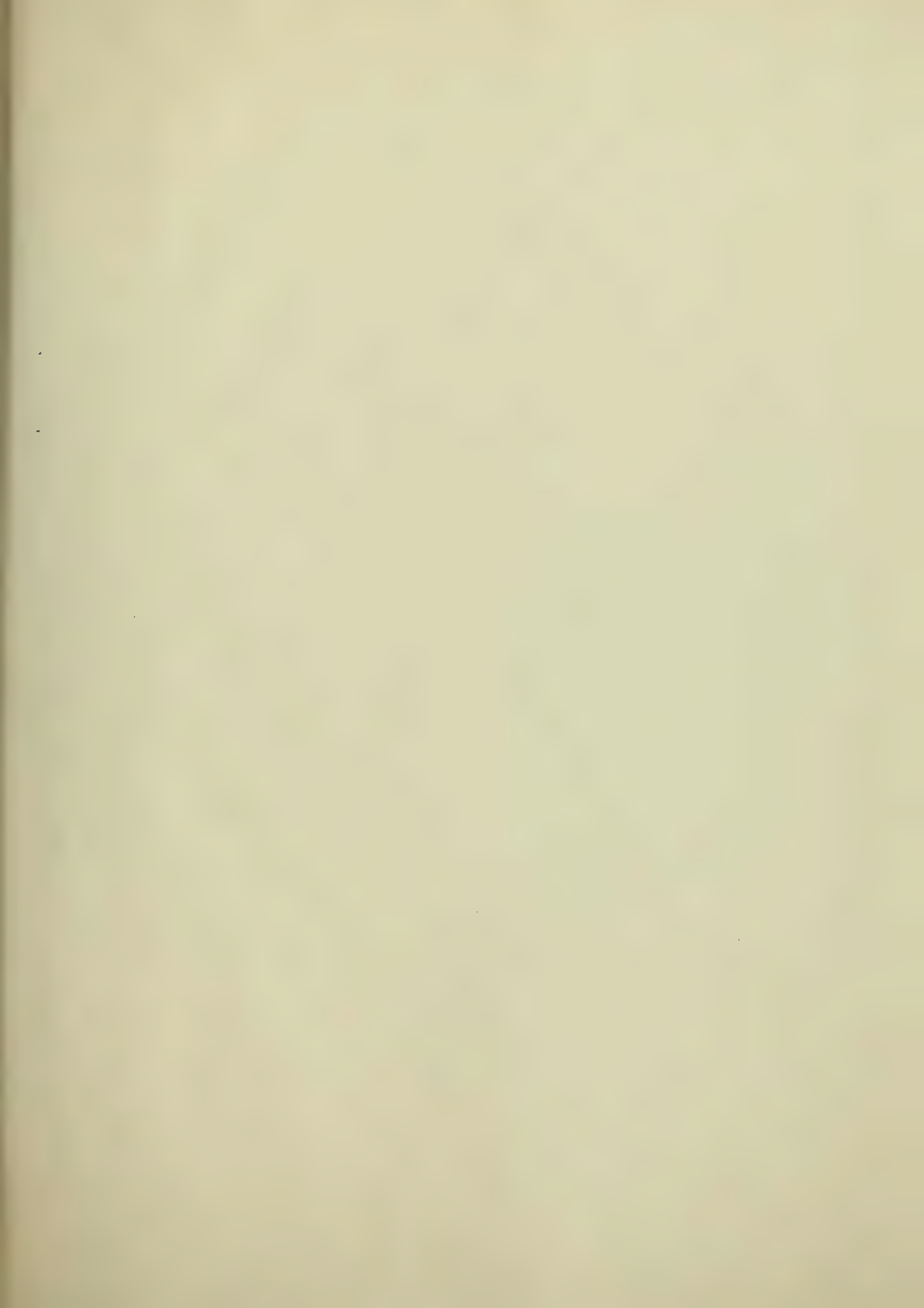
AMERICAN MINING CONGRESS AND NATIONAL EXPOSITION OF MINES AND MINING EQUIPMENT will hold its twenty-fourth annual convention in the Coliseum, Chicago, Oct. 17 to 22.

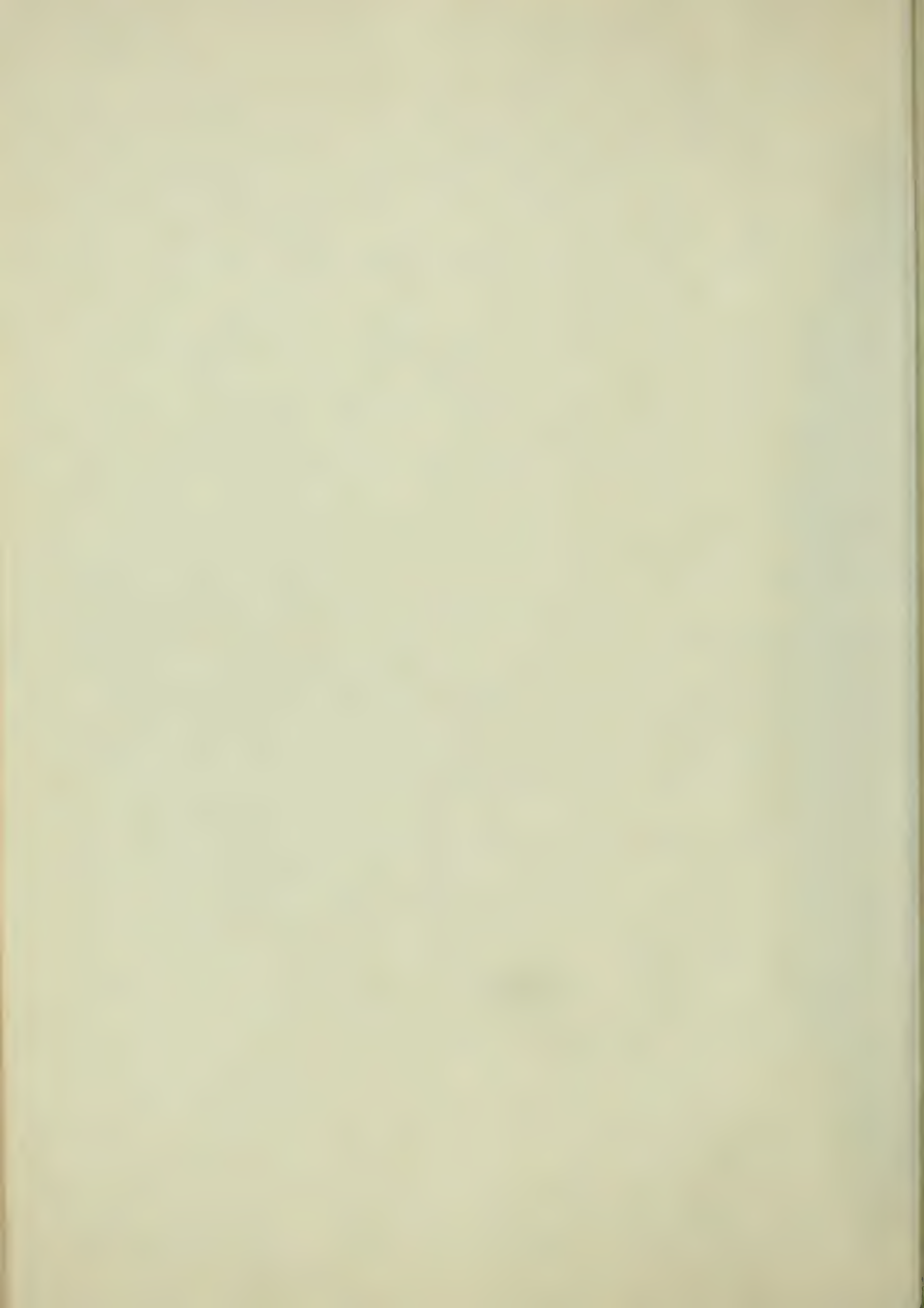
AMERICAN SOCIETY FOR STEEL TREATING will hold its third annual convention and exhibition Sept. 19 to 24 at Indianapolis.

THE NATIONAL EXPOSITION OF CHEMICAL INDUSTRIES (SEVENTH) will be held during the week of Sept. 12 in the Eighth Coast Artillery Armory, New York City.

NEW JERSEY CHEMICAL SOCIETY holds a meeting at Stettens Restaurant, 842 Broad St., Newark, N. J., the second Monday of every month.

SOCIETY OF CHEMICAL INDUSTRY (BRITISH) at the invitation of the Montreal section will hold its annual meeting in Montreal and other Canadian cities during the week of Aug. 29, 1921. Details will be printed in this magazine from time to time.





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Chemical engineering

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